Eye-catching Anaphora

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Eye-catching Anaphora

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door
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geboren op 16 februari 1978 te Amsterdam

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Prof. dr. F. Wijnen

Voor Maartje

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Imagine that you are a young graduate student, with an interest in language comprehension processes. What kind of guidance would you need to obtain your master's degree and to complete a PhD-project in experimental psycholinguistics successfully?

First of all, you need to get inspired, preferably by a talented and well-trained researcher, who shows you some of the do's and don'ts of your future job as an AiO. Second, since your project has some important roots in (syntactic) linguistics, you need somebody to acquaint you with the terminology, frameworks and quirks of this unfamiliar scientific field. Finally, it would be ideal if you could also consult someone with extensive knowledge of both linguistics and psychology, to help you to keep these two ingredients of your project balanced.

> *If you are fortunate enough to have bumped into all of these people, then your name must be Arnout.*

Eric Reuland was my 'syntactic' supervisor, although I should add that he was much more than that. I sincerely doubt whether I will meet another person who will show such a genuine and broad interest in science, people, or just the funny quirks of life.

Frank Wijnen was my 'keep it all together' supervisor. He happens to know a lot about everything and as such was very important for me to… keep it all together.

I have also been extremely fortunate to have Jos van Berkum as a supervisor at the University of Amsterdam. He helped me to obtain my master's degree in Cognitive Psychology and, more importantly, inspired me to pursue a scientific carrier.

What these three guys seem to have in common is that they never give you the impression that they are the professors and you are student. They just discuss matters as if you were a professor too (or as if they were students – pick your favorite).

Of course, in addition to Eric, Frank and Jos there are others who helped me in one way or another. In fact, the list that will follow below cannot possibly be exhaustive. So, to those among you who have been left out – yet are convinced that they should be mentioned – I apologize and, furthermore, I show my appreciation to all these 'outcasts' with one general 'thank you'.

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Of course, I saved the best for last: my family. I'm greatly indebted to my parents Hettie and Maarten. They have always supported me in every imaginable way and, perhaps more importantly, never pushed me into doing something I did not really want to do – and they gave me a lot of money. Furthermore, I wish my 'little' brother Joris all the best with his PhD project – just watch him, he is going to be really big!

You tend to see it in a lot of acknowledgement sections: the author has just written a book of some 300 pages, yet is lost for words when it comes to thanking his or her spouse. Being a (psycho)linguist it is especially difficult to acknowledge that I am one of those unfortunate authors. So, I keep it simple: Lies, you probably know how much I love you, but do you also know that I could not have done this without you?

BUT, although it is certainly not my intention to trivialize the contribution of all those mentioned above, there is actually one very tiny person who inspired me in particular to finish this long endeavor in a reasonable timeframe. The funny thing is that I have only known her for a year-and-half, but apparently that is long enough to completely change your attitude towards a lot of things in life. Maartje, without you I sincerely doubt whether I would ever have finished this dissertation and,

therefore, I dedicate it to you. I hope you will read it someday – probably not ☺.

Chapter 1

Anaphoric dependencies: A window into the architecture of the language system [1]

1.1. Introduction

1.1.1. Linguists, psycholinguists and a virus

For decades or even centuries people have thought and written extensively about the intriguing ability of human beings to use language to, sometimes very effectively, communicate with each other. Just to get an impression of how much language-related information is actually out there, I conducted a quick *Google* search. The results were overwhelming as the string *language* returned a dazzling 686 million hits. To get an idea of how much this really is, *death* will only give you 416 million hits and even *s•x* does not reach the 500 million. However, the romantics among us will be pleased to hear that at least *love* is more important than language. In fact, only *life* itself returned more hits (1270 million!) than the astonishing 1040 million links to articles, songs, books, movies, websites and forums about love. Having said that, most of the information on the internet is of course in a written form and, even worse, you have to enter a word to initiate your search. Thus, in fact you need language to find love, which according to Jean Baudrillard will eventually create a huge problem as he has warned us that "if you say, I love you, then you have already fallen in love with language, which is already a form of break up and infidelity".[2] In other words, language will bring you love, but if you speak about it, the word itself will destroy the love just as a mistress would break up a marriage.

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[1] Eric Reuland (one of the supervisors of this dissertation) published an article under the same title (Reuland, 2003). Kindly enough he allowed me to commit plagiarism and recycle this enlightening title.

[2] The citations in this section were found by surfing the internet. Since the primary sources were not consulted the exact formulation of Baudrillard, Whorf, Wittgenstein, Burroughs and Chomsky may have been slightly different.

The mini experiment described above gives a striking example of how we are completely surrounded by language – and Baudrillard's remark illustrates its potentially destructive power. Obviously, I am aware of the fact that searching the internet and counting the number of hits does not really tell you anything about language. Fundamental questions that keep some of us awake at night like 'how should we define language?' and 'how do people process it?', remain unanswered. On the other hand, simply because almost every human being is constantly producing, processing, or blocking language in one way or another, we do all seem to share some sort of intuition about what language is. For instance, if you asked a stranger in the street to define human language, he or she could easily respond by saying something like "oh that is easy, language is the way people communicate with each other, they talk about the world, share ideas, express inner thoughts, give instructions, make jokes and they can even talk to themselves without actually speaking" (or "get a life" if you pose the question in a major city). This illustrates that people have the idea that language is mainly used to describe the world (to each other) and, furthermore, that there is a close relationship between language and thought. Many philosophers share this general intuition, although they sometimes take the importance of language even a step further. For instance, to quote Benjamin Lee Whorf:

> "Language shapes the way we think, and determines what we can think about."

Thus, according to Whorf language defines our world and not the other way around. The famous Ludwig Wittgenstein framed the same idea in a poetic way by saying:

> "The limits of my language mean the limits of my world."

You may or may not agree with these views, at the very least they illustrate that language is regarded as a very important, and perhaps defining, characteristic of our species. Therefore, dissecting language is crucial if we want to get closer to understanding human behaviour. Before we turn to the contribution of this dissertation to the latter quest I have to mention that some among us are actually very pessimistic about what we will eventually learn about the nature of human language. For instance, according to Jean Baudrillard, 'our language hater', a perfect world is a speechless one because:

> "If everything is perfect, language is useless. This is true for animals. If animals don't speak, it's because everything's perfect for them. If one day they start to speak, it will be because the world has lost a certain sort of perfection."

Or it may even be worse if William S. Burroughs was right when he came to the conclusion that:

> "Language is a virus from outer space."

Thus, at the very best human language is essentially useless and merely reflects a side-effect from a less than perfect world, or in a worst case scenario it should be diagnosed as a disease without a cure.

My view on language in this dissertation is not as exotic or exiting as Baudrillard's or Burroughs'. I have no strong feelings about the usefulness of language and more importantly do not think language is an alien life-form. Although very interesting in their own right, I do not ask myself the questions why human language evolved, whether it is qualitatively different from animal communication and how it shapes our thoughts. I am, however, interested in the rules that make up language and, more specifically, how the human brain processes expressions that are part of this incredibly powerful system.

According to Noam Chomsky – and many others – human language is such a powerful device, because it very effectively combines laws and free creation. Chomsky stated it as follows:

> "Language is a process of free creation; its laws and principles are fixed, but the manner in which the principles of generation are used is free and infinitely varied. Even the interpretation and use of words involves a process of free creation."

Creativity allows us to express basically everything we want. However, to make sure others can comprehend us, we have to follow some basic rules, otherwise there is no way of knowing how specific parts of an expression relate to each other. Thus, paradoxically the power of language emerges due to its flexibility on the one hand and rigidity on the other.

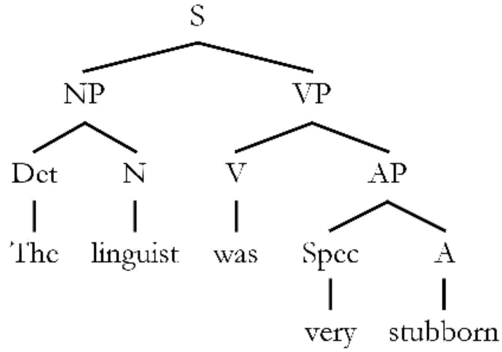
Linguists have set out to discover what rules and principles constitute the fundament of human language. Although they have come a long way, traditionally linguists were not particularly interested in how our brain represents or uses these rules while processing language expressions in real time. This led to a split between linguistics and psycholinguistics in the 1970s. The bad news is that from that day on the gap between them has only got bigger, despite the fact that both have the same goal, namely understanding human language. To an objective observer this may come as a big surprise, to say the least, as it is obvious that both disciplines could benefit substantially from working closely together. Fortunately, the good news is that recent developments point exactly in that direction, that is, linguists are increasingly adopting psycholinguistic methods to put their formal theories to the behavioural (and neuro-imaging) test and psycholinguists are becoming aware of the fact that one cannot discard linguistic theories while exploring language processing in real time. In fact, in a way this dissertation is just one example of the many attempts to re-unite linguistics and psycholinguistics (e.g. Burkhardt, 2005; Grodzinsky & Friederici, 2006; Hauser, Chomsky & Fitch, 2002; Jackendoff, 2002; Runner, Sussman & Tanenhaus, 2006; Sturt, 2003a, 2003b; Vasić, 2006).

1.1.2. Modularity

In the above we briefly touched upon the distinction between linguistics and psycholinguistics. Whereas in the former research mainly focuses on questions regarding language itself (i.e. 'What is the structure? What kinds of computations are necessary and sufficient? Can we find universal principles?'), the latter is mainly occupied with exploring how our brain or mind deals with language comprehension and production 'on the fly' (i.e. while people process it). However, because both disciplines have the same fundamental goal, that is, understanding human language, there are bound to be some important parallels as well, and there are. Most linguists and psycholinguists agree that language is a multi-layered system and we should therefore analyse it accordingly. Although the exact definitions and terminology of the layers differ between researchers – and some even refute the existence of a multilevel system altogether – most of them differentiate between a phonological, lexical, syntactic, semantic and pragmatic or discourse component (from this point onwards I will use the latter two terms interchangeably).

In the present study the focus will be on the latter three components (i.e. the syntactic, semantic and discourse components). To avoid being misconstrued, I will briefly describe my view on the capacity of these different sub-mechanisms of the language system. As illustrated in Figure 1, the syntactic component is a highly specialized computational system, designated to build the (abstract) hierarchical structure of a sentence predominantly on the basis of word category information (cf. e.g. Friederici, 2002; Grodzinsky & Friederici, 2006).

Figure 1. A simple syntactic structure.[3]



In a way, the syntactic component is detached from meaning in the usual sense, that is, it will not represent the meaning of *linguist* being a (stubborn) person obsessed with language. That is not to say that the syntactic component is completely deprived of meaning. The fact that the syntactic component 'knows' that *linguist* is a noun and not a verb, for example, illustrates the idea that syntactic structure is not completely 'meaningless'.

The semantic component encodes the logico-semantic properties of a sentence (and feeds into the inferential system, see Reinhart, 2006, for discussion). The semantic system is also regularly referred to as *logical form* or *LF* (e.g. Frazier & Clifton, 2000; Haegeman, 1994; Heim & Kratzer, 1998) and represents, for example, the logical meaning of quantifiers like *everyone* and *no one* (and their scope). Since quantificational expressions do not denote an individual in the real (or a virtual) world, they cannot have a representation at the discourse level. Thus, in a sentence like *No one likes a stubborn linguist*, the quantifier *no one* does not refer specifically to an individual or group of individuals and, consequently, has no discourse status.

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[3] S = sentence, NP = noun phrase, Det = determiner, N = noun, VP = verb phrase, V = verb, AP = adjective phrase, Spec = specifier, A = adjective.

Finally, the representation of the actual entities and events of a sentence or text is constructed at the discourse level. This component of the language system manages any imaginable non-structural factor of language, including social, environmental and psychological aspects. Hence, in a sense the discourse component is non-linguistic, because its operations are not necessarily encoded in the language (e.g. Reuland, 2005).

Language processing entails the unification of the information supplied by the different language components. Hence, together they must "solve the 'binding problem' for language, or in other words, how speakers and writers, listeners and readers bind single-word information into multiword utterances and complex messages" (Hagoort, 2003a, p. S18). Especially in psycholinguistic literature, a central and hotly debated issue has become how and when the different language components communicate with each other in real time. That is, do they immediately share their information in an interactive fashion, or do they rather behave as autonomous mechanisms that keep their computations to themselves and only influence each other through fixed input-output sequences?

The autonomy-interaction debate really took off after Fodor's influential *Modularity of Mind* (1983). In this monograph Fodor states that language is a modular system and can be recognized by a number of characteristics. For present purposes, the two most important ones are *domain specificity* and *informational encapsulation*. The first refers to the idea that modules only operate on certain kinds of inputs, or in other words, they are specialized. The second reflects the assumption that modules do not have to refer to other cognitive systems in order to operate. Hence, although the output of a module is visible to other modules, the exact algorithms employed by a particular module are not. In that sense, modules are blind, automatic and self sufficient. In the light of our present discussion this entails that the syntactic, semantic and discourse components could be regarded as modules in the traditional sense: they are highly specialized and, furthermore, they operate independently of each other.

I should stress that modularity does not necessarily imply that different psychological systems communicate in a fixed sequential order. Nevertheless, modular or autonomous systems often incorporate an inherent sequence as well. Perhaps the most well-known serial model in the language processing literature is the so-called *Garden Path model* (e.g. Frazier, 1978, 1987; Frazier & Rayner, 1982). This parsing model explicitly states that syntactic principles always take precedence over semantic and pragmatic ones, thereby often misleading or 'garden pathing' readers and listeners, since the initial syntactic interpretation may be incompatible with semantic and pragmatic information. Other investigators, however, have taken a radically different approach by adopting *constrained-based models* (e.g. Arnold, Eisenband, Brown-Schmidt & Trueswell, 2000; MacDonald, Pearlmutter & Seidenberg, 1994; Marslen-Wilson, 1973; Tanenhaus & Trueswell, 1995; Taraban & McClelland, 1988). These competing models have typically assumed some degree of parallelism and, moreover, do not in general distinguish between the first stage of structure-building (i.e. syntax) and later stages in which semantic and discourse information is integrated. Instead, within a constrained-based framework it is assumed that all syntactic, semantic and pragmatic information is evaluated at the same time and, furthermore, that these different sources of information immediately and constantly influence each other. That is, they interact.

1.1.3. Anaphoric dependencies

In this dissertation I will try to make a contribution to the autonomy-interaction and the associated serial-parallel debate by focusing on one of the most striking phenomena of human language. That is, humans have the ability to establish rather complex (linguistic) dependencies and, moreover, are able to construct and process them in matters of only a few hundred milliseconds. Although dependencies come in all sorts and sizes, they have the following in common: some linguistic elements (either overt or covert) depend for their interpretation on other elements found in the same sentence or broader context.

For example, a dependency may occur between dislocated arguments and their so-called traces. A well-known example of dislocation or *movement* is given in (1).

(1) What will the clown eat <t>?[4]

In this sentence *what* is an argument of the predicate *eat*, but it has been moved from its original position (i.e. following *eat*) to the beginning of the sentence to signal a question. Nevertheless, people establish a

[4] The <t> symbol indicates the 'trace' of the original position of the argument *what*.

dependency between the moved element *what* and its trace and therefore 'know' that *what* is an argument of *eat*.

Another type of dependency is illustrated in (2).

(2) The clown eats a sandwich and the acrobat <e> a banana.[5]

In this example the verb *eat* has been deleted from the second part of the sentence (i.e. its syntactic position is silent), yet we have no problems understanding that *the clown* and *acrobat* are both eating. In other words, in order to comprehend a sentence like (2) the reader establishes a dependency between the verb of the first clause and the so-called 'gap' of the second clause, which results in the interpretation that 'the clown eats a sandwich and the acrobat eats a banana'.

A third example in which the human language system has to construct specific dependencies – and the main topic of this dissertation – is during the processing and interpreting of *anaphors*. Similar to the examples above, the most important feature of anaphoric elements is that they cannot be fully interpreted in isolation, but instead depend on other elements in the utterance or text. For instance, in (3) the reflexive *himself* and the pronominal *his* can be interpreted because, in a way, they can be linked back to *the clown*.

(3) *The clown*$_i$ hates *himself*$_i$, because *his*$_i$ jokes are not funny.[6]

In isolation on the other hand, *himself* and *his* would not bear a 'full' meaning. Thus, if an anaphoric dependency is constructed, as the result of the linking process that takes place between an anaphor and its referent, the established dependency gives an otherwise semantically defective word its meaning.

Complex dependencies in general and anaphoric dependencies in particular, present the perfect means to study the blueprint of the human language system, because establishing reference heavily relies on the integration of syntactic, semantic and discourse information. Not surprisingly, over the last decades anaphora have been studied extensively by both linguists and psycholinguists. These different types

[5] The <e> symbol indicates the position of the elided verb or in other words the 'gap'.
[6] Indices are used to indicate the dependency between the anaphoric element and its antecedent.

of research revealed a range of syntactic (both structural and morphological) and pragmatic constraints that affect the reference resolution process. An as yet unresolved issue is, however, when these constraints influence the comprehension process and, furthermore, whether the associated processes are governed fundamentally by one mechanism or by different independent ones. In the remainder of this chapter I will try to illustrate this by presenting a selection of both linguistic and psycholinguistic approaches to anaphora resolution. By doing so, I hope the reader will acknowledge that anaphoric dependencies indeed offer a window into the architecture of the language system.

1.2. Structural constraints: From classical binding to Primitives of Binding

1.2.1. Classical binding approach

One widely held assumption is that structural (i.e. syntactic) factors heavily constrain the reference resolution process. Within the linguistic field the most influential way of describing these structural constraints is via binding theory (Chomsky, 1981). Chomsky's binding theory consists of three principles: Principle A defines constraints on reflexives and reciprocals (e.g. *himself*, *herself*, *each other*), Principle B constrains pronoun resolution (e.g. *he*, *she*, *his*, *her*) and Principle C constrains full referring expressions and proper names (e.g. *the clown*, *Peter*).[7]

According to Principle A, a reflexive or reciprocal can be linked to an antecedent if two requirements are fulfilled. First of all, the antecedent must *c(onstituent)-command* the anaphor. A widely accepted definition of c-command is as follows: phrase α c-commands phrase β if and only if phrase α does not contain phrase β and the first branching node

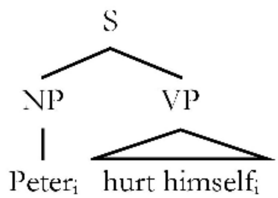
---

[7] Binding Theory (Chomsky, 1981):

I. An anaphor is bound in its governing category (Principle A).
II. A pronominal is free in its governing category (Principle B).
III. An R-expression is free (Principle C).
IV. Governing Category: β is a governing category for α if and only if β is (i) the minimal category containing α, (ii) a governor of α, and (iii) a SUBJECT accessible to α.
V. Binding: α binds β iff α and β are coindexed and α c-commands β, where coindexing requires non-distinctness in features.

dominating phrase α also dominates phrase β (see Reinhart, 1976, 1983 for discussion). For present purposes we could rephrase the above in: phrase α c-commands phrase β if α is a 'sister' of the phrase that contains β. For instance, in Figure 2 the NP *Peter* c-commands its sister, the VP *hurt himself* and equally, the VP c-commands its sister NP. However, note that whereas *Peter* c-commands the different subcomponents of the VP, including the reflexive *himself*, the latter does not c-command *Peter*, since the reflexive is only part of the sister node and not a sister node in itself. That is, *himself* is structurally 'not high enough' in the syntactic tree to c-command *Peter*.

Figure 2. C-command or 'sisterhood'.



The second requirement of Principle A is that the antecedent must be in the local domain of the anaphor, where for present purposes the local domain consists of the minimal clause that contains both the anaphor and its subject (i.e. its antecedent). Hence, Principle A can account for the contrast between example (4), in which the reflexive *himself* can (or in fact must) depend on the antecedent *Peter*, and example (5), in which a connection is prohibited.

(4) *Peter*$_i$ hurt *himself*$_i$.
(5) **Peter*$_i$ said that Mary hurt *himself*$_i$.[8]

Even though in both examples the antecedent *Peter* c-commands the reflexive *himself*, the second requirement of Principle A is violated in (5). In this sentence *Peter* is not within the local domain of the reflexive, since the minimal clause containing the anaphor and its subject is *Mary hurt himself*. So, the antecedent is 'structurally too far' from the reflexive to establish an anaphoric dependency.

---

[8] Stars are used to indicate that a dependency between the anaphoric element and the antecedent yields an ungrammatical structure.

Principle B states that pronouns cannot depend on an antecedent that falls within the domain of the pronoun. In other words, a pronoun must be 'free' in its local domain. As a result, a connection is allowed in example (6), as the antecedent is outside the pronoun's domain, but disallowed in example (7), as the antecedent is within the pronoun's domain.

(6) *Peter*$_i$ said that Mary hurt *him*$_i$.
(7) **Peter*$_i$ hurt *him*$_i$.

Finally, Principle C stipulates that a pronoun cannot c-commands its antecedent. Thus, in example (8) *Peter* is a grammatical antecedent of *he* because the pronoun does not c-command the antecedent. However, the pronoun cannot depend on the subsequent antecedent in example (9) since the former c-commands the latter.

(8) Before *he*$_i$ stood up, *Peter*$_i$ began to sing.
(9) **He*$_i$ said that *Peter*$_i$ hurt Mary.

One important implication of the principles described in classical binding theory is that reflexives and pronouns should appear in a complementary distribution, or put differently, a reflexive cannot appear where a pronoun can appear (i.e. yielding the same interpretation). Although this holds in many contexts, there are some notable exceptions in which there is no sign of complementarity. For instance, in example (10) either a reflexive or pronoun can be used to refer to the intended antecedent, that is, both strings yield a grammatically acceptable structure.

(10) *Peter*$_i$ saw a gun near *himself*$_i$/*him*$_i$.

The natural occurrence of structures like example (10) poses a real problem for binding theory in its classical form. More specifically, it raises the question why in structures like (10) both a reflexive and pronoun can be used and, yet, in structures like example (4) and (7) (repeated as ex. (11) below) the use of a pronoun is prohibited.

(11) *Peter*$_i$ hurt *himself*$_i$/**him*$_i$.

According to Reinhart and Reuland (1993) the critical notion is whether the anaphoric element and antecedent are arguments of the same predicate. If so, only a reflexive can be used to express the anaphoric relation. Consequently, in example (11) the occurrence of a pronominal is ungrammatical, since both the anaphoric element and the antecedent are arguments of the predicate *hurt*.

However, if the critical elements are arguments of different predicates, reflexives and pronouns are often interchangeable. This is for example the case in (10), as the antecedent *Peter* is an argument of the verb *saw*, while the anaphoric element (*himself/him*) is an argument of the preposition *near*. Reflexives used in a manner as in (10) are referred to as *logophors*. Another instantiation of a logophor can be found in structures in which the reflexive is a constituent of a conjoined argument phrase. In example (12) both a reflexive and pronoun can depend on the antecedent *Peter*, since the anaphoric element is not a syntactic argument in itself, but part of the larger argument *Mary and himself*.

(12) *Peter*$_i$ said that the queen invited Mary and *himself*$_i$/*him*$_i$ to tea.

Reinhart and Reuland proposed that a crucial distinction exists between the interpretation of a reflexive as in (11), in which the antecedent and reflexive are coarguments of the same predicate, and reflexives as in (10) and (12), in which they are used logophorically. For the former the anaphoric dependency can be interpreted on syntactic grounds alone. However, for the latter extra-syntactic (i.e. discourse related) information is required to determine the proper referent. Hence, in their proposal, Reinhart and Reuland in fact argue for a modular approach to the interpretation of anaphoric dependencies, that is, depending on the exact nature of an anaphoric dependency either the syntactic or discourse module is accessed for the interpretation of that dependency. In this respect, their view differs fundamentally from classical binding theory in which a (more or less) unified binding system accounts for all types of dependencies between pronouns, reflexives and their antecedents.

1.2.2. Primitives of Binding approach

Building partly on the proposal of Reinhart and Reuland, and partly on concepts of the *minimalist program* (Chomsky, 1995), Reuland (2001) presented the outline for the *Primitives of Binding* framework (henceforth POB). This linguistic model distinguishes between five independent 'low-level' modules for encoding anaphoric dependencies, namely: (i) encoding by intrinsic properties of a verb, (ii) encoding by a reflexive marker, (iii) encoding by a strictly syntactic process, (iv) encoding in the semantic module and (v) encoding in the discourse module.[9] These hypothesized modules and the associated algorithms are discussed in more detail below.

1.2.2.1. Syntactic anaphoric dependencies

Some verbs (e.g. *behave*) never allow an independent interpretation of their object argument. These inherently reflexive verbs always require a reflexive interpretation as is shown by the contrast between example (13) and (14). In these cases a dependency is *lexically encoded* by the intrinsic properties of the verb.

(13) *Peter$_i$* behaved *himself$_i$*.
(14) *Peter behaved the child.

In Dutch such verbs require a special anaphoric expression, *zich* (also referred to as SE or simplex reflexive), in object position:

(15) *Peter$_i$* gedroeg *zich$_i$*.
Peter$_i$ behaved himself$_i$.

Inherent reflexive verbs differ fundamentally from transitive verbs, which often allow both a reflexive and independent interpretation. In order to express the reflexive interpretation in Dutch, a special reflexive form is required, namely *zichzelf*. The SELF-part of this complex reflexive functions as a *reflexive marker* and triggers a syntactic process to transform the transitive verb into a reflexive verb (see ex. (16) and (17)).

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[9] For explanatory purposes, I describe the function of each module in terms of anaphoric dependencies. It should be noted, however, that the POB model in fact dispenses with the idea of having a language component, dedicated to governing the use and resolution of anaphoric elements. Instead, in the POB model each component of the language system includes processes that as a by-product determine whether a particular anaphoric dependency is allowed or not.

(16) Peter verdedigde het kind.
Peter defended the child.
(17) *Peter$_i$* verdedigde *zichzelf$_i$*.
Peter$_i$ defended himself$_i$.

The syntactic module can only link SELF to a verb if it is roughly an argument. Otherwise, syntactic linking is blocked and the logophoric interpretation will take place within the semantic or discourse module (Reinhart & Reuland 1993; Reuland, 2001).

As mentioned above, Dutch inherent reflexive verbs require the semantically and syntactically impoverished SE-reflexive *zich* in object position. However, the anaphoric element *zich* behaves differently in structures like (18) in which the verb *voelde* (i.e. English *felt*) is not marked as reflexive. The antecedent and reflexive are not coarguments, no SELF-form is present to transform the verb into a reflexive verb and a logophoric dependency is also blocked since the use of a pronominal is prohibited (see ex. (19)). Yet, the structure is perfectly grammatical and the only possible value of *zich* is *Peter*. According to Reuland, in these cases *zich* is linked to its antecedent by a process that underlies various kinds of grammatical agreement relations (e.g. subject-verb agreement, case, etc.). That is, in this case the encoding is also *strictly syntactic.*

(18) *Peter$_i$* voelde *zich$_i$* wegglijden.
Peter$_i$ felt himself$_i$ slide away.
(19) **Peter$_i$* voelde *hem$_i$* wegglijden.
**Peter$_i$ felt him$_i$ slide away.*

Even though there are some differences between these first three ways to connect reflexives to their antecedents, the underlying linking mechanism is essentially the same. That is, encoding by intrinsic properties of a verb, encoding by a reflexive marker and encoding by a strictly syntactic process is only possible if A-Chain formation between the reflexive and antecedent is allowed. Without going into further detail, an A-Chain can only be established in the POB framework if the anaphoric element is referentially deficient, which entails it not being fully specified for morphosyntactic features like person, number and gender, collectively referred to as phi-features[10], i.e. in the examples (13), (17) and (18) above, a pronominal like *him* cannot be used to establish a dependency via A-Chain formation, because pronouns are fully specified for person, number and gender. Since the three modules discussed so far all make use of the syntactic A-Chain algorithm, I will from this point onwards refer to them collectively as the syntactic module.

1.2.2.2. Semantic and discourse anaphoric dependencies

Unlike elements such as *zich*, *zichzelf* and *himself*, which in many environments must depend on an antecedent for their interpretation, pronominal elements such as *he* and *she* need not always depend for their interpretation on an antecedent. Furthermore, given the hypothesized nature of syntactic computations (i.e. A-Chain formation), a dependency between a pronominal and an antecedent cannot be encoded by the syntactic system: it would result in a clash between the properties (i.e. phi-features) of the pronoun and antecedent (see Reuland, 2001, for discussion). Consequently, it follows that pronominals are interpreted at a different level, namely at a semantic or discourse level.[11]

The assumption that the human language system has two independent routes for establishing reference between pronominals and

[10] A more formal definition on A-Chains is: (α, β) form a Chain if (i) β's features have been (deleted by and) recovered from α, and (ii) (α, β) meets standard conditions on Chains such as uniformity, c-command, and locality (see Reuland, 2001, for extensive discussion).

[11] The labels used to specify the three levels of representation (i.e. the syntactic, semantic and discourse level) differ slightly from the original terminology of the POB framework. Furthermore, in the psycholinguistic literature the term 'semantics' is often used in a much broader sense than is the case throughout this dissertation (cf. e.g. Sturt, 2003a). To avoid confusion, I included Table I, which illustrates my conception of syntax, semantics and discourse.

Table I. Classification of the syntactic, semantic and discourse module.

<table>
<tr><th>Labels used in dissertation</th><th>Minimalist Program (Chomsky, 1995)</th><th>Reuland (2001)</th><th>Reinhart & Reuland (1993)</th><th>Chomsky (1981)</th><th>Psycholinguistic Literature (e.g. Sturt, 2003a)</th></tr>
<tr><td>Syntactic Module</td><td>Computational System of Human Language (C_{HL})</td><td>C_{HL}</td><td rowspan="2">Syntactic Module</td><td rowspan="2">Principle A, B and C</td><td rowspan="2">Syntactic Constraints</td></tr>
<tr><td>Semantic Module</td><td>Conceptional-Intentional Interface (C-I interface)</td><td>Sem (Logical Syntax)</td></tr>
<tr><td>Discourse Module</td><td>External (System of Thought)</td><td>Discourse Storage</td><td>Discourse Module</td><td>-</td><td>Semantic Constraints</td></tr>
</table>

their antecedents originated from the ideas of Heim (1982; see also Grodzinsky & Reinhart, 1993; Reinhart, 1983; Reuland, 2001; Reuland, 2005). She distinguished two possible representations for a sentence like (20): one in which the pronoun *he* is bound by *the clown* (ex. (20a)) and one in which the value of *he* can be freely chosen from the discourse through coreference (ex. (20b)). If in the latter representation *the clown* is picked as the proper antecedent for the pronoun (i.e. $a = x$) the two derivations have the same interpretation.[12,13]

(20) *The clown$_i$* thinks that *he$_i$* is funny.
   a. The clown λx (x thinks x is funny)
   b. The clown λx (x thinks a is funny) and $a = x$

However, not every structure allows both a bound and coreferential interpretation of a pronoun. To be precise, variable binding is only licensed in structures with a c-commanding antecedent. So, in example

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[12] Readers who are unfamiliar with the concepts of binding and coreference may find the following passages helpful (taken from Reuland, 2005): "Natural language allows different expressions to receive identical values in some actual or virtual world. To take a venerable example, in the world as we know it, English *morning star* and *evening star* both have the planet Venus as their value. That is, both *refer* to Venus. Such expressions are *coreferential*. Coreference may hold on the basis of an empirical fact, as in the Venus case, but also speakers' intentions may suffice to establish coreference. A pronominal such as *he* can be used to refer to any object that is linguistically classified as masculine and singular, as in *John's mother thought he was guilty*. Here, *he* may refer to John but also to some other masculine individual. One may therefore note that coreference is not encoded in the language" (p. 2) and "Coreference is not the only way in which the interpretation of two elements can be related. *No one* in *no one believes he is guilty* does not refer to an individual, hence *a fortiori*, *he* cannot refer to that individual. Under the most salient reading *he* does, nevertheless, depend on *no one* for its interpretation. In this case the dependency is linguistically encoded, and is called *binding*." (p. 2). Hence, whereas binding is classified as a purely linguistic operation, coreference simply reflects the way in which our cognitive apparatus in general (i.e. not confined to the language component) establishes that two 'entities' are one and the same.

[13] Semanticists and logicians use the lambda operator (λ) to indicate that an expression represents a property. So (20a) should be interpreted as follows: there is some clown (x) with the property (thinks that x is funny). Subsequently, replacing (x) with *the clown* immediately yields the interpretation 'the clown thinks that the clown is funny'. In (20b), on the other hand, there is some clown (x) with the property (thinks that a is funny). If we now replace (x) with *the clown* the interpretation 'the clown thinks that a is funny' will emerge. The entity (a) may, however, co-refer with *the clown* (i.e. a = x) giving rise to the same interpretation as in (20a): 'the clown thinks that the clown is funny.'

(21) a binding dependency is not allowed, since the antecedent and pronoun appear in different sentences and, hence, only a coreferential dependency can be constructed.

(21) *The clown*$_i$ is very happy. The bearded woman loves *him*$_i$.

On the other hand, if the antecedent contains a quantifier such as *every* and consequently has no clear discourse status, coreference is ruled out. The latter explains why example (22) is ungrammatical: the language comprehension system simply has no algorithm to connect *him* to *every clown*, since both routes are blocked.

(22) **Every clown*$_i$ is happy. The bearded woman loves *him*$_i$.

This is not the case in (23). Even though a coreferential dependency is out due to the quantifier *every*, variable binding is permitted as the antecedent and pronoun appear in a c-command configuration.

(23) *Every clown*$_i$ thinks that *he*$_i$ is funny.

These observations have been taken as evidence in favor of the claim that different linking mechanisms are at work in example (21) and (23), yet, at first glance, nothing in the final interpretation of sentence (20) provides direct evidence for the psychological reality of this two-route architecture: *he* refers to *the clown* in both. Interestingly, however, the theoretical distinction between bound-variable and coreference interpretations becomes visible in sentences with an elided verb phrase as in (24).

(24) *The acrobat*$_i$ thinks that *he*$_i$ is funny and *the clown*$_j$ does <e> too.

For present purposes a sufficient approximation of the reconstruction process that underlies the interpretation of these so-called VP-ellipses is to assume a *copy-and-paste* operation in which the verb phrase of the first conjunct (i.e. *thinks that he is funny*) is copied into the 'gap' of the second conjunct, resulting in a mental representation resembling example (25).

(25) The acrobat$_i$ thinks that he$_i$ is funny and the clown$_j$ does (*thinks that he*$_{i,j}$ *is funny*) too.

This operation gives rise to ambiguity as the 'reconstructed' pronoun in the gap can either refer to *the acrobat* or *the clown*. In other words, the second conjunct of the sentence can mean that 'the clown thinks that the clown is funny' or, alternatively, that 'the clown thinks that the acrobat is funny'. The former interpretation results from binding between *the clown* and the reconstructed pronoun *his* and is also known as the 'sloppy reading'. The latter, in which the reconstructed pronoun is connected to *the acrobat*, is the coreference interpretation and is also known as the 'strict reading'.

1.2.2.3. Rule-I

Without positing both a semantic and discourse route for pronoun resolution, it seems very hard to explain why structures like VP-ellipses can receive two distinct readings. However, while a dual-route architecture may solve this problem, it also introduces a new potential problem, illustrated in example (26).

(26) **The clown*$_i$ loves *him*$_i$.

In (26) syntactic constraints rule out a variable binding relation between the pronoun and the antecedent, since it would result in a feature clash (or in classical binding terms, it violates Chomsky's Principle B). To obtain a grammatical dependency in cases like (26) we have to use a reflexive like *himself*. But, even if variable binding is blocked, we still have to explain why the availability of a coreferential interpretation does not (systematically) by-pass these syntactic constraints, as they by definition do not apply to the discourse module. A solution for this problem is provided by Rule-I. The original idea was that Rule-I always compares the bound-variable interpretation to the coreference interpretation and opts for the former unless the two potential dependencies yield distinguishable interpretations (Grodzinsky & Reinhart, 1993; Reinhart, 1983).[14] By applying this rule to (26), both variable binding and coreference are ruled out: variable binding is blocked through the grammar and the coreference interpretation, in which *he* refers to *the clown*, is therefore blocked as well because the two interpretations would be indistinguishable.

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[14] A more formal definition of original Rule-I is as follows: α cannot be co-valued with β if the interpretation is indistinguishable from what would be obtained if α binds β.

Yet, on this construal Rule-I does not only bear on ill-formed dependencies like (26), but on all dependencies that have an antecedent in a potential binding position (i.e. a c-commanding position), and a coreference solution that points to that same antecedent. Thus, in well-formed example (20), repeated below as (27), where both variable binding and coreference are possible in principle, the application of Rule-I is predicted as well.

(27) *The clown*$_i$ thinks that *he*$_i$ is funny.

More recently however, Reinhart (2000) has proposed that Rule-I is only relevant if variable binding is blocked and therefore only checks whether coreference is allowed in potentially ungrammatical derivations.[15] According to this version of the rule the parser compares the bound-variable interpretation to the coreference interpretation in structures like (26), but not in structures like (27).

At this point one might wonder why a complicated decision rule like Rule-I, either in the original or revised version, is necessary at all. A more parsimonious account would be that the language processor blocks the coreference route if the grammar has ruled out a variable binding dependency, rather than basing this decision on a costly and on the face of it redundant comparison between two hypothetical derivations. As is well known, however, simply blocking the coreferential interpretation under all circumstances where binding is out would be wrong, because this would incorrectly rule out (28) (from Reinhart, 1983).

(28) I know what Mary and *Bill*$_i$ have in common. Mary adores *him*$_i$ and *Bill*$_i$ adores *him*$_i$ too.

Here, *him* must admit *Bill* as its value, yielding coreference between *Bill* and *him* and, hence, any theory should represent the fact that coreference is allowed in (28), but impossible in (26) (e.g. Reuland, 2001). Now, if we apply Rule-I, it will block both the bound-variable and coreferential interpretation in (26), but it will allow the coreferential interpretation in (28), because in the latter the bound and coreference reading would not

[15] A more formal definition of revised Rule-I is as follows: α cannot be co-valued with β if (i) α is in a potential binding position, yet cannot bind β (due to Principle B), and (ii) the interpretation is indistinguishable from what would be obtained if α binds β.

yield exactly the same interpretation. The variable binding route – if not blocked – would result in an interpretation equivalent to *Bill adores himself* which is about 'self-adoration', yet the coreference interpretation would suggest a slightly different kind of adoration, namely 'Bill-adoration'. Because these two different interpretations emerge, Rule-I correctly allows a coreferential reading even if the variable binding reading is ruled out by the grammar.

To sum up, the POB model presents a comprehensive framework to explain the relatively complex pattern of anaphora use across a large number of languages (i.e. in addition to English and Dutch, Frisian and Icelandic also conform to the POB model). The model consists essentially of three different modules, namely a syntactic, semantic and discourse module. Reflexives like *himself*, *zichzelf* and *zich* are connected to their antecedents in the syntactic module through A-Chain formation. For the interpretation of pronominals like *he* and *she*, on the other hand, two algorithms are available. They are either bound in the semantic module or co-valued in the discourse module. This dual-route architecture for pronominals is needed in order to explain the contrast as observed in examples (20) to (23) and, in addition, provides an explanation for the sloppy-strict ambiguity that emerges in VP-ellipses. However, consequently we also have to assume a rule (i.e. Rule-I) to prevent the discourse route from systematically by-passing structural constraints on anaphoric dependencies.

1.2.3. The POB framework in real time

Thus far, I have discussed the differences between classical binding and the POB model from a purely linguistic point of view and suggested that the modular POB system covers the relevant linguistic data better than the classical binding approach. There is, however, another fundamental difference between both approaches, which gives the POB framework a clear advantage. Namely, Chomsky's binding theory has no direct bearing on the time course of the construction of anaphoric dependencies, that is, it is not stated when the specific constraints on anaphoric processing are applied during real time language comprehension.[16] It is of course possible to incorporate the notion of time ad hoc, as was done for instance by Nicol and Swinney (1989),

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[16] This is not an objection to the classical binding theory, since this account was never intended to describe language processing in real time.

Badecker and Straub (2002) and Sturt (2003a). Nicol and Swinney argued that the binding principles function as an initial filter on subsequent processing, meaning some (ungrammatical) anaphoric interpretations are blocked at all times. Sturt adopted a similar view by assuming a 'defeasible' filter in which the binding principles operate at the very earliest stages of processing, yet can be violated during later processing stages. Badecker and Straub took a very different approach. They stated that the structural binding principles have no privileged status at all, but are evaluated in parallel with semantic and pragmatic constraints.

Within the POB framework there is no need to make such ad hoc assumptions concerning the time course of the construction of anaphoric dependencies. These follow naturally from a general *economy principle* that governs the division of labour between the modules. In the next section I will present a detailed picture of the nature and purpose of the economy principle and, furthermore, address the implications for real time language processing.

1.2.3.1. The economy principle

We can distinguish a number of possible rationales for considering economy as an important organizing principle of the human language system (Reuland, in prep.). Reinhart (1983), for example, introduces the notion economy as a rationale for (original) Rule-I. In a way Rule-I reflects a processing hierarchy stating that binding should always be preferred over coreference unless there is a very good reason to choose the latter option. According to Reinhart this preference for binding results from the more general tendency of the language system to keep working memory demands to a minimum by closing 'open expressions', including pronominals, as soon as possible. Unlike coreferential pronouns, bound pronominals do not require a search through the discourse storage and, hence, variable binding can close an open pronominal expression earlier than coreference. Or in other words, binding reflects a more economical option.

The above implies that semantic computations are *intrinsically* 'cheaper' than discourse computations, simply because the two subcomponents of the language system differ in terms of the size of their 'working space'. That is, the semantic module operates more locally and the degrees of freedom can thus be kept to a minimum. This logic applies to syntactic operations as well. In fact, purely syntactic computations are plausibly even more constrained than semantic computations and, consequently, often categorized as being highly automatized. One of the main characteristics of automatic processes is that they require (virtually) no monitoring while they apply and, hence, this would present a clear rationale for why syntax would be an economical component as well, possibly the most economical subcomponent of the language system.

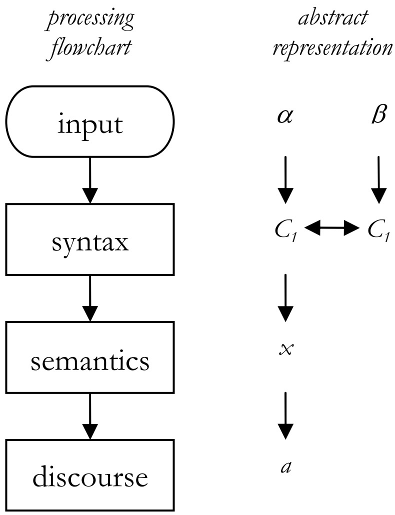
So far, the notion of economy is used to describe the processing costs that emerge within the different subcomponents. However, economy considerations may not only be formulated in terms of processes that occur *within* modules, but plausibly also apply to the processes that occur *between* modules. In fact, the economy principle of the POB model is based on the latter type. As noted previously language processing entails the unification of the information afforded by the different language components. Or to use Hagoort's (2003a) terminology, together they solve the 'binding problem' for language. However, in order to do so, the subcomponents must communicate with each other.

One of the core assumptions of the POB framework is that cross-modular communication comes at a cost. Or as Reuland (in prep.) puts it, economy defined in terms of cross-modular costs "takes human laziness as a rational. If you are doing something, the easiest thing is to just keep doing it". Furthermore, another important feature of the POB model is that the information flow through the three modules is fixed. That is, first the to-be-interpreted anaphoric element enters the syntactic module. After finishing its operations, which includes A-Chain formation, the syntactic module transmits the output to the semantic module. Subsequently, after completing operations like variable binding, the semantic module sends its output to the discourse module in which coreference may occur. On the basis of this sequential architecture and the assumption that cross-modular processes are costly, the model incorporates an economy hierarchy to govern the division of labour between the different subcomponents. This hierarchy is determined by the number of cross-modular steps required to assign reference to an anaphoric element. More specifically, for a syntactic interpretation less cross-modular steps need to be made than for a semantic interpretation. In this sense the syntactic process is more economic than the semantic process. Similarly, for a semantic interpretation less cross-modular steps are required than for a discourse interpretation and hence the former is more economic.

In Figures 3 to 5 the sequential architecture and the economy hierarchy of the POB model are illustrated by three simple examples. For instance, interpreting sentence (29) entails establishing a dependency between the reflexive *himself* and the NP *Peter*.

(29) *Peter*$_i$ defended *himself*$_i$.

Figure 3. A-Chain formation: two cross-modular steps.



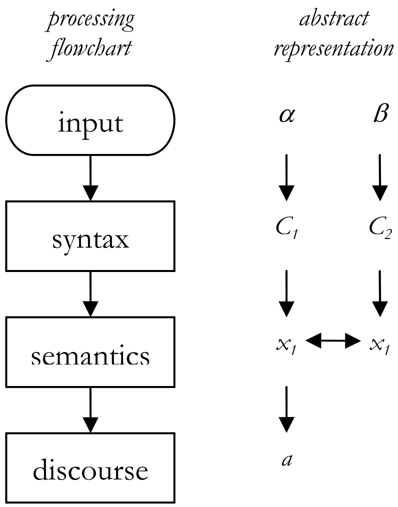
The cheapest way to do so is by means of A-Chain formation, which only requires two cross-modular steps. Let's clarify this. First of all, since *Peter* and *himself* are coarguments of the predicate *defended*, the two elements are immediately linked at the syntactic level. In Figure 3 this is indicated by the fact that both are part of the same syntactic Chain (C_1). This first step, however, does not count as a cross-modular step, since the process occurs *within* the syntactic module. The first genuine cross-modular step is translating the single syntactic Chain into a single object (x) at the semantic level. Note that the distinction between *Peter* and *himself* in the written or spoken input is not visible to the semantic module. This module simply represents the two coarguments as one informational unit. Furthermore, the semantic module cannot recover the distinction between the reflexive and antecedent, that is, it cannot undo the syntactic linking process. So, the next cross-modular step is simply translating the single object (x) into a single discourse value (a), which amounts to two cross-modular steps in total.

Variable binding requires one additional step. Let's illustrate this with example (30) in which the pronoun *he* is bound by *every clown*.

(30) *Every clown*$_i$ thinks that *he*$_i$ is funny.

First of all, since A-Chain formation is not possible, the antecedent and pronominal are transferred from the syntactic to the semantic level as two distinct objects. Thus, this operation in itself already involves two cross-modular steps. At the semantic level variable binding takes place and, as indicated in Figure 4, from this point onwards the antecedent and pronoun are represented as the same object (x_1). In the next step, this single object is translated into a discourse value. As a result, variable binding requires three cross-modular steps in total.

Figure 4. Variable binding: three cross-modular steps.

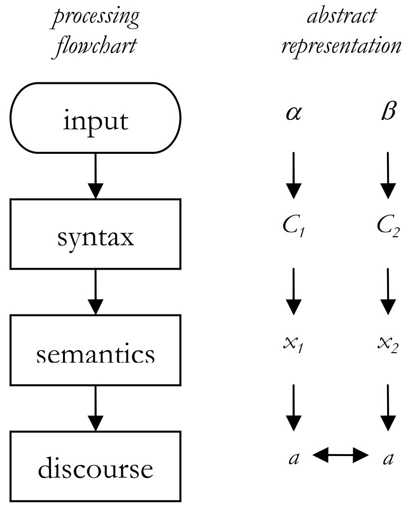


As is shown in Figure 5, coreference is the most expensive process with four cross-modular steps. For instance, if the language comprehension system establishes a dependency between *the clown* and *him* in example (31), the first step is to transfer two different Chains from the syntactic to the semantic module.

(31) *The clown*$_i$ is very happy. The bearded woman loves *him*$_i$.

Moreover, since *the clown* does not c-command the pronoun, the two elements are represented as two distinct objects at the semantic level as well. Consequently, translating these two objects into a discourse value requires another two cross-modular steps, which gives us a total of four cross-modular steps.

Figure 5. Coreference: four cross-modular steps.



The economy hierarchy, based on the number of cross-modular steps (i.e. syntax < semantics < discourse), represents the essence of the POB model. On the one hand it offers a notational device for explaining the rather complex grammaticality patterns of anaphora use across a number of languages and, on the other hand, it allows for specific predictions in terms of real time processing.

To start with its formal function, the economy principle could be interpreted as a linguistic blocking device, similar to the classical Principles A and B, to explain for instance why pronominals cannot be used in a sentence like (29) (i.e. *Peter*$_i$ *defended himself*$_i$) to establish reference, yet are mandatory in sentences like (30) (i.e. *Every clown*$_i$ *thinks that he*$_i$ *is funny)*. Its explanatory power follows from the hypothesis that the language system always opts for the most economical anaphoric dependency available and, furthermore, that the more expensive dependencies – in terms of the number of cross-modular steps – are blocked. To illustrate this, in (29) the cheapest way in which the parser can establish a dependency is via A-Chain formation in the syntactic module. Consequently, the more expensive semantic and discourse routes are blocked, which explains why the use of a pronominal like *him* is prohibited. In sentence (30), on the other hand, A-Chain formation is not possible and the semantic route presents the cheapest way to establish a dependency, which explains why the use of a pronominal yields a grammatical structure.

In this dissertation, however, the term economy will regularly be interpreted in the more literal sense. That is, since one of the main goals is to evaluate whether the POB model could be implemented as an online model for anaphora resolution, I am particularly interested in the actual costs of establishing reference within the different modules. More specifically, if the economy principle is not only relevant from a purely linguistic point of view, but also psychologically valid, it predicts the following for online language processing:

1. The construction of syntactic anaphoric dependencies requires less effort than the construction of semantic anaphoric dependencies.
2. The construction of semantic anaphoric dependencies requires less effort than the construction of discourse anaphoric dependencies.
3. If a pronominal is ambiguous between a bound-variable (i.e. semantic) or coreferential (i.e. discourse) interpretation, the former is (initially) preferred, since it reflects the most economical option.

In the next two chapters we will zoom in on these predictions and I will present the results of a number of eye-tracking experiments which, as the reader will see, in general conform to the POB model. Note, however, that the predictions are all based on structural principles like coargumenthood (prediction 1) and c-command (prediction 2 and 3). Furthermore, recall that establishing a dependency between an anaphoric element and its antecedent is not always determined by sentential structure alone, but often requires the integration of discourse information as well. More specifically, pronominal dependencies in particular are largely constrained by discourse factors. Thus, since the ultimate goal is to present a model with the power to elucidate every aspect of real time anaphora comprehension, the 'full story' should also include *how* and *when* discourse information enters the resolution process. To illustrate this issue further, the next section presents an overview of experimental studies that have examined the influence of a range of discourse factors and, furthermore, includes a discussion on how these findings may fit into the POB model.

1.3. Discourse constraints: The accessibility of antecedents

The modularity assumption of the POB model implies that pragmatic (i.e. discourse) cues can only influence the processing mechanism of the discourse module, yet, the model in its present form does not provide a detailed description of the nature of this component. That is, whereas the algorithms of the syntactic and semantic module (i.e. A-Chain formation and variable binding respectively) are clearly defined in terms of coargumenthood and c-command, the pragmatic constraints on the discourse algorithm (i.e. coreference) remain rather underdetermined.

Throughout this dissertation I will frequently make use of the concept of *accessibility* to explore these non-structural constraints on coreference (cf. Reuland, 2001). In the pronoun resolution literature the term accessibility often functions as a metaphor to indicate the relative importance of a potential antecedent: whereas story characters with a leading role are highly accessible, story characters with a supporting role are less accessible.[17] In fact, Sanders and Gernsbacher (2004) stated that studies on accessibility reflect one of the most important challenges at the intersection of linguistics and psycholinguistics. Linguists have shown how the use of referential expressions shows a systematic pattern: longer linguistic forms, such as full lexical NPs, are preferred when antecedents are relatively low in accessibility, and shorter forms, like pronominals, are preferred when antecedents are highly accessible. Along these lines, a particular comprehensive framework was put forward by Ariel (e.g. 2001, 2004). In her *Accessibility Theory* Ariel suggested that the availability of a referent is determined by a number of factors. Among them are (i) distance (between the antecedent and the anaphor), (ii) competition (from other potential antecedents), (iii) saliency and (iv) unity (i.e. whether the anaphor and antecedent are in the same textual 'unit'). Crucial in her theoretical account is the introduction of a graded scale of low to high accessibility markers. Full names like *Eric Reuland* or *Frank Wijnen*, for example, reflect low accessibility markers and are primarily used to introduce or reactivate a remote discourse

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[17] Many labels have been proposed to capture accessibility, such as *topicality*, *focus of attention* and *activation* (see Arnold, 1998, for discussion), but – over generalizing a little bit – they all seem to refer to more or less the same phenomenon: in general pronouns tend to refer to entities that play a prominent role in the discourse.

entity. Alternatively, 'reduced' linguistic forms like pronominals are high accessibility markers and, consequently, used to refer to entities that are already highly activated.

The above illustrates that, at least from a linguistic point of view, accessibility and pronoun use are closely related. More interesting for our present discussion is, however, that many experimental studies suggest that constraints on accessibility, like distance and competition, have an effect on real time pronoun comprehension as well, i.e. in terms of the POB model they modulate both the outcome and pace of the coreference algorithm. In fact, psycholinguistic research has revealed a number of additional accessibility constraints such as first mention, subjecthood, parallelism and implicit causality (see Arnold, 1998, or Garnham, 2001, for an overview). These constraints have in common that they all seem to influence the activation level of potential antecedents and, as a result, affect the ease with which a subsequent pronominal is connected to one of those antecedents, for example, because highly activated antecedents require less 'searching' in the discourse storage. Below, I will provide a more detailed discussion on the different constraints on antecedent accessibility.

Distance

A number of studies suggest that the *distance* between the antecedent and pronominal affects the speed of the pronoun resolution process. For instance, already some thirty years ago Clark and Sengul (1979) demonstrated that pronouns were read more quickly if their antecedents were in the previous clause than in more distant clauses (see also Ehrlich, 1983; Ehrlich & Rayner, 1983). More recently, Streb, Hennighausen and Rösler (2004) reported similar results in an Event-Related Potential (ERP) study. Pronouns referring to distant antecedents elicited a larger negative deflection (i.e. a more pronounced N400, see Kutas & Van Petten, 1994, for review) than pronouns referring to antecedents in their immediate vicinity, which suggests a higher processing load for the former. Taken together, these results may be taken to suggest that the activation of the mental representation of a distant entity declines and, hence, becomes less accessible over time. However, according to Clark and Sengul the decay of activation does not proceed in a linear fashion, since they found no differences for antecedents two or three clauses back.

First mention and subjecthood
Another factor that may influence the activation level of potential antecedents is order of mention. For instance, Gernsbacher and Hargreaves (1988, 1992) report a *first mention* advantage regardless of the syntactic and semantic role of the antecedent. Another factor, closely related with first mention, is *subjecthood*. A number of studies have shown that pronouns are preferably connected to antecedents in subject position (e.g. Garnham, Traxler, Oakhill & Gernsbacher, 1996; MacDonald & MacWhinney, 1995; Stevenson, Crawley & Kleinman, 1994). In fact, since most studies have been conducted in English, the first mention effect is often hard to distinguish from the preference of subjecthood, since they often overlap: subjects tend to be mentioned earlier than other arguments.

Parallelism
A fourth factor (categorized as a stylistic factor by Garnham, 2001) is *parallelism*. The parallel function strategy refers to the preference of readers and listeners to connect a pronoun in subject position to an antecedent in subject position and, similarly, a pronoun in object position to an antecedent in object position. For instance, in the short discourse given in (32) (taken from Arnold, 1998) the first pronoun of the second sentence preferably takes *Celia* as its antecedent and the second pronoun is most likely connected to *Sharon*.

(32) *Celia*$_i$ hugged *Sharon*$_j$ at the train station.
She$_i$ asked *her*$_j$ how the trip was.

In their review of the literature both Arnold (1998) and Garnham (2001) mention that the earlier studies on parallelism (e.g. Corbett & Chang, 1983; Crawley, Stevenson & Kleinman, 1990; Grober, Beardsley & Caramazza, 1978; Sheldon, 1974) could not distinguish between a preference for parallel function and a preference for subjecthood, since the former was only demonstrated with pronouns in subject position. However, Smyth and Chambers (1998) controlled for this potential confound and showed parallelism effects for both subject-subject and object-object dependencies. Thus, it appears that parallelism is indeed a relevant factor for pronoun resolution.

Implicit causality

Another constraint that has the potential to influence the accessibility of antecedents for a later pronoun is termed *implicit causality*. Implicit causality is a property of some interpersonal verbs in which one or the other of the verb's arguments is implicated as the underlying cause of the action or attitude (Au, 1986; Brown & Fish, 1983; Garvey & Caramazza, 1974; Garvey, Caramazza, & Yates, 1975; Greene & McKoon, 1995; Long & De Ley, 2000; Stewart, Pickering & Sanford, 2000). For example, in a 'cloze' task implicit causality affects the way in which participants complete sentences like *David apologized to Linda because*__. They normally ascribe the underlying cause to the referent of the subject NP and continue the sentence by providing some information about *David* (e.g. *he had actually been behaving rather badly*). The opposite occurs with a sentence such as *David praised Linda because*__, which is more likely to be continued with information concerning the object NP *Linda* (e.g. *she had been able to complete the difficult assignment with very little help*). Thus, in a canonical sentence order some interpersonal verbs provide language users with implicit information about the likely cause of a particular event or situation and as such people are biased towards either the subject or object of the main clause.

Since the original work of Caramazza, Grober, Garvey and Yates (1977), numerous studies have shown that the implicit causality constraint is not only a relevant factor during offline tasks, but affects language processing in real time as well (e.g. Garnham *et al.*, 1996; Greene & McKoon, 1995; Long & De Ley, 2000; MacDonald & MacWhinney, 1995; Stewart *et al.*, 2000). More specifically, one consistent finding is that if the pronoun in the subordinate clause goes *against* the bias of the verb, as in example (33) below, people need more time to read the subordinate clause. This suggests that implicit causality influences antecedent accessibility and, in fact, it has been claimed that the implicit causality bias may reverse the general tendency of the parser to connect a pronoun to the first mentioned antecedent or the antecedent in subject position (e.g. MacDonald & MacWhinney, 1995).

(33) *David*$_i$ praised <u>Linda</u> because *he*$_i$ had done well.

In sum, many structural and discourse factors affect the processes underlying the construction of anaphoric dependencies. The POB approach describes first and foremost the former type of constraints. On the basis of a range of linguistic facts, observed across a number of languages, the model presumes an architecture consisting of three components: a syntactic, semantic and discourse module. Each module makes use of its own designated algorithm. A-Chain formation is performed within the syntactic module and is specialized in establishing dependencies between coargument reflexives and their antecedents. Alternatively, pronouns and logophors depend on variable binding or coreference for their interpretation. Variable binding takes place in the semantic module and is only possible if the antecedent c-commands the anaphoric element. However, we also observed that whereas both binding and A-Chain formation are clearly defined within the POB model, the nature of coreference remains less clear. As a working hypothesis I therefore proposed that the outcome and speed of the coreference process depends on the accessibility levels of the potential antecedents, i.e. the processor preferably connects a coreferential pronominal to a highly accessible antecedent.[18] Accessibility in turn is modulated by a range of discourse factors, such as order of mention, subjecthood, distance, parallelism and implicit causality. Hence, bearing these assumptions in mind, studying the effects of accessibility cues on pronoun resolution may offer insight into the properties of the discourse module, or more specifically, into its designated coreference algorithm.

1.4. Experimental methodology

At this point I hope the reader recognizes that anaphora resolution entails the integration of both structural and discourse information. More specifically, even though the processes underlying the resolution of reflexives, bound-variable pronouns and coreferential pronouns are functionally similar (i.e. their outcome is a dependency between an anaphoric element and its antecedent), the hypothetical mechanisms differ substantially. As such, anaphora present the perfect means to study the architecture of the language system. The next question then becomes: how do we *measure* the influence of sentential structure and discourse accessibility on real time anaphora resolution?

This section briefly introduces the self-paced reading and eye-tracking technique, the online methodologies employed in the subsequent chapters. Even though there are some notable differences between these two methodologies, the dependent measures are essentially the same.

[18] Reuland (2001) also briefly addresses this issue (see p. 446).

That is, both allow the researcher to present sentences or short discourses on a computer screen and measure *reading times* for the individual words or, alternatively, for larger regions of interest. From a psycholinguistic point of view, reading times are very informative, since they allow inferences about the underlying cognitive processes. Of course, it is implicitly assumed that cognitive processes, or more specifically, language comprehension processes, indeed affect reading times. In general, research on reading times is therefore based on the following logic: if reading times for a particular word/region increase in comparison to the same or minimally different word/region in some other (control) condition, the language comprehension system apparently experiences some processing difficulties in the former. Then, depending on one's theory of language comprehension such an increase in processing costs is either expected or not. Hence, in light of our discussion on anaphora resolution, the measurement of reading times presents a very useful tool to evaluate the POB model and to examine the influence of accessibility on anaphora comprehension. That is, the POB model predicts measurable processing differences and therefore significant reading time differences for the construction of syntactic, semantic and discourse anaphoric dependencies. Furthermore, the accessibility of potential antecedents should also influence the processing costs of a subsequent pronoun. More specifically, linking a pronoun to a highly accessible antecedent is relatively easy for the processor (e.g. because the 'search time' can be kept to a minimum) and should elicit shorter reading times than the linking process between a pronoun and an antecedent with a lower activation level.

In the remainder of this section, I will present a short overview of the self-paced reading and eye-tracking methodology, and discuss the major advantages and disadvantages of both. However, for more comprehensive reviews the interested reader is referred to Rayner (1998), Garnham (2001), Boland (2004) and Mitchell (2004).

1.4.1. Self-paced reading

In a typical self-paced reading experiment, participants read a text on a computer screen by pressing a button, on for instance a keyboard, to progress through that text at their own pace. Each time the participant presses the button, a new part of the text becomes visible. Since the computer records each press, the researcher can calculate the interval between two presses and, hence, obtain a reading time for the newly displayed text.

It is entirely up to the experimenter to decide whether the new text is a word, a phrase, a clause or even a complete sentence. Another choice to make is whether the text is presented in a cumulative or non-cumulative fashion. In the former the new part of the text is added to the previous parts. That is, the previous sections of the text remain visible until the participant has read the entire text. However, this introduces the potential problem that readers try to simplify the task and approach a more natural way of reading by pressing the button a number of times to visualize a larger portion of the text. If a reader resorts to this strategy, the intervals between two presses do not necessarily reflect the processing time of the newly displayed text and the data may be very hard to interpret. To avoid this potential problem the experimenter may decide to present the text in a non-cumulative manner. In this case a button press replaces the text already on screen. The most elegant way of doing this, is by adopting the so-called *moving window* paradigm, in which the new portion of text appears at the same position it would occupy if the entire text was present. The area of the screen outside the moving window may either be blank, or it may show its overall sentential and formatting layout (including punctuation), by replacing every letter of the non-visible words by hyphens or underscores.

The main advantage of the self-paced reading technique is that it is easy to set up and analyze. Moreover, self-paced reading is relatively inexpensive since no specific computer hardware is required: a simple PC will do. The latter may explain why the self-paced reading methodology, or 'the poor man's eye tracker', has been very popular over the last decades and has led to some important advances in language comprehension and anaphora resolution research.

However, as any experimental technique, self-paced reading has disadvantages as well. First of all, self-paced reading is of course somewhat unnatural, since readers normally do not press a button while reading a text. So, the nature of the task may somehow interfere with normal reading processes. Furthermore, the self-paced reading technique, especially the moving window version, is not sensitive enough to pick up all the different strategies people may follow in order to solve a processing problem. Namely, when confronted with a problem, readers in general pursue one out of three strategies: (i) they decide to pause at the location of the problem, (ii) they regress to earlier parts and, hence, overtly re-analyze their current interpretation, or (iii) they anticipate that the mental inconsistency will be resolved by new information in the sentence or discourse, and simply keep on reading (e.g. Liversedge, Paterson & Pickering, 1998). Obviously, the moving window paradigm cannot be used to record the second strategy, that is, the strategy in which readers regress to earlier sections. Recall that in a moving window design previous parts of the text disappear with every press on the button and as a result there is simply nothing to regress to. Since regressive eye movements are very common in everyday reading, the moving window paradigm seems to be particularly vulnerable to the possibility that readers resort to atypical reading strategies. More specifically, Garnham (2001) argues that whereas in normal reading people have the choice of using short-term memory or looking back to resolve reading difficulties, they are forced to rely solely on memory in the moving window paradigm.

A further problem of self-paced reading is that participants tend to get into a pressing rhythm. In particular when the text is presented in very small portions, for instance in a word-by-word fashion, people can get into a routine of tapping the button at more or less fixed intervals, which may mask or at least delay the effects of a processing difficulty. The term *spillover* is used to refer to the latter phenomenon in which the processing consequences of a critical word or region become visible only one or a couple of words downstream in the sentence. In that sense the temporal resolution of self-paced reading is relatively low and, hence, if one addresses hypotheses which require a very precise estimate of where in a sentence an effect emerges, it may be better to resort to more fine-grained techniques such as eye tracking.

1.4.2. Eye tracking

In a typical eye-tracking experiment participants read a sentence or text presented on a computer screen while the eye-tracking device monitors where the eyes are looking relative to the head. To reduce noise, either the head has to be restrained by using a forehead rest and bite bar, or alternatively, the tracking device must have the ability to compensate for head movements.[19] Especially when the experimenter uses the latter type of eye tracker, an advantage over self-paced reading is that, in addition to obtaining a higher temporal resolution, participants approach a more normal way of reading because the experimenter does not have to chop

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[19] I used a so-called *head-mounted eye tracker*, which has the latter ability.

up a text into different parts in order to measure separate reading times.[20] In fact, since participants are allowed to progress or regress freely through the text, the experimenter can extract much more information than simple (first-pass) reading times. However, before I discuss the measures commonly used in eye-tracking studies, some basic facts about reading are presented (see Rayner, 1998, for an excellent overview).

First of all, while reading a text people do not move their eyes in a 'smooth' continuous manner, but rather fixate a particular word and than 'jump' to another word. In general, the duration of a fixation is between the 200 and 300 milliseconds, but is, however, heavily influenced by a word's frequency, length, predictability and ease of integration. Furthermore, a jump or *saccade* usually covers 7 to 9 letter spaces, which means that short words are often skipped. Moreover, readers tend to skip words that are highly predictable or very frequent as well. The latter certainly does not mean readers do not process, short, frequent and predictable words, but it illustrates that words are also processed parafoveally. That is, a word may receive the reader's attention, without being fixated. In fact, the *perceptual span* of readers while fixating a word is remarkable. It covers 3-4 letters to the left of the fixation site and even 14-15 letters to the right. The asymmetrical nature of the perceptual span is most likely caused by the fact that we tend to read from left to right. For instance, native readers of the Hebrew language, which is read from right to left, appear to have a reversed asymmetrical span (Pollatsek, Bolozky, Well & Rayner, 1981). That is, they process more information on the left of a fixation location.

1.4.2.1. Different reading time measures

As mentioned previously, the eye-tracking methodology allows the researcher to monitor the complete reading pattern of a participant, including regressive eye movements, which enables him or her to extract different reading time measures. The reading time measures most commonly reported in the literature are first fixation duration, first gaze duration, regression path duration, total reading time and second-pass reading time. Figure 6 illustrates how these different measures are computed. The *first fixation duration* reflects the duration of the very first fixation on a word. *First gaze durations* (also referred to as first-pass

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[20] Moreover, shifts of attention are not naturally linked to manual responses, whereas they are to changes of gaze direction.

reading time, for instance by Rayner, 1998) is the total reading time of a word or region before the reader either moves on, or looks back into the text. *Regression path durations* (also referred to as total-pass reading time by Kennedy, Murray, Jennings & Reid, 1989; go-past reading time by Clifton, Bock & Raddo, 2000; and cumulative region reading time by Mitchell, Brysbaert, Grondelaers & Swanepoel, 2000) are the sum of fixation durations from the time when the reader enters a region, to the time when the reader enters the following region. This means that if the reader looks back after reading a particular region (i.e. the reader makes a regression such as fixation nr. 5 in Figure 6), the regression path time includes all fixation durations of this regression. In addition to these so-called *first-pass* measures, eye-tracking also allows the computation of second-pass and total reading times. *Second-pass reading time* reflects the sum of the re-fixations made on a region after the region has been exited either to the left or right. *Total reading time* is the sum of all fixations on a particular region. In addition to these well-known eye-tracking measures I will frequently report *total first gaze durations*. As illustrated in Figure 6 this measure is calculated by adding all fixation durations in a region before the region is left in a forward direction. However, note that the measure differs from the regression path measure, since the fixation durations during a regression are left out of the equation. As a final point, eye-tracking data allows the researcher to compute all sorts of probabilities. For instance, the probability of a regression out of a region has been reported by many authors, since a high percentage of regressive eye movements may indicate the reader is experiencing some processing difficulty within that region.

So, we can extract a lot of measures out of the raw eye-tracking data, but what does it all mean, that is, how should we interpret these different, yet related, reading times and probabilities? In order to fully appreciate this discussion, some fundamental aspects of the relationship between eye-movement behavior and language processing should be addressed. Intuitively, linking eye movements to cognitive processes like reading is relatively straightforward: reading involves visual attention, and visual attention requires fixation, hence, fixation durations are tightly coupled with language processes. However, as it turns out, the relationship between eye movement and the human mind is by no means a simple one.

Figure 6. Computation of different reading time measures in eye-tracking studies.

```
David  praised  Linda  because  he
  1      2 5   3 4 6 9  7  10    8
```

First fixation:	duration of fixation 3
First gaze:	duration of fixation 3 and 4
Total first gaze:	duration of fixation 3, 4 and 6
Regression path:	duration of fixation 3, 4, 5 and 6
Second-pass:	duration of fixation 6 and 9
Total reading:	duration of fixation 3, 4, 6 and 9

Note: The numbers below the sentence '*David praised Linda…*' represent hypothetical fixations. Thus, the first fixation is on *David*, the second on *praised*, the third on *Linda* and so on. The different measures are computed for the word *Linda*

1.4.2.2. Linking eye-movement behavior to the human mind

Almost three decades ago, Just and Carpenter (1980) unleashed the discussion on the eye-mind linking assumptions by proposing two of them. First of all, they stated that (i) all comprehension processes on a word start as soon as the word is viewed (immediacy assumption) and (ii) that readers remain fixating the word until it is completely integrated (eye-mind assumption). That is, they argued that all processes, such as word recognition, syntactic parsing, semantic integration and referential processing, are completed before the reader moves on to the next word. However, in particular the latter assumption suffers from at least two problems. First, certainly not every word is fixated: short, highly frequent and predictable words are often processed parafoveally (i.e. from 'the corner of our eye'). Hence, if a word is skipped, readers obviously do not maintain their fixation on that word until it is fully integrated. Second, although it would make our life, being researchers, much easier if we lived in a neatly arranged world, an inconvenient truth is that our world is a real mess. More in line with the present discussion, the human language system does not always fully process a particular word before moving on. As a result, in the real world the processing of a word may, and often will, proceed while the reader is fixating words more downstream in the sentence, which complicates the linking of cause and effect (see Van Berkum, 2004, for further discussion).

The latter implies that not only self-paced reading, but eye-tracking suffers from spillover effects as well. However, note that spillover in this context may have a much deeper cause than the *task-induced spillover* of self-paced reading. To avoid confusion, I therefore coin the term *cognitive spillover* to refer to the observation that the processing consequences of a reading problem are not limited to the word itself but affect the processing of later words as well. Interestingly, cognitive spillover seems to be a genuine characteristic of the human brain and therefore not causally related to the eye-tracking technique, since event-related potential (ERP) research clearly shows that the processing consequences of for instance referential problems can last until over a second after pronoun onset, that is, well beyond the average time that people look at such a word (Van Berkum, Zwitserlood, Bastiaansen, Brown & Hagoort, 2004).

The above suggests the initial eye-mind assumption of Just and Carpenter cannot be correct. Therefore, Boland (2004) made an adjustment by suggesting that the eyes do not leave a word until it has been *structurally* integrated. Hence, in her proposal lexical access and initial syntactic processing is completed before a reader moves on (or looks back) in the text, yet, solving problems concerning semantic and discourse integration may be postponed and affect reading times later on. I should emphasize that the latter does not necessarily imply that only fixations on later words are affected by semantic and discourse integration problems, but that, since a reader may decide to look back, the processing problems are possibly reflected by more or longer re-fixations on previous parts of the text as well.

Boland's revised version of the eye-mind assumption is partly based on the observation that the calculation of different eye-tracking measures may result in two different types of evidence, namely *converging* and *diverging* evidence. In the former the overall pattern of the different dependent measures is roughly the same and as such presents a coherent set of results. However, Boland argues that in some cases one could actually learn more about the underlying cognitive events if the different dependent measures present diverging evidence. More specifically, her reduced eye-mind assumption allows for the intriguing possibility that the different eye-tracking measures are sensitive to different subparts of the language comprehension process. Since a reader keeps fixating a word until it is structurally integrated, first fixation and first gaze durations may be highly suited to answer questions on lexical access and initial structure building. By contrast, regression path, total first gaze and second-pass durations may be more appropriate to study issues on pragmatic integration and other higher-level processes. Of course, whether the different dependent measures can be linked to specific cognitive events is an empirical question in itself, and diverging evidence should therefore be interpreted with caution at all times. Nevertheless, the potential advantages of Boland's framework are evident and may allow the eye-tracking methodology to mirror, or at least approach, the advantages of methodologies like ERP research, which has been proven to be a very useful tool to study the different (sub)components of the language comprehension system (e.g. Van Berkum, 2004).

To conclude, self-paced reading and eye tracking are very useful methodologies to study real time anaphora resolution and especially the latter presents a very detailed picture of *when* particular processing events disturb (or speed up) comprehension. Furthermore, since eye-tracking data allows the extraction of different dependent measures, which may be sensitive to specific components of the language system, it could also answer questions on *what* is happening. However, I reemphasize that the latter application of the eye-tracking methodology is still highly controversial and, therefore, throughout this dissertation I will connect the different eye-tracking measures only occasionally – and always tentatively – to specific syntactic, semantic or discourse processes.

1.5. Main research questions and a quick preview

In this chapter I argued that real time anaphora resolution entails the integration of both structural and discourse information (e.g. constraints on accessibility) and, furthermore, that reading time studies may be very useful to study when and how these different sources of information enter the language comprehension process. Since the influence of both structural and accessibility constraints are addressed in this dissertation, one could divide it into roughly two parts. In the first part (i.e. Chapter 2, 3 & 4), I will focus on the effects of structure by evaluating whether the POB model is not only a comprehensive linguistic framework, but can be implemented as an online (i.e. psycholinguistic) model on anaphora resolution as well. In the second part (i.e. Chapter 5), I will address how accessibility may affect pronoun resolution by focusing on a particularly interesting and hotly debated accessibility constraint: *implicit causality*.

1.5.1. Part 1: Evaluating the POB model

As discussed and illustrated in Paragraph 1.2.2 and 1.2.3 one should distinguish three core features of the POB model, namely modularity, sequentiality and economy. First of all, anaphora resolution is thought to occur within three autonomous modules, that is, within the syntactic, semantic and discourse module. In addition to the modular architecture, the POB model also incorporates an inherent sequentiality. Since discourse representations are built upon semantic representations and the latter are in turn built upon syntactic representations, anaphora resolution entails three distinct phases. In a first syntactic phase reflexives are interpreted through A-Chain formation. In the second phase the output of the syntactic module is transmitted to the semantic module in which variable binding takes place and in a third phase the output of the semantic module enters the discourse module in which pronominals can be interpreted through coreference. The third assumption of the POB framework is that the processing costs required to establish referential dependencies, increase as a function of how many cross-modular steps have to be made. As a result the differences between syntactic, semantic and discourse dependencies are also captured in an economy hierarchy. According to this hierarchy syntactic dependencies are cheaper than semantic dependencies, which in turn are cheaper than discourse dependencies.

Since the economy principle forms the heart of the POB model, the focus throughout this dissertation will be on the examination of this core feature. In Paragraph 1.2.3.1, I mentioned three ways in which the economy principle should affect anaphora resolution in real time. These three predictions are repeated below:

1. The construction of syntactic anaphoric dependencies requires less effort than the construction of semantic and discourse anaphoric dependencies.
2. The construction of semantic anaphoric dependencies requires less effort than the construction of discourse anaphoric dependencies.
3. If a pronominal is ambiguous between a semantic or discourse interpretation, the former is (initially) preferred, since it reflects the most economical option.

In Chapter 2, the first prediction will be tested. More specifically, I will present the results of an eye-tracking experiment in which a comparison is made between the online resolution processes of the Dutch anaphoric element *zich* in two different structures. In one condition *zich* constitutes a coargument reflexive and according to the POB model can only be resolved in the syntactic module through A-Chain formation. In the other condition *zich* behaves as a logophor and should be interpreted extra-syntactically, either through variable binding or coreference. Hence, by presenting *zich* in these different situations and measuring the associated reading times, we have the opportunity to examine whether syntactic anaphoric dependencies are indeed cheaper to construct than semantic and discourse anaphoric dependencies.

In Chapter 3 we will zoom in on the distinction between the semantic and discourse component by testing the second and third prediction, again through use of the eye-tracking methodology. Prediction 2 is examined by comparing the resolution process of unambiguous pronominals that can only be resolved semantically, to unambiguous pronominals that can only be resolved in the discourse module. Furthermore, in order to test prediction 3 short discourses will be presented in which the interpretation of the critical pronominal is ambiguous between a semantic and discourse interpretation.

In Chapter 4, I will present my final assessment on whether the POB model could be implemented as an online model on anaphora resolution. However, in that chapter the discussion is not centred exclusively around the economy principle, which is more or less the case in the two preceding chapters, instead I attempt to present a more comprehensive overview by also discussing online studies on modularity and sequentiality – the two other core features of the POB model. I will conclude Chapter 4 by comparing the online version of the POB model to a number of other proposals on anaphora resolution in real time and elucidate why at present the POB model should be preferred.

1.5.2. Part 2: Studies on accessibility

Although evaluating the POB model is the main objective throughout this dissertation, I am also highly interested in how the activation or accessibility level of potential antecedents affects the pronoun resolution process. Given that within the POB model constraints on accessibility apply at the discourse level and consequently enter the resolution process somewhat later than structural constraints, it may be fruitful to establish at which moment in time accessibility influences the comprehension process. That is, an answer to the latter question may help us to present a more comprehensive reconstruction of the time course of anaphora resolution.

In Chapter 5, I will study the contribution of accessibility to pronominal resolution by focusing on one discourse constraint in particular, namely implicit causality. As discussed previously, implicit causality refers to the phenomenon that a specific class of interpersonal verbs makes either the subject or object more accessible for (future) reference (e.g. Caramazza *et al.*, 1977; Greene & McKoon, 1995; Long & De Ley, 2000; MacDonald & MacWhinney, 1995). However, an important unresolved issue is exactly how and when verb-based implicit causality information is brought to bear on the processing of an unfolding sentence. As we will see in Chapter 5, two contrasting accounts have been proposed, namely the *clausal integration* and *immediate focusing* account. According to the clausal integration account (e.g. Garnham *et al.*, 1996; Stewart *et al.*, 2000), verb-based implicit causality information is brought to bear on comprehension relatively late in the unfolding sentence. Proponents of the immediate focusing account (e.g. Greene & McKoon, 1995; Long & De Ley, 2000; McKoon, Greene, & Ratcliff, 1993), on the other hand, have suggested that implicit causality information can be brought to bear on comprehension much more rapidly, perhaps even as early as the verb itself. In this account, implicit causality is assumed to bring one of the persons referred to rapidly into *focus* (i.e. the relevant discourse entity becomes more accessible), at the expense of the other. Because readers and listeners prefer to relate a pronoun to the most accessible antecedent, such a rapid modulation of antecedent accessibility would in turn affect the ease with which a subsequent pronoun is processed.

In Chapter 5, I will present the results of one self-paced reading and two eye-tracking experiments will be presented, in which I try to pinpoint when implicit causality information enters the comprehension process. First of all, the results obtained will be used to decide between the clausal integration and immediate focusing account, and as it turns out the latter presents a better explanation for the effects of implicit causality on real time sentence comprehension. Second, I will discuss the implications of this conclusion in relation to the anaphora resolution process in general and the architecture of the POB model in particular.

In the final chapter (Chapter 6), an attempt is made to integrate all the experimental results into one coherent picture. First, the reader is provided with a summary of the preceding chapters. Next, I will present my conclusion(s) concerning the construction of anaphoric dependencies in real time. In the second part of the chapter these conclusions will be taken to the next level. That is, I will move beyond anaphora resolution and discuss the implications of my conclusions for the language comprehension system in general. In other words, at that point anaphoric dependencies are really used as *a window into the architecture of the language system*.

CHAPTER 2

Cheap reflexives versus pricey logophors

2.1. Introduction

In this chapter we will zoom in on the distinction between the syntactic and the extra-syntactic modules.[1] Or more specifically, since my research focuses on the economy hierarchy of the POB model, I will examine the first prediction as formulated in Paragraph 1.2.3.1 and 1.5.1 of the previous chapter, i.e. '*the construction of syntactic anaphoric dependencies requires less effort than the construction of semantic and discourse anaphoric dependencies*'. As will become clear below, the dissociation between (cheap) coargument and (pricey) logophoric reflexives plays a crucial role in this chapter, since the POB model assumes that only the former receive their interpretation in the syntactic module. Hence, comparing the resolution process of coargument reflexives to the resolution process of logophoric reflexives will offer important information pertaining to the underlying architecture of the system. In order to appreciate the potential value of this line of research fully, I will first give a more detailed description of the occurrence of coargument and logophoric reflexives in natural language. Next, I will discuss a number of dual task studies that provide some striking evidence in favor of the first prediction of the economy hierarchy (Piñango, Burkhardt, Brun & Avrutin, 2001; Burkhardt, 2005). I will then present the results of my first eye-tracking experiment. As the reader will see, the results are promising, since they suggest that establishing syntactic anaphoric dependencies uses less processing resources than extra-syntactic anaphoric dependencies, i.e. consistent with the first prediction of the POB model.

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[1] Because most relevant studies conducted so far do not distinguish between the semantic and discourse module, I will refer to them collectively as extra-syntactic modules.

2.1.1. Logophoricity

Over the last decades logophoricity has been a widely discussed phenomenon, mainly because its existence reflects striking evidence against Chomsky's binding theory (1981). In this paragraph, the difference between true coargument reflexives and logophors will be illuminated by presenting some well-known examples. However, it should be noted that this paragraph is merely included to illustrate under which conditions logophors may occur and by no means represents an exhaustive overview of this exciting research area (see for instance Burkhardt, 2005, for a more comprehensive overview).

Initially the term *logophor* was introduced to label a special type of anaphoric element, found in a number of African languages, which refers to the individual whose thoughts are being reported (Hagège, 1974, cited in Burkhardt, 2004). Nowadays, however, the terminology is used in a much broader sense, namely to refer to reflexives exempt from binding theory. Even though *binding-exempt reflexive* (introduced by Pollard & Sag, 1992, 1994) may therefore be a more suitable term, most studies on the matter (e.g. Burkhardt, 2005; Runner *et al.*, 2006) prefer the term logophor. To avoid confusion I will do the same, that is, throughout this dissertation the term logophor is used to refer to reflexives that do not conform to the classical binding principles.

In Chapter 1, I presented an important counterexample to the classical binding approach, here repeated in examples (1) to (3).

(1) *Peter$_i$* hurt *himself$_i$/*him$_i$*.
(2) *Peter$_i$* said that Mary hurt **himself$_i$/him$_i$*.
(3) *Peter$_i$* saw a gun near *himself$_i$/him$_i$*.

The first two sentences show that, in general, reflexives and pronouns appear in a complementary distribution, consistent with the predictions of Principle A and B. However, the third sentence clearly suggests this does not hold in all contexts: sometimes both the use of a pronoun and reflexive is allowed. According to Reinhart and Reuland (1991, 1993; see also Pollard & Sag, 1992, 1994) the crucial difference between a true reflexive (ex. (1) and a logophor (ex. (3)) is whether the anaphoric element and antecedent are arguments of the same predicate. In (1) both *Peter* and *himself* are arguments of the predicate *hurt.* As a result A-Chain formation is allowed (or in fact obligatory) and the anaphoric dependency can be interpreted on syntactic grounds alone (see

Paragraph 1.2.2.1). By contrast, in (3) *Peter* and *himself* are arguments of different predicates. Whereas *Peter* is an argument of the verb *saw*, *himself* is an argument of the preposition *near* (see Baker, 1988; Hestvik, 1991; Marantz, 1984; Reinhart & Reuland, 1993, for evidence supporting the non-coargumenthood status of NPs in locative PPs). Consequently, A-Chain formation is not permitted and the comprehension system has to resort to extra-syntactic (i.e. semantic or discourse related) strategies to determine the proper referent.[2] Hence, in their proposal, out of which the POB model eventually evolved, Reinhart and Reuland argue for a modular approach to the interpretation of anaphoric dependencies. True reflexives are resolved within syntax, and logophors are resolved extra-syntactically. In this respect, their view and the POB model differ fundamentally from the classical binding theory in which a more or less unified binding system accounts for all types of dependencies between pronouns, reflexives and their antecedents.

The extensive literature on logophoricity presents many examples in which logophors may occur. For present purposes, however, I will restrict the discussion to logophors used intrasententially and informally distinguish three subtypes. We have already seen example (3), which reflects a *locative logophor*. In these cases the logophor is part of a prepositional phrase headed by locative prepositional elements like *behind*, *next to* or *in front of*. Another instantiation can be found in structures in which the logophor is a constituent of a conjoined argument phrase. These *conjoined argument logophors* are not true reflexives either, since the anaphoric element is not a syntactic argument in itself, but part of a larger argument. For instance, in example (4) *himself* is embedded within the conjoined argument *Mary and himself* and, hence, cannot depend on A-Chain formation for its interpretation, but is interpreted extra-syntactically instead.

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[2] In some cases A-Chain formation is allowed despite the absence of a *semantic* coargumenthood relation between the reflexive and antecedent. For instance, in ECM constructions like (i) below an A-Chain is established between *Jan* and *zich*, since *zich* needs to be marked for case by the matrix verb *zag* 'saw' (i.e. the non-finite verb *dansen* 'dancing' cannot check the case feature of *zich*; for further details, see Reuland, 2001) leading to *syntactic* coargumenthood (Reinhart & Reuland, 1993).

(i) *Jan*$_i$ zag *zich*$_i$ dansen.
Jan$_i$ *saw SE*$_i$ *dancing.*
(Jan$_i$ *saw himself*$_i$ *dancing.)*

(4) *Peter*$_i$ said that the queen invited Mary and *himself*$_i$/*him*$_i$ to tea.

A third structure in which logophors are observed are so-called *picture-noun-phrases* (henceforth PNPs). PNPs are NPs headed by a representational noun such as *picture*, *photograph* and *opinion* (for a brief overview, see Runner *et al.*, 2006). If an anaphoric element such as *himself* is embedded within a PNP (ex. (5)), it can establish a grammatical dependency with the antecedent *John*, yet again A-Chain formation is impossible since *John* and *himself* do not constitute coarguments of the same predicate. Thus, it appears that PNPs allow the interpretation of anaphoric elements like *himself* on extra-syntactic principles as well.

(5) *John*$_i$ said that there was a picture of *himself*$_i$/*him*$_i$ in the post office.

It should be noted that there are other types of PNPs in which the distinction between a coargument reflexive and logophor becomes less clear-cut. For instance, if the PNP contains a possessor like *Harry* in example (6), A-Chain formation is possible in principle, if the assumption is made that a PNP, like a verb, represents a syntactic predicate.

(6) Joe saw *Harry's*$_i$ picture of *himself*$_i$.

In that case the possessor in the specifier position is the PNP's external argument and the reflexive its internal argument and, hence, the antecedent and reflexive are coarguments of the same predicate, allowing a syntactic anaphoric dependency to be established. However, Reinhart and Reuland (1993, footnote 49) also discussed the possibility that syntactic predicates can only be formed if the head of the predicate denotes an *event*. Assuming that an NP like *picture* does not include the property of eventhood, it follows that PNPs are not syntactic predicates and, consequently, A-Chain formation is not possible, since the antecedent and reflexive are not syntactic coarguments. In other words, according to this analysis, all reflexives embedded within a PNP, including the reflexive in example (6), are logophors.

Some recent experimental findings of Runner *et al.* (2006), suggest the latter analysis of PNPs should be preferred (see also Keller & Asudeh, 2001). They used a very elegant paradigm in which participants' eye movements were monitored while performing actions that required assigning a referent to a reflexive in PNPs closely resembling example (6). Before discussing their results, I will first give a short impression of their 'eye-catching' method.

The participants were placed in front of an array containing nine pictures of three dolls (i.e. three pictures of each doll), namely Ken, Harry and Joe. Furthermore, the three dolls were also 'physically' present and each was placed below three pictures. The experimenter explained to the participant that the pictures above each doll were *that* doll's pictures. So, every doll 'owned' three pictures: one picture depicted himself and the other two pictures depicted the other two dolls. The task was as follows. First, the participants heard instructions like 'Pick up Joe'. Subsequently, they had to carry out the action 'Have Joe touch Harry's picture of himself'. Hence, in order to accomplish this task, the participants had to resolve the reflexive within the PNP.

If the PNP forms a syntactic predicate, it follows that the proper antecedent can only be *Harry,* because this dependency is constructed syntactically and should therefore block other (extra-syntactic) dependencies. However, this prediction was violated frequently. Thus, participants often had Joe touch *Harry's picture of Joe* instead of *Harry's picture of Harry*. Moreover, Runner *et al.* observed that the looks to the non-local referent (*Harry's picture of Joe*) occurred as early as looks to the local referent (*Harry's picture of Harry*). On the basis of these findings they suggested a unification approach to reflexives in PNPs. That is, they argued that regardless of whether the PNP contains a possessor, reflexives embedded within a PNP should be treated as logophors, because they behave more like pronominals than like true reflexives.[3] Or

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[3] Furthermore, Runner *et al.* also show that when a PNP like (6) is placed within an ellipsis like (ii), listeners allow both sloppy and strict interpretations of the sentence (see paragraph 3.2 of the next chapter, for a discussion of sloppy-strict interpretations).

(ii) Joe touched Ken's picture of himself and then Joe touched Harry's <e>.

Although the two sloppy readings – in which the second clause is either interpreted as *Joe touched Harry's picture of Harry* or *Joe touched Harry's picture of Joe* – are preferred, listeners also pick the strict reading – *Joe touched Harry's picture of Ken* – more often than expected by chance. Since the sloppy-strict ambiguity is usually only observed for pronominals, these results suggest once again that reflexives in PNPs are not true reflexives but logophors.

in other words, we may tentatively conclude that PNPs do not form syntactic predicates.

2.1.2. Reflexives and logophors in Dutch

Up to this point, I restricted the discussion on reflexives (and logophors) to English. However, throughout this dissertation the experiments will be conducted using Dutch materials and participants, and as it turns out, matters on reflexivity are a little bit more complicated in the Dutch language. In contrast to English, Dutch has two types of reflexives, namely complex and simplex reflexives. The complex SELF reflexive *zichzelf* is used in sentences like (7) to license reflexivity of the transitive verb *haten* 'hate'.

(7) *Jan$_i$* haat *zichzelf$_i$*.
Jan$_i$ hates SELF$_i$.
(Jan$_i$ hates himself$_i$.)

On the other hand, some Dutch verbs like *wassen* 'wash' are inherently reflexive (e.g. Everaert, 1986) and only require the simplex SE reflexive *zich* in object position (ex. (8)). The *SELF* part of the reflexive is not obligatory since the verb *wassen* 'wash' is already reflexive-marked in the lexicon.

(8) *Jan$_i$* wast *zich$_i$*.
Jan$_i$ washes SE$_i$.
(Jan$_i$ washes himself$_i$.)

It should be noted that inherently reflexive verbs like *wassen* allow the use of complex *zichzelf* as well. However, that does not mean that the choice is fully optional. In general *zich* is the unmarked option and *zichzelf* is typically used in contrastive situations (see ex. (9))

(9) *De vrouw$_i$* wast het kind en daarna wast *zij$_i$ zichzelf$_i$*.
The woman$_i$ washes the child and then washes she$_i$ SELF$_i$.
(The woman$_i$ washes the child and then she$_i$ washes herself$_i$.)

Previously we observed that English reflexives like *himself* often allow a logophoric interpretation. In order to see whether Dutch reflexives behave the same as English reflexives with respect to their logophoric use, it may be useful to examine whether Dutch reflexives appear as locative, PNP and conjoined argument logophors as well (see ex. (10) to (12))

(10) *Jan*$_i$ legt het boek naast *zich*$_i$/*zichzelf*$_i$/*hem*$_i$.
Jan$_i$ *puts the book next to SE*$_i$/*SELF*$_i$/*him*$_i$.
(*Jan*$_i$ *puts the book next to himself*$_i$/*him*$_i$.)

(11) *John*$_i$ zei dat er een foto van **zich*$_i$/*zichzelf*$_i$/*hem*$_i$ in het postkantoor lag.
John$_i$ *said that there a picture of *SE*$_i$/*SELF*$_i$/*him*$_i$ *in the post office was.*
(*John*$_i$ *said that there was a picture of himself*$_i$/*him*$_i$ *in the post office.*)

(12) *Peter*$_i$ zei dat de koningin Mary en **zich*$_i$/**zichzelf*$_i$/*hem*$_i$ voor een kopje thee had uitgenodigd.
Peter$_i$ *said that the queen Mary and *SE*$_i$/**SELF*$_i$/*him*$_i$ *for a cup of tea had invited.*
(*Peter*$_i$ *said that the queen had invited Mary and himself*$_i$/*him*$_i$ *to tea.*)

In the examples above we see that, like *himself*, the simplex reflexive *zich* and complex reflexive *zichzelf* appear as logophors as well. For instance, in example (10) *zich* and *zichzelf* can both be used as a locative logophor, although the latter is again typically used in contrastive situations. Simplex *zich* is therefore generally the preferred choice. The PNP sentence (ex. (11)), however, shows another pattern. *Zich* is ungrammatical, but *zichzelf* presents a much better alternative, although the pronominal *hem* 'him' seems to be the best option here. Example (12), the approximate Dutch translation of example (4), is even more constrained, since both *zich* and *zichzelf* are out.[4] Thus, on the one hand *zich*, *zichzelf* and *himself* are similar, because they can all be resolved syntactically if the reflexive and antecedent are coarguments, or occasionally extra-syntactically if they constitute arguments of different predicates. On the other hand, such extra-syntactic or logophoric use of *zich* and *zichzelf* is more restricted than the logophoric use of *himself*.

[4] Dutch does allow another anaphoric form in example (12), namely *hemzelf*.

To sum up, even though reflexives cannot be replaced by a pronominal in general, there are specifically defined occasions – both in English and Dutch – where reflexives and pronominals are interchangeable. A fairly accurate generalization is that the use of both types of anaphoric elements is only allowed if the dependent element and its antecedent are arguments of different predicates and, hence, do not constitute coarguments. According to the POB model, which is partly based upon the ideas put forward by Reinhart and Reuland (1993), only coargument reflexives are resolved syntactically through A-Chain formation. Logophors, on the other hand, behave like pronominals and are resolved extra-syntactically, either through variable binding or coreference.

2.1.3. Studies on economy differences between true reflexives and logophors

This fundamental difference between true reflexives and logophors leads us to a very straightforward prediction. Namely, according to the economy hierarchy of the POB model reflexives should impose fewer costs on the comprehension system than logophors.

A few studies addressed whether economy differences between coargument and logophoric reflexives emerge during online language comprehension. To my knowledge Piñango *et al.* (2001) were the first to do so. They compared the processing costs of resolving coargument and logophoric reflexives using a cross modal interference task. In this dual task paradigm the participant performs a comprehension and lexical decision task at the same time. Piñango *et al.* auditorily presented sentences like (13) and (14) for comprehension which comprised the primary task for the participant (note that in sentence (13) the reflexive *herself* is a coargument reflexive and in sentence (14) *herself* is used logophorically).

(13) *The girl*$_i$ who was arrogant praised *herself*$_i$ because the network had called about negotiation for a leading role.
(14) *The girl*$_i$ sprayed bug repellent around *herself*$_i$ because there were many mosquitoes in the Everglades.

The secondary task consisted of a lexical decision for a visually presented probe which was entirely unrelated to the sentence. The rationale behind this particular design is that the two tasks compete for the same processing resources. As a result, the reaction time for the lexical decision is an indicator of the processing resources required for the primary task of sentence comprehension. In the experiment the probe was presented at two critical points in the sentence: at a control position just before the reflexive and at an experimental position immediately after the reflexive. Piñango *et al.* reported no difference in reaction times at the control position, yet the reaction times at the experimental position were longer in the case of logophors (i.e. in ex. (14)). These results suggest that the processing of coargument reflexives is more economic than the processing of logophors, or put more generally, syntactic processing is more economic than extra-syntactic processing.

In a replication study Burkhardt (2005), adopted exactly the same design, only now using Dutch materials and participants. Recall that in contrast to English, Dutch has two types of reflexives, namely the SELF reflexive *zichzelf* and the SE reflexive *zich*. Since in Dutch locative logophoric dependencies are most naturally established through the use of simplex *zich*, she presented sentences like (15) and (16).

(15) Coargument reflexive
De logopedist$_i$ die serieus was, verraadde *zich$_i$* zodat de cliënt geen hoop meer zag in de behandeling.
The speech therapist$_i$ who serious was, betrayed SE$_i$ so-that the client no hope anymore saw in the treatment.
(The speech therapist$_i$ who was serious, betrayed himself$_i$ so that the client did not have any hope for the treatment.)

(16) Logophor
De logopedist$_i$ verschoof een kleine stoel naast *zich$_i$* zodat de volwassen cliënt kon gaan zitten.
The speech therapist$_i$ moved a little chair next-to SE$_i$ so-that the adult client could go sit.
(The speech therapist$_i$ moved a little chair next to himself$_i$ so that the adult client could sit down.)

Very similar to the Piñango *et al.* study, Burkhardt reported longer reaction times in the logophor condition at the experimental position and no differences in reaction times at the control condition. Hence, together these findings from English and Dutch provide evidence in favor of a regulating economy principle as proposed in the POB model.

Interestingly, in another experiment Burkhardt (2005) tested two English speaking agrammatic aphasics and a control group matched on age and education.[5] She used the same experimental setup as Piñango *et al.*, but added an additional experimental probe position. Hence, in this experiment the processing costs of language comprehension are measured at three points: at a control position just before the reflexive, at an experimental position immediately after the reflexive and again at an experimental position some 600 ms later (i.e. the additional probe position). The results for the control group replicated the findings of the previous dual task studies. At the control position no differences in reaction times were reported, but the reaction times at the first experimental position (i.e. immediately following the coargument reflexive or logophor) were longer in the logophor condition. The processing advantage for coargument reflexives disappeared further downstream at the second experimental position. According to Burkhardt, this may indicate that both the coargument reflexive and logophor are resolved within this timeframe and no longer impose extra processing costs on the comprehension system. For the agrammatic aphasics, however, matters were different. No significant differences were observed at the control and first experimental position, yet the analysis at the second experimental position, some 600 ms more downstream, revealed longer reaction times for the logophor condition. More recently, Burkhardt, Avrutin, Piñango and Ruigendijk (2008) replicated these results with three Dutch agrammatic patients and matched control participants. According to Burkhardt (and colleagues) this suggests that although agrammatic aphasics are able to establish anaphoric dependencies, they simply need more time to do so. The question is: why is that the case?

Burkhardt based her explanation on a growing body of evidence suggesting that the error patterns in agrammatics result from one general syntactic deficit (e.g. Love, Swinney & Zurif, 2001; Piñango, 1999, 2002; Piñango & Burkhardt, 2001; Swinney, Zurif, Prather & Love, 1996; Zurif, Swinney, Prather, Solomon & Bushell, 1993). The idea is that the main problem for agrammatic aphasics is not that they lack certain

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[5] The term agrammatism is closely associated with Broca's aphasia (e.g. Vasić, 2006), i.e. "there is consensus in the field to use the term 'agrammatism' to refer to a language deficit that is characteristic of patients who suffered brain lesions in Broca's region, the underlying white matter and the areas surrounding it in the left hemisphere" (Burkhardt *et al.*, 2008, p. 121, footnote 2).

syntactic knowledge, but rather that syntactic processing is simply slower than normal, possible due to a reduction of the brain activation required to perform the relevant computations (e.g. Avrutin, 2006). Building on this hypothesis, better known as the Slow-Syntax hypothesis (Piñango, 1999), Burkhardt suggests the following: the processing consequences of a logophor emerge somewhat later for agrammatic aphasics than for healthy adults because the extra-syntactic operations needed to resolve that logophor require the mental representation of syntactic structure, which is delayed in the agrammatic brain. So, on this view the results are interesting for two reasons. First of all, they reinforce the idea of the Slow-Syntax model that the error patterns of agrammatics are not the result of a lack of syntactic knowledge, but rather are a consequence of slower-than-normal syntactic processing. Second, in light of this hypothesis the results are also relevant for the evaluation of the POB model. Namely, they indicate that extra-syntactic operations essentially have to wait until a syntactic structure is in place, i.e. consistent with the sequential architecture of the POB model (see Burkhardt, 2005, for a similar conclusion).[6]

Although the results discussed so far are in line with the POB model, a possible concern regarding the cross modal interference method needs to be addressed. Its value for measuring processing costs during online language comprehension notwithstanding, the method is somewhat unnatural, as people do not normally perform a lexical decision task while understanding language in day-to-day life. Of course, every experimental setting comes with its limitations. However, eye tracking, for instance, presents a 'better', or at least an ecologically more valid tool for tapping into the language comprehension system in real time.[7]

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[6] I should point out though, that the results present evidence in favor of the Slow-Syntax hypothesis *given that* syntactic processing precedes extra-syntactic processing and, similarly, the results are consistent with a sequential order of processing *given that* agrammatics show slower-than-normal syntactic processing.

[7] Note, however, that Piñango *et al.* (2001), Burkhardt (2005) and Burkhardt *et al.* (2008) opted for the cross modal interference paradigm, because they specifically assume that in this paradigm sentence comprehension takes place in a normal fashion (Avrutin, personal communication; see also Piñango, Zurif & Jackendoff, 1999).

2.2. Experiment 1: Coargument reflexives and logophors in unrestrained reading

In order to overcome the potential concern regarding the cross modal interference task, I repeated the study conducted by Burkhardt (i.e. the study with healthy Dutch participants), but this time by keeping track of the eye movements of participants while they freely read through the sentences. If the economy hierarchy for anaphora resolution is reflected in real time language processing, the eye-tracking results should mirror the findings of the dual task studies for healthy adults. That is, relative to a coargument reflexive, a logophor should cause a delay in reading time right at the anaphoric element, or due to spillover, rapidly thereafter (see Chapter 1, Paragraph 1.4, for a discussion of spillover effects in reading studies).

2.2.1. Stimuli

In (15) and (16) above, I presented examples of the stimuli used by Burkhardt in her Dutch dual task study. Despite the fact that she controlled for a large number of factors (e.g. the distance between antecedent and reflexive was kept equal; the verbs in each experimental pair – i.e. *betrayed* and *moved* in ex. (15) and (16) – were matched for frequency; the same complementizer was used after the reflexive), these sentences are not appropriate for eye tracking because the sentences as a whole are clearly not matched. In order to have more suitable eye-tracking stimuli, I constructed new sentences, but maintained the general structure as used in Burkhardt's study. Examples of the stimuli are given in (17) and (18) below.

(17) Coargument reflexive

De astronaut$_i$ die op Mars een Amerikaanse vlag plantte, verbaasde *zich$_i$* toen plotseling een marsmannetje met een nieuwsgierige blik in zijn ogen kwam aanlopen.

The astronaut$_i$ who on Mars an American flag planted, amazed SE$_i$ when suddenly a Martian with a curious look in his eyes came walking-by.

(The astronaut who planted an American flag on Mars, was amazed when suddenly a Martian with a curious look in his eyes approached.)

(18) Logophor
De astronaut$_i$ plantte op Mars een grote Amerikaanse vlag naast *zich$_i$* toen plotseling een marsmannetje met een nieuwsgierige blik in zijn ogen kwam aanlopen.
The astronaut$_i$ planted on Mars a big American flag next-to SE$_i$ when suddenly a Martian with a curious look in his eyes came walking-by.
(The astronaut$_i$ was planting a big American flag next to himself$_i$ on Mars when suddenly a Martian with a curious look in his eyes approached.)

Three elements were held constant across experiments. First, like Burkhardt, a relative clause was included in the coargument reflexive condition (see ex. (17)), which enabled me to control for the linear distance between antecedent and anaphoric elements (i.e. the linear distance in the coargument condition was the same as or longer than the linear distance in the logophor condition). Second, the prepositional phrase containing the logophor (ex. (18)) was also introduced either by *achter* 'behind', *naast* 'next to' or *voor* 'in front of'. Third, I decided to re-use the critical verbs, which were already matched for frequency (i.e. in ex. (17) and (18) the verbs *planten* 'plant' and *verbazen* 'amaze' were matched for frequency).[8] However, the remaining parts of the sentences were altered radically. First of all, the words in the relative clause of the coargument reflexive were closely matched to the words that appeared before the logophor. Moreover, from the anaphoric element *zich* onwards, the two conditions contained exactly the same material. Hence, in case of spillover effects this allows measuring the reading times of the regions directly following the critical reflexive or logophor without a confound.

2.2.2. Method

Participants. Participants were 36 members from the Utrecht University community (33 female, mean age 22, range 18 - 38 years) who received money for their participation. In this and the following experiments, participants were native speakers of Dutch, without a

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[8] I thank Petra Burkhardt for sending her stimuli. It made my job a lot easier and less time-consuming.

diagnosed reading or learning disability and normal or corrected to normal vision.

Materials. I constructed 24 experimental pairs as illustrated in examples (17) and (18) (see Appendix I for all Dutch originals). The stimuli were divided into two lists, with only one version of each story in a particular list. Another 48 stories were included as fillers. One pseudo-randomization was used for each list. The original randomization order was used for half of the participants, the reversed order for the other half. Half of the experimental and filler trials were followed by a statement about the story to encourage discourse comprehension. Participants had to indicate whether the statement about the story was correct or false (half were correct and half were false). These statements never directly probed the interpretation of the reflexive or logophor.

Procedure. A head-mounted *SMI Eyelink I* eye tracker with an angular resolution of 20 seconds of arc was used to monitor eye movements every 4 milliseconds. Viewing was binocular but the tracker monitored only the gaze location of the right eye. Each session started with an oral instruction, after which the eye tracker was mounted and calibrated. During this latter procedure the participants had to fixate a random sequence of dots at various locations on screen. Upon successful calibration the experiment started with 3 practice trials, 2 followed by a question. The calibration procedure was repeated two times throughout the experiment. The stories were presented in their entirety on a CRT (Nokia Multigraph 446xpro) screen. Before presentation, a fixation mark appeared on the screen at the position of the first word of the first sentence. Participants were instructed to fixate this mark and after a successful fixation the story appeared automatically. Participants pressed a button to progress when they finished reading a story. The comprehension questions were answered using two buttons on the same response box (all participants scored above 78% correct; mean score 91%). Each session was completed within 35 minutes.

Analysis. For analysis purposes the sentences were divided into the following regions (illustrated with the regions of ex. (18)).

1. The astronaut *(antecedent region)*
2. planted on Mars a big American flag next to *(pre-critical region)*
3. himself *(reflexive/logophor region)*
4. when suddenly *(spillover region 1)*
5. a Martian *(spillover region 2)*
6. with a curious look in his eyes *(remaining-words region)*

7. approached *(final word region)*

Thus, the first region consisted of the antecedent. The second region consisted of the words that appeared between the antecedent and reflexive or logophor. Region 3 contained the critical reflexive or logophor. Spillover region 1 included the two words following the reflexive or logophor and spillover region 2 included the third and fourth word following the reflexive or logophor. Region 6 consisted of any remaining words of the sentence up to the final word region.

I will report mean reading times for five different eye-movement measures, namely first gaze, total first gaze, regression path, total fixation and second-pass durations (see Chapter 1, paragraph 1.4.2.1 for a discussion of the different measures). Prior to all analyses, 1% of the trials was removed, because major tracker losses and eye blinks made it impossible to determine the course of fixations. For all different measures reading times more than 2 standard deviations from both the participant's mean and the item's mean in a region in a particular condition were treated as missing data (< 2.1% of all measures). Furthermore, in the present experiment and all subsequent eye-tracking experiments, skipped regions in first-pass measures are treated as missing data. This procedure is based on the idea that readers presumably spent some time processing the skipped words parafoveally. Since the reading times are used as a measurement of cognitive processing time, and the cognitive processing time of a skipped word is almost certainly not zero, the best option (in my view) is to exclude first-pass reading times of zero from the analysis (but see Versteeg, in prep., for discussion). Similarly, if a region was not fixated at all (i.e. not during first- and second-pass), the data point was treated as missing data in the total fixation duration. By contrast, a second-pass time of zero was used for regions that were not re-fixated by the reader. This decision is based on the idea that if no re-fixations emerge in a region, readers do not allocate additional cognitive processing resources to that particular region. Hence, second-pass reading times of zero should not be treated as missing data, but as a valid measurement of cognitive processing.

2.2.3. Results and discussion

Table 1 to 5 report the different reading time measures as a function of *Anaphor Type* (i.e. *reflexive* vs. *logophor*) and story region. In addition, the tables include the associated Paired-Sample T-Tests. I will only discuss effects that are significant by subjects (t_1) and by items (t_2) (i.e. $p < .05$). The eye-movement measures revealed significant reading time differences in two regions: namely, in the reflexive/logophor region and the pre-critical region. I will start the discussion with the former finding.

Table 1. Mean first gaze durations (in ms) and Paired-Sample T-Tests for Exp. 1.

	Region						
	1	2	3	4	5	6	7
e.g.:	*The astronaut*	*planted on Mars…*	*himself (SE)*	*when suddenly*	*a Martian*	*with a curious …*	*approached*
			First gaze duration				
condition							
reflexive	563	1892	224	302	388	1000	277
logophor	558	1623	224	315	400	983	264
t1							
t	< 1	5.404	< 1	< 1	< 1	< 1	< 1
df	-	35	-	-	-	-	-
Se	-	49.64	-	-	-	-	-
p	-	.001*	-	-	-	-	-
t2							
t	< 1	3.403	< 1	< 1	< 1	< 1	1.465
df	-	23	-	-	-	-	23
Se	-	77.44	-	-	-	-	17.33
p	-	.002*	-	-	-	-	.157

Table 2. Mean total first gaze durations (in ms) and Paired-Sample T-Tests for Exp. 1.

	Region						
	1	2	3	4	5	6	7
e.g.:	*The astronaut*	*planted on Mars…*	*himself (SE)*	*when suddenly*	*a Martian*	*with a curious …*	*approached*
			Total first gaze duration				
condition							
reflexive	563	2090	229	357	490	1231	362
logophor	557	1912	243	370	468	1155	338
t1							
t	< 1	4.392	1.311	< 1	< 1	1.259	1.151
df	-	35	35	-	-	35	35
Se	-	40.47	11.09	-	-	60.27	20.63
p	-	.001*	.199	-	-	.216	.258
t2							
t	< 1	2.715	2.140	< 1	1.143	1.679	1.333
df	-	23	23	-	23	23	23
Se	-	67.78	9.71	-	16.58	32.85	30.57
p	-	.012*	.043*	-	.265	.107	.196

Table 3. Mean regression path durations (in ms) and Paired-Sample T-Tests for Exp. 1.

	Region						
	1	2	3	4	5	6	7
e.g.:	*The astronaut*	*planted on Mars…*	*himself (SE)*	*when suddenly*	*a Martian*	*with a curious …*	*approached*
	Regression path duration						
condition							
reflexive	563	2154	275	429	594	1599	1876
logophor	557	1972	335	466	552	1500	1776
t1							
t	< 1	4.001	2.138	1.137	1.281	1.176	< 1
df	-	35	35	35	35	35	-
Se	-	45.51	28.18	33.24	32.75	83.74	-
p	-	.001*	.040*	.263	.209	.248	-
t2							
t	< 1	2.727	2.075	< 1	1.526	1.259	1.280
df	-	23	23	-	23	23	23
Se	-	70.08	30.25	-	27.44	73.62	148.46
p	-	.012*	.049*	-	.141	.221	.213

Table 4. Mean total fixation durations (in ms) and Paired-Sample T-Tests for Exp. 1.

	Region						
	1	2	3	4	5	6	7
e.g.:	*The astronaut*	*planted on Mars…*	*himself (SE)*	*when suddenly*	*a Martian*	*with a curious …*	*approached*
	Total fixation duration						
condition							
reflexive	756	2495	296	495	566	1286	348
logophor	748	2299	311	499	558	1206	329
t1							
t	< 1	2.762	< 1	< 1	< 1	< 1	< 1
df	-	35	-	-	-	-	-
Se	-	70.90	-	-	-	-	-
p	-	.009*	-	-	-	-	-
t2							
t	< 1	2.068	< 1	< 1	< 1	2.259	1.285
df	-	23	-	-	-	23	23
Se	-	94.62	-	-	-	32.20	28.79
p	-	.050*	-	-	-	.034*	.212

In the reflexive/logophor region the regression path duration measure showed a significant difference (see Table 3). Inspection of the means revealed that the anaphoric element *zich* elicited longer reading times when it was used logophorically (see Figure 7). Hence, the prediction was borne out: logophoric *zich* imposes a higher processing load on the comprehension system than reflexive *zich*.

Figure 7. Mean regression path durations (in ms) for the reflexive and logophor in Exp. 1.[9]

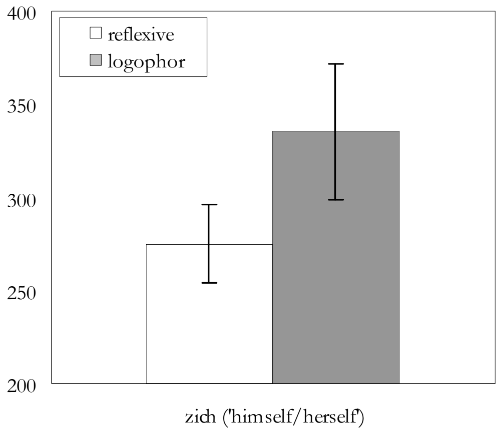


Table 5. Mean second-pass durations (in ms) and Paired-Sample T-Tests for Exp. 1.

	Region						
	1	2	3	4	5	6	7
e.g.:	*The astronaut*	*planted on Mars…*	*himself (SE)*	*when suddenly*	*a Martian*	*with a curious …*	*approached*
			Second-pass duration				
condition							
reflexive	232	864	103	214	211	429	47
logophor	208	892	110	192	181	365	44
t1							
t	1.407	< 1	< 1	1.064	1.607	1.319	< 1
df	35	-	-	35	35	35	-
Se	17.11	-	-	20.10	18.40	48.47	-
p	.168	-	-	.295	.117	.196	-
t2							
t	1.791	< 1	< 1	< 1	1.406	1.861	< 1
df	23	-	-	-	23	23	-
Se	13.13	-	-	-	21.49	34.62	-
p	.087	-	-	-	.173	.076	-

[9] Error bars in Figure 7 and subsequent figures indicate a 95% *inferential* confidence interval (Tryon, 2001). Tryon's procedure reduces the standard descriptive confidence interval such that nonoverlapping inferential confidence intervals are algebraically equivalent to null hypothesis statistical testing, i.e. if the confidence intervals do not overlap, then $p < .05$.

In addition to the critical reflexive/logophor region, the pre-critical region showed also significant differences. First gaze, total first gaze, regression path and total fixation durations for the pre-critical region were longer in the reflexive condition (see Table 1 to 4). No significant second-pass differences were observed, which suggests that the effect in the pre-critical region emerged exclusively before readers encountered the critical anaphoric element and, hence, is not due to the reflexive-logophor manipulation. As such the effect is essentially unrelated to the main issue of the experiment. However, as the pre-critical region immediately precedes the critical reflexive or logophor and, furthermore, reading time experiments are known to suffer from spillover effects, I decided to conduct a more fine-grained examination of the pre-critical region. First of all, as on average the pre-critical region of the reflexive condition contained more characters (i.e. more letters), I calculated the mean reading time per character. Although the significant difference disappeared for all measures using reading time per character as the dependent variable (all p-values > .073), I examined the reading pattern in the pre-critical region even further, that is, on a word-by-word basis. A rather complicated pattern emerged, but it appeared that participants slowed down in the reflexive condition at the last two words of the pre-critical region.[10] This makes sense for the following reason. In Dutch the word order of relative clauses, which were only present in the reflexive condition, is such that the main verb most naturally occurs towards the end of the clause (i.e. Subject-Object-Verb order). Consequently, in the reflexive condition, but not in the logophor condition, the last two words before the reflexive were often verbs (i.e. the first verb was part of the relative clause and the second verb was part of the main clause). It seems uncontroversial to assume that processing and integrating these two verbs into the developing structure may impose a high processing load on the comprehension system. In other words, if the pre-critical region of the reflexive condition indeed requires more processing, these extra costs are most likely caused by a relatively complex ending of the region. The latter conclusion is important, since first-pass processing costs of the pre-critical region may spillover and as a result influence the reading times for the reflexive and logophor. However, as the processing load prior to the critical anaphoric element appears to be higher in the reflexive condition, this would only work *against* the prediction of the

[10] Note that these words differ across conditions.

POB model, which states that the interpretation of logophors exerts more costs.

2.3. General discussion

In light of the above, I believe the significant regression path duration difference for the anaphoric element *zich* can be safely attributed to a processing advantage for coargument reflexives: despite the fact that the sentential structure in the reflexive condition may well be more complex just before the critical reflexive region, a significant reading time delay was nevertheless observed for logophors. Thus, as predicted by the POB model, the interpretation of logophors is more time-consuming than the interpretation of coargument reflexives.

For some, however, the question may emerge as to why the processing advantage for true reflexives is only visible in the regression path measure? Boland's eye-mind assumption (2004) may shed some light on this issue. Recall from the discussion in Chapter 1 that she proposed the eyes do not leave a word until it has been structurally integrated. Thus, lexical access and initial syntactic processes are completed before a reader moves on (or looks back) in the text, yet, solving problems concerning semantic and discourse integration may be postponed and affect reading times later on. Consequently, the different eye-tracking measures may be sensitive for different subparts of the language comprehension process. More specifically, since a reader maintains fixating a word until it is structurally integrated, first gaze durations may be highly suited to answer questions on initial structure building. By contrast, regression path durations may be more appropriate to study issues on semantic and discourse integration. So, according to this hypothesis, the results of the eye-tracking experiment suggest that logophors require more semantic- or discourse-level processing. Interestingly, this conclusion would be entirely consistent with the POB model, since it assumes that logophors are resolved at an extra-syntactic level and, hence, require more semantic and/or discourse processing than true reflexives, which are already resolved at the syntactic level. Of course, as was already mentioned in Chapter 1, linking the different eye-tracking measures to specific cognitive events is a delicate matter and should be presented tentatively at all times. Nevertheless, in this case a coherent picture emerges: according to the POB model a logophor requires more extra-syntactic processing resources than a true reflexive and, hence, this difference is most notably reflected in the regression path measure, being particularly sensitive to the processing costs of extra-syntactic components.

Since I conducted the study using Dutch materials, and presented the SE reflexive *zich* either in a coargument or logophoric position, the results are also relevant with respect to the distinction between SE and SELF reflexives. That is, together with the results for English reflexives in the dual task studies (Burkhardt, 2005; Burkhardt *et al.*, 2008; Piñango *et al.*, 2001), the findings suggest that – at least from a processing point of view – simplex SE reflexives like Dutch *zich* may be resolved in a similar way as complex SELF reflexives like English *himself*. More specifically, given that both exhibit a similar processing advantage if used as true reflexives, coargumenthood appears to be the crucial factor and not the complexity of the anaphoric element itself (cf. Burkhardt, 2005). This is again consistent with the POB model which assumes that, notwithstanding some important differences between simplex SE and complex SELF reflexives, the same fundamental principles and processing mechanisms apply. That is, both types are resolved through A-Chain formation, a relatively inexpensive operation, if the reflexive and antecedent are coarguments. Yet, if the anaphoric element and its antecedent are not coarguments and the parser has to resort to extra-syntactic mechanisms like variable binding or coreference, the comprehension process takes more time, regardless of whether the logophor is of the SE or SELF type.

However, some words of caution are called for here. Clearly, the most valid comparison between simplex and complex reflexives arises if it is made within a language, rather than between languages. Relevant to this issue is a study by Ruigendijk, Baauw, Avrutin and Vasić (2004), who conducted a story elicitation task to determine whether young Dutch children (around the age of six) are more likely to use simplex reflexives like *zich* or complex reflexives like *zichzelf*. They reported that children exhibited more difficulties with the production of *zich* in the appropriate context than with *zichzelf*. This led the authors to suggest that the underlying production (and resolution) mechanisms may be slightly different. More specifically, Ruigendijk *et al.* propose that the interpretation of *zich* is purely syntactic. The reflexive *zichzelf*, on the other hand, is identified with its antecedent through processes that lay (partly) outside syntax. Then, in order to explain the production advantage for extra-syntactic *zichzelf*, Ruigendijk *et al.* assume children have immature abilities to establish referential dependencies syntactically, yet extra-syntactic processes are relatively unproblematic. Hence, together these two factors explain why Dutch children exhibit a production advantage for the complex reflexive *zichzelf*: children prefer extra-syntactic computations and since the production of *zichzelf* is more extra-syntactic in nature than *zich*, children prefer to use the former. More relevant for our discussion, however, is that the findings may also suggest that establishing anaphoric dependencies with SELF reflexives are qualitatively different from establishing dependencies with SE reflexives, thereby opposing the idea that both types of reflexives are fundamentally the same. Future research should be able to resolve the latter issue, for instance by studying both simplex *zich* and complex *zichzelf* in coargument and logophoric structures, preferably within one experimental design. Thus, at this point in time it seems difficult to claim that simplex reflexives are resolved in exactly the same way as complex reflexives.[11] Be that as it may, it clearly does not invalidate the main conclusion of this chapter: in terms of processing costs true reflexives are cheap, but logophors are pricey.

[11] In fact, according to the POB model the most likely outcome is that they are not resolved in the same way. Recall that complex reflexives require an additional processing step, namely, the SELF-part of complex reflexives like *himself* and *zichzelf* must transform a transitive verb into a reflexive verb. Simplex reflexives like *zich* are used in case of inherently reflexives verbs and, therefore, do not require this step (see Chapter 1, Paragraph 1.2.2.1).

CHAPTER 3

Strictly discourse or sloppy semantics?

3.1. Introduction

In the previous chapter a comparison was made between the processing costs of syntactic and extra-syntactic anaphoric dependencies. In this chapter we will have a closer look at the latter type of dependencies, which can be divided into two separate categories, namely, semantic and discourse anaphoric dependencies. Although the title of this chapter addresses this dichotomy, most readers will, without a doubt, be puzzled by it and some may even find it completely incomprehensible. However, I assure you that at the end of the chapter you will not only understand the question, but you will also be able to provide the answer.

3.1.1. A dual-route architecture for pronoun resolution

First, let's briefly go back to Chapter 1. Recall that the syntactic module establishes dependencies between reflexives like *himself*, *zich* and *zichzelf*, whereas the semantic and discourse model are responsible for the interpretation of pronominals like *he* and *hij* (and logophoric reflexives). Furthermore, in Paragraph 1.3 it was mentioned that experimental studies have identified quite a few factors that influence the resolution process for pronominals. To name some, first mention (e.g. MacDonald & McWhinney, 1995), semantic gender information, (e.g. Arnold *et al.*, 2000), parallelism (e.g. Smyth & Chambers, 1996), recency or distance (e.g. Clark & Sengul, 1979), and implicit causality information of interpersonal verbs (e.g. Caramazza *et al.*, 1977) all affect the search for the referent of a pronominal. The (psycho)linguistic debate mainly focuses on the question *when* during comprehension these factors influence the pronoun resolution process. To give an example, some argue (semantic) gender information becomes available and is put to use before other factors can have an affect (e.g. Crawley *et al.*, 1990; Ehrlich, 1980), while others claim gender is only used during strategic processing, possibly at a later stage (e.g. Gernsbacher, 1989; Greene, McKoon & Ratcliff, 1992). Still others propose fully dynamic accounts where multiple sources of information are used in parallel to guide the resolution process (e.g. Arnold *et al.*, 2000). However, these different views all implicitly assume that the pronoun will be connected to a referent by accessing the discourse representation of the preceding written or spoken text. More specifically, they presume a single-route architecture to resolve a pronoun.

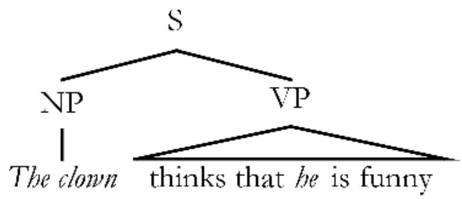
On the other hand, linguistic accounts of pronoun resolution (originating from Heim, 1982; Grodzinsky & Reinhart, 1993; Reinhart, 1983; Reuland, 2001) argue that the language system has two ways by which a pronoun is connected to an antecedent; (i) the pronoun behaves as a variable and is bound by its antecedent, or (ii) the pronoun receives a value from the discourse storage through coreference. Consequently, sentence (1) actually has two possible representations, one in which *he* is bound by *the clown* (1a) and one in which the value of *he* can be freely chosen from the discourse (1b). If in the latter *the clown* is picked as the proper antecedent for the pronoun the two derivations have the same interpretation (i.e. deixis *he,* in which the pronoun refers to some other male person is not taken into account).

(1) *The clown*$_i$ thinks that *he*$_i$ is funny.
  a. The clown λx (x thinks x is funny)
  b. The clown λx (x thinks a is funny) and $a = x$

In addition, we observed that variable binding is only licensed in structures with a c-commanding antecedent. Informally, a c-commanding antecedent was characterized as 'a sister' of the constituent that contains the pronominal (see Paragraph 1.2.1).[1] As can be seen in Figure 8, the NP *the clown* is a sister of the VP *thinks that he is funny* because both are dominated by the same 'mother' node, which is in this case the highest sentence (S) node. Hence, in example (1) the antecedent *the clown* c-commands the pronoun *he* and variable binding is therefore licensed.

[1] The formal definition of c-command was as follows: phrase α c-commands phrase β if and only if phrase α does not contain phrase β and the first branching node dominating phrase α also dominates phrase β (see Reinhart, 1983, for discussion).

Figure 8. Simplified syntactic tree of example (1).



In example (2) there is no c-command relation because the antecedent and pronoun appear in different sentences. This means that in structures like (2) only a coreferential dependency can be constructed. On the other hand, if the antecedent contains a quantifier such as *every*, coreference is ruled out (ex. (3)) and variable binding is the only option for establishing an anaphoric dependency (ex. (4)). Thus, whereas in sentence (1) both binding and coreference are available in principle, the dependency in sentence (4) can only be constructed through variable binding.

(2) *The clown*$_i$ is very happy. The bearded woman loves *him*$_i$.
(3) **Every clown*$_i$ is happy. The bearded woman loves *him*$_i$.
(4) *Every clown*$_i$ thinks that *he*$_i$ is funny.

The goal of this chapter is similar to that of the previous chapter: I will try to establish whether the distinction between the different modules and the regulating economy principle of the POB model affect real time anaphora comprehension processes. In the eye-tracking experiment of Chapter 2 the focus was on the first prediction of the economy principle, i.e. *'the construction of syntactic anaphoric dependencies requires less effort than the construction of semantic and discourse anaphoric dependencies'*. I compared an unambiguous reflexive that allowed A-Chain formation with its antecedent, to an unambiguous logophor that did not allow this syntactic relation. Consistent with the POB approach, the results suggested less processing costs for the former, indicated by shorter reading times right at the anaphoric element.

Drawing the analogy with the present chapter, similar processing differences are expected for the semantic and discourse route. More specifically, the second economy prediction was: *'the construction of semantic anaphoric dependencies requires less effort than the construction of discourse anaphoric dependencies'*. Hence, according to this prediction unambiguous bound pronominals involve less processing and should elicit shorter reading times than unambiguous coreferential pronominals. I will address this second prediction thoroughly in Experiment 4 and 5. However, the initial focus in this chapter will not be on the interpretation of anaphoric elements with only one possible antecedent, but on structures that are ambiguous between a bound and coreferential reading. As discussed in Chapter 1, the POB framework strongly predicts that *'if a pronominal is ambiguous between a semantic or discourse interpretation, the former is (initially) preferred, since it reflects the most economical option'* (i.e. the third economy prediction). In other words, the POB model predicts a general binding preference.

Obtaining empirical evidence that is consistent with a general binding preference in ambiguous structures is crucial in the evaluation of the POB model, in particular because it is expected for two different, although interrelated, reasons. First of all, according to the (cross-modular) economy hierarchy bound dependencies require less processing resources and should therefore be preferred. However, even without posing an economy hierarchy, the POB model predicts a preference for bound dependencies, because the semantic and discourse component are thought to operate in sequence as functionally independent modules. More specifically, semantic processing precedes discourse processing and, hence, an initial binding preference is also expected due to a time course effect: during online comprehension bound dependencies are simply available prior to coreference dependencies.

Before I discuss my experiments, specifically designed to further address the predictions of the POB model, an overview will be given of both offline and online language comprehension studies that already provide some striking empirical support for the existence of a general binding preference. In the next section I will first focus on some very interesting results obtained offline by Vasić and colleagues who studied binding preferences in language acquisition and agrammatic aphasics. As most studies on the matter they used VP-ellipsis constructions to induce the ambiguity between binding and coreferential interpretations. I will continue by reviewing a number of studies with healthy adults. Particularly interesting for the present purpose is a study by Frazier and Clifton (2000) who in a mix of offline and online experiments explored whether the binding preference is restricted to VP-ellipses or generalizes to other structures as well.

3.2. Studies on agrammatic aphasics and pre-school children

At the beginning of this dissertation, I mentioned the existence of so-called VP-ellipses and their intriguing capability of introducing referential ambiguity if the VP of the first conjunct contains a pronominal (see ex. (5)).

(5) *The acrobat*$_i$ likes *his*$_i$ jokes and *the clown*$_j$ <e> does too.
   a. The acrobat$_i$ likes his$_i$ jokes and the clown$_j$ <*likes his*$_{i,j}$ *jokes*> does too.
   b. The acrobat$_i$ likes his$_i$ jokes and the clown$_j$ <*likes the clown's jokes*> does too. *(sloppy)*
   c. The acrobat$_i$ likes his$_i$ jokes and the clown$_j$ <*likes the acrobat's jokes*> does too. *(strict)*

I will assume that sentences like these are interpreted by copying the verb phrase of the first conjunct (i.e. in this case *likes his jokes*) into the 'gap' of the second conjunct (but see Merchant, 2001, for discussion and alternative views). This operation gives rise to ambiguity as the 'reconstructed' pronoun in the gap can either refer to *the acrobat* or *the clown.* In other words, the second clause of the sentence can mean that 'the clown likes his own jokes' or, alternatively, that 'the clown likes the jokes of the acrobat'. The former interpretation results from binding between *the clown* and the reconstructed pronoun *his* and is also known as the 'sloppy reading'. The latter, in which the reconstructed pronoun is connected to *the acrobat* is the coreference interpretation and is also known as the 'strict reading'.[2]

In a recent study, Vasić (2006; see also Vasić, Avrutin & Ruigendijk, 2006) tested the interpretations of agrammatic aphasics on complex sentences like (5) and compared the results to a control group of matched healthy adults. Her aim was (i) to investigate whether agrammatic aphasics were able to obtain both readings, (ii) to determine

[2] More formally:

(i) *The acrobat* likes *his* jokes and *the clown* <e> does too.
   a. *The acrobat* (λx (x likes x's jokes) and *the clown* (λx (x likes x's jokes) does too. (*sloppy*)
   b. *The acrobat* (λx (x likes y's jokes) and *the clown* (λx (x likes y's jokes) does too. (*strict*, y can be valued as any male individual, including *the acrobat*)

whether one of the two is preferred given a choice and, very interestingly, (iii) to find out whether the preference pattern would be consistent with an economy-based approach. Because this study directly bears on the issues that are addressed in this chapter, a detailed description of the experiment is given below.

Vasić (and colleagues) used a picture selection task to test Dutch-speaking patients and controls on target sentences like (6).

(6) *De oma*$_i$ fotografeert *haar*$_i$ paard en *de vrouw*$_j$ doet dat ook.
(The grandmother$_i$ *photographs her*$_i$ *horse and the woman*$_j$ *does so too.)*

Even though in Dutch no classical VP-ellipses appear (e.g. according to Reinhart, 1991, the Dutch equivalent should be analyzed as a bare argument ellipsis), I agree with Vasić's analysis that the main concern is not the exact status of the syntactic structure, but rather the fact that the structure induces ambiguity between a sloppy and strict reading due to the reconstruction process in the second conjunct. However, to avoid confusion I will from this point onwards use the more general term ellipsis instead of VP-ellipsis.

Prior to the target sentence, the experimenter introduced three story characters to the participant by describing a picture containing for instance a girl, woman and grandmother. Two of them were part of the test sentence and the third functioned as a distracter (i.e. as a deictic alternative for the possessive pronoun). After the participants heard the critical sentence they had to decide which picture out of three described the situation in the best way. The critical manipulation was as follows. In the first condition there was only one correct picture, namely the one depicting the sloppy interpretation. This condition was included to test whether patients were able to construct a sloppy reading. Alternatively, to examine whether patients were able to establish a strict reading as well, the second condition only included a correct picture illustrating the latter. In the third and final condition both the sloppy and strict picture were an option and this condition could therefore give information about the preference of the participants for either the sloppy or strict interpretation.

The results showed that the agrammatic aphasics could establish a sloppy reading, which in turn suggests that they are able to process semantic dependencies. However, contrary to the healthy controls the patients scored at chance level in the strict condition, revealing a problem with discourse representations. In addition, the third condition also showed a contrast between the patient and control group. Namely, patients showed a much stronger preference for the sloppy reading than the healthy controls. Of course, taking the results of the first two conditions into account, this makes perfect sense. After all, why should you prefer a particular interpretation over another if you are unable to compute the former to begin with?

Thus, the results so far provide an answer to the first two of the three questions raised by Vasić and colleagues. The answer on the first question would be 'no', that is, agrammatic aphasics are not capable of establishing both interpretations as the strict reading is unavailable for patients. The second question can be answered with a satisfying 'yes': patients have a strong preference for sloppy interpretations. In fact, this preference is much stronger for the patients than for the healthy controls. In the remainder of this section I will present their explanation for the obtained results, which should also make clear why I find the answer to the second question 'satisfying'.

Vasić hypothesizes that for healthy adults the ambiguity in ellipses results from the fact that the language system constructs two distinct copies of the VP in the first conjunct. One is a copy of the bound dependency and will result in a sloppy reading, the other is a copy of the discourse dependency and will result in a strict reading. Furthermore, she argues that the bound dependency is available before the discourse dependency and therefore the bound interpretation will also be copied faster into the second conjunct. However, because healthy adults have enough resources and time to copy the discourse dependency as well, both readings will be available eventually. As we have seen, matters are different for agrammatic aphasics.

Recall from the discussion in Chapter 2, that a growing body of evidence suggests that the error patterns in agrammatics result from one general syntactic deficit. More specifically, the idea is that the main problem for agrammatic aphasics is not that they lack certain syntactic knowledge, but that syntactic processing is slower than normal, possible due to a reduction of the brain activation required to perform the relevant computations (see e.g. Avrutin, 2006). Like Burkhardt (2005; see Chapter 2, Paragraph 2.1.3 of this dissertation), Vasić discusses her results in light of this hypothesis, better known as the Slow-Syntax model (Piñango, 1999). She argues that the economy hierarchy (i.e. syntax-semantics-discourse) is preserved in agrammatic aphasics, however, because syntactic structure building is delayed, the computations of the other components are delayed as well. This has the effect that when aphasics process an ellipsis they have (just) enough time to construct and copy the bound interpretation, but simply lack the resources or time to copy the discourse dependency as well. Hence, aphasics are unable to construct a strict reading of an ellipsis and therefore have a strong preference for a sloppy interpretation.

In a way the agrammatic brain can be viewed as a system that has to work under enormous time pressure. A 'smart' overloaded system will, of course, resort to the cheapest available option to save precious energy. For that reason, the result that aphasics strongly prefer bound interpretations are particular interesting as it suggests a clear processing advantage for semantic computations, as predicted in the POB framework.[3]

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[3] Although the results of the Vasić *et al.* study are consistent with an economy-based approach to anaphoric processing, I have to point the reader to an alternative explanation related to the stimuli that were used in the experiment. As mentioned, the target sentence was preceded by an introductory discourse about a picture portraying three story characters. In (ii) the introduction for target sentence (6) is given.

(ii) This is a girl with her own horse that is black, a grandmother with her own horse that is white and a woman with her own horse that is black and white.

As can be seen, every character is introduced together with an animal of her own, in this case a horse. In fact, by stating that it is *her own* horse the connection between the person and the animal becomes rather strong. As a figure of speech, one could say that the two are almost 'bound' to each other. Trivial as this may seem, the results of Experiment 2 in this chapter will show that if you introduce story characters by linking them all individually to an object and, furthermore, if the critical VP in the target ellipsis contains something like *her <object>*, people will be biased towards a sloppy interpretation. This makes sense if you realize that in a sloppy interpretation the subject of the second conjunct and its object remain so-to-say linked (i.e. the woman photographs *her own* horse). In a strict reading, on the other hand, the link between the subject of the second conjunct and its object will be broken (i.e. the woman is not photographing *her own horse* but *grandmother's horse*).

A plausible assumption is that a biased interpretation is easier (i.e. 'cheaper') to establish. As a result, the contrast between aphasics and healthy adults can be explained without assuming a fixed processing hierarchy. That is, it is only within this specific context that the sloppy interpretation happens to be cheaper and therefore highly preferred by agrammatic aphasics. However, if the preceding discourse would be biased towards a strict interpretation the results could very well be reversed. In sum, it is hard to tell whether the reported pattern results from the fact that binding dependencies are

In addition to agrammatic aphasics, another population that shows signs of a reduced processing capacity in comparison to healthy adults can be distinguished. However, in this case the brain is not easily overloaded due to neurological damage, but due to the fact that the brain is in a developing stage and has not reached its full potential yet. I am (of course) talking about language-learning children. Although there are probably as many differences between the two populations as there are similarities, the same logic should apply. Namely, children should strongly prefer bound dependencies over coreferential dependencies as the former are cheaper to construct and therefore the first choice for their overloaded system.

To test whether the economy hierarchy would still hold for unimpaired developing brains, Vasić (2006) replicated the picture selection task described previously, only now using pre-school children as participants. The results again showed a preference for bound interpretations when the child was given a choice between pictures depicting the sloppy and strict identity. Thus, similarly for Dutch children the discourse route is the most costly route. In fact, the binding preference is not restricted to Dutch children, as in addition English and also Chinese children prefer a sloppy interpretation to a strict interpretation (Foley, Nunez del Prado, Barbier & Lust, 1997; Guo, Foley, Chien, Chiang & Lust, 1996). Interestingly, the youngest children seem to exhibit the strongest preference. So, if we assume that the processing capacity of a developing brain increases gradually in time, this latter result suggests that the strength of the binding preference is proportional to the available processing resources. In other words, if the capacity of the brain decreases, the bias towards the semantic route will increase. This observation is exactly what the POB's economy-based approach to anaphoric dependencies predicts.

3.3. Online studies on healthy adults

The studies on impaired and developing brains discussed so far are consistent with the predictions of the POB model. Both groups show a striking bias towards bound-variable interpretations. Interestingly, unimpaired adults have a similar bias, but to a lesser degree. (e.g. Fiengo

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always cheaper than coreferential dependencies or that they are just cheaper in this specific situation.

& May, 1994; Shapiro, Hestvik, Lesan & Garcia, 2003). For them the strict reading is also the most difficult interpretation to generate, but probably due to having a bigger processing capacity they are able to compute both derivations rather quickly. As a result, their bias towards a sloppy interpretation is somewhat weaker than for young children and agrammatics.

Even though offline studies can provide valuable information regarding the processes that underlie the formation of anaphoric dependencies, it does not tell us a lot about the time course of these processes. If you want to know what happens in the language system in real time, it is of course necessary to measure the system of interest in real time, that is, while it actually performs the relevant computations. Unfortunately, relatively few studies adopted online methods to explore for instance when the language system establishes sloppy and strict identities and/or whether there might be a timing difference between the two. There are, however, a couple of notable exceptions. In the first two, Shapiro and Hestvik (1995) and Shapiro *et al.* (2003) conducted several cross-modal priming experiments to explore whether unimpaired adults compute both the sloppy and strict interpretation during the online comprehension of ellipses. In another exception Frazier and Clifton (2000) used self-paced reading to examine the hypothesis that a sloppy reading is preferred over a strict reading. Both studies will be discussed in more detail below.

3.3.1. Reactivation of antecedents

Earlier it was suggested that healthy adults show a weaker bias towards sloppy interpretations than children and aphasics, presumably because they have a relatively high processing capacity. This enables them to compute both the sloppy and strict identity rather quickly which attenuates the binding preference. However, this implies that healthy adults compute both interpretations online. In a series of cross-modal priming studies Shapiro and Hestvik (1995) and Shapiro *et al.* (2003) set out to test whether this is indeed the case. They did so by presenting sentences highly biased towards a sloppy interpretation (see ex. (7)).

(7) *The policeman*$_i$ perjured *himself*$_i$ and *the fireman*$_j$ did <e> too.

While listening for comprehension, participants had to make a lexical decision to a visually presented word that was either semantically related or semantically unrelated to the subject of the first conjunct (i.e. *the policeman*), or to the subject of second conjunct (i.e. *the fireman*). The idea is that if listeners compute both the bound-variable and coreferential interpretation of the reconstructed anaphoric element in the elided conjunct, listeners should respond faster to semantic associates of these antecedents at the gap position (i.e. just after *did*) relative to a control position before the gap (i.e. just before *did*). And indeed, the results showed reactivation of both subjects in the immediate vicinity of the elided position. The authors therefore concluded that listeners activate both the sloppy and strict reading momentarily and relatively simultaneously (however, for an alternative explanation see Koeneman, Baauw & Wijnen, 1998; Wijnen & Bene, in prep.).

The findings of Shapiro and colleagues are consistent with a two-route architecture for pronoun resolution in which the semantic and discourse module function independently of each other. Namely, despite the fact that the sentences have a very strong bias towards a sloppy interpretation the language system still computes the strict interpretation suggesting that the two routes are distinct. On the other hand, at first glance the results seem inconsistent with a sequential approach in which semantic interpretations always emerge before discourse interpretations. After all, the priming effects suggest activation of both the semantic (sloppy) and discourse (strict) reading at the same time.

However, the cross-modal priming experiments of Shapiro and colleagues may not be suitable for answering questions on sequentiality. First of all, note that the set-up of the experiments does not allow a detailed reconstruction of how the sloppy and strict reading evolve over time as the activation levels are only measured at one fixed point, that is, right after the gap. Even though this is the earliest moment where one could possibly detect any activation differences, the relatively long reaction times to probes (i.e. around 700msec) could easily have obscured any small differences between the exact onset time of the sloppy and strict reading. Furthermore, in this dissertation I am particularly interested in the *preference* of people for either a sloppy or strict identity, an issue that is difficult to address using a cross-modal priming paradigm. To explore the online preferences in ambiguous structures it might therefore be better to use reading times as a dependent measure instead.

3.3.2. Self-paced reading and the LF-only hypothesis

To the best of my knowledge, only one study directly examined the hypothesis that bound-variable dependencies are preferred over coreferential dependencies by measuring reading times. In a series of self-paced reading experiments, Frazier and Clifton (2000) examined the predictions of the LF-only hypothesis. Very similar to the POB's economy-based approach the LF-only hypothesis states that "a bound-variable interpretation is preferred because the perceiver need only consult the Logical Form representation (not the discourse representation) in order to identify the bound-variable analysis of the sentence" (p.126). To test the hypothesis Frazier and Clifton acquired reading times for the second conjunct of, again, biased ellipses like (8) and (9).

(8) *Sally*$_i$ happened to strain *her*$_i$ back yesterday and *Fred*$_j$ did <e> too. (*sloppy bias*)

(9) *John*$_i$ thinks it's a good idea to shave *his*$_i$ face before he goes to sleep and *Alice*$_j$ does <e> too. (*strict bias*)

In (8) the interpretation is biased towards a sloppy reading (i.e. bound-variable interpretation) as it is implausible that 'Fred strained Sally's back'. Alternatively, (9) is biased towards a strict reading (i.e. coreferential interpretation) because it seems unlikely that 'Alice (a woman) shaves her face before going to bed'.

They reported longer reading times for the second conjunct in sentences biased towards a strict reading (i.e. ex. (9)), which suggests that the construction of a coreference dependency requires more processing resources than the construction of a bound-variable dependency. This would be consistent with both the LF-only hypothesis and the POB model. However – as the authors point out themselves as well – we have to interpret the results with some care as significant differences only emerged in one particular experiment with unmatched critical sentences. In the other experiments the authors either did not report statistical testing or the conditions only showed a numerical difference (i.e. not a significant difference) in the expected direction. Moreover, one of these latter experiments also seem to suffer from a lack of experimental control as the verbs in the first conjunct were not the same and, hence, the material that the language system had to copy into the gap of the second conjunct differed across conditions, thereby leaving room for alternative explanations. Despite these potential problems, Frazier and Clifton tentatively conclude that an advantage does exist for bound interpretations of ellipsis sentences.

Of course, an investigation of the LF-only hypothesis and POB model should not be restricted to possible preferences in elliptic structures. In order to evaluate whether the proposed processing hierarchy reflects a general tendency of the parser, we need to study the resolution of ambiguous dependencies in other structures as well. Frazier and Clifton arrived at the same conclusion and continued their study, but this time by gathering offline data of other (quantificational) contexts. For instance, they presented sentences like (10) to (13) to participants and asked them to indicate whether they interpreted the pronoun as referring to either the proper name (i.e. *John* or *Jill*), the quantified element *everyone* or some other unmentioned male character.

(10) *John*$_i$ says that *everyone*$_j$*'s* mother loves *him*$_{i,j}$ *(ambiguous)*
(11) *Jill*$_i$ says that *everyone*$_j$*'s* mother loves *him*$_{*i,j}$ *(unambiguous)*
(12) According to *John*$_i$, *everyone*$_j$ loves *his*$_{i,j}$ sister *(ambiguous)*
(13) According to *Jill*$_i$, *everyone*$_j$ loves *his*$_{*i,j}$ sister *(unambiguous)*

According to the analysis of the authors the preference for binding dependencies should be illustrated by a clear preference for the quantifier *everyone* in all sentences. Yet, contrary to this prediction, participants were more likely to pick the coreferential antecedent in the ambiguous sentences (i.e. *John* in ex. (10) and (12)) and the unmentioned character in the unambiguous sentences. These findings seem to go against a general preference for binding dependencies.

However, I should point out to the reader some of the important aspects of the stimuli, putting some doubt on whether they are appropriate to test any binding preferences. Most importantly, in (10) the competing coreferential antecedent (i.e. *John*) in fact c-commands the pronoun, thereby allowing a binding relation between the two. Moreover, the quantifier does not c-command the pronoun, either in (10) or (11). As a result, a binding dependency between the quantifier and pronoun will always be rather marked. Taking these two things together, the LF-only hypothesis and POB approach could just as easily account for the finding that *him* will be connected to *John* in (10) and even to some unknown male in (11). Furthermore, in my opinion sentence (12) is not sufficiently controlled for either, as the competing coreferential antecedent *John* is introduced firstly and as a proper name.

Recall that first mentioned antecedents are highly accessible as possible referents for a subsequent pronominal (e.g. MacDonald & McWhinney, 1995), and moreover, proper names are also known to elevate the prominence level of a story character strongly (Sanford, Moar & Garrod, 1988). Hence, these other (discourse) factors could have obscured the default preference for a binding dependency in sentences like (12). As a final point on the matter, because Frazier and Clifton did not present the results for the different sentences separately, but collapsed them over the ambiguous and unambiguous conditions, there is no way of telling how the potentially confounding factors might have affected the preferences of the participants.

I conclude the discussion of Frazier and Clifton's study by presenting a small questionnaire experiment in which participants were asked how they interpreted sentences like (14).

(14) Only *Alfred*$_i$ thinks that *he*$_i$ is a good cook.

In a way, sentences like these are similar to ellipses as they allow both a sloppy and strict identity. That is, the sentence can either mean that 'Only Alfred thinks that Alfred is a good cook', the strict interpretation, or 'The only person who thinks of himself as a good cook is Alfred', the sloppy interpretation.[4] If the preference of the parser for binding dependencies is general, we expect the participants to choose the second option more often than the first. This was not the case as participants in fact highly preferred the strict interpretation. In my opinion this is the only finding of Frazier and Clifton that suggests that the binding preference is restricted to specific structures and, hence, not a general property of the language processor.

3.4. Summary of experimental studies

In the previous sections I have discussed a number of studies that directly bore upon the POB's economy-based approach to anaphoric processing. The offline studies provided convincing empirical support for the existence of a binding preference in different populations. Dutch,

[4] This is a very subtle distinction and some readers will have a hard time obtaining both readings (I know I had). Section 3.5.1 contains a more detailed discussion on the sloppy-strict ambiguity in *only*-structures.

English and Chinese children prefer a bound-variable or sloppy interpretation to a coreference or strict interpretation and interestingly, the youngest children exhibit the strongest preference (Foley *et al.*, 1997; Guo *et al.*, 1996; Vasić, 2006). The proposed processing hierarchy was also reflected in the performance of agrammatic aphasics with ellipsis constructions. Although these patients are capable of establishing a bound-variable interpretation, they had severe problems with obtaining a coreference interpretation (Vasić, 2006). The author explained her results by assuming that agrammatic patients have insufficient processing resources to compute both interpretations in real time. Also for unimpaired adults the strict reading is the most difficult interpretation to generate offline (e.g. Fiengo & May, 1994; Shapiro *et al.*, 2003). However, probably due to having a greater processing capacity they are able to compute both derivations rather quickly and, as a result, their bias towards a sloppy interpretation is somewhat weaker than for young children and agrammatics.

The online evidence, on the other hand, is more limited or even absent. For the cross-modal priming studies (Shapiro & Hestvik, 1995; Shapiro *et al.*, 2003), I noted that this technique might not be the best option for exploring the predictions of an economy-based approach. Furthermore, the self-paced reading experiments reported by Frazier and Clifton (2000) were in my opinion far from convincing. The results were either difficult to interpret due to a lack of experimental control, or the effects simply did not reach the required level of significance. However, in the latter study the authors very rightly mentioned that at this point in time insufficient (online) empirical evidence is available to support an LF-only or economy-based approach to anaphoric processing.

In the remainder of this chapter I will present the results of one offline questionnaire and three online eye-tracking experiments especially designed to study the binding preference of healthy adults in different structural environments. As we will see, the results will provide additional evidence in favor of a (sequential) economy-based approach like the POB framework.

3.5. Experiment 2 and 3

3.5.1. The *only*-operator

The first two experiments of the present chapter – a questionnaire and an eye-tracking experiment – address one of the objections raised by

Frazier and Clifton in regard to a general preference for binding dependencies. They showed offline that, in contrast to ellipses, participants do not choose the sloppy identity of sentences like *Only Alfred thinks that he is good cook* more often than the strict identity. On the contrary, participants had a clear preference for the strict interpretation instead, which seems to be at odds with the predictions of the POB model. However, in the remainder of this section I will argue that their results in fact do not necessarily rule out an initial binding preference for *only*-structures.

First of all, we should ask ourselves what kind of information the language processor has to draw together, to obtain either a sloppy or strict interpretation in sentences with the *only*-operator. Across both interpretations of example (14) one factor remains constant, namely the fact that Alfred is happy about his own cooking. For a full interpretation, however, this is not enough. It seems that the comprehension system should represent some sort of 'hidden' reference set consisting of everybody but Alfred, or in other words 'the rest' – often referred to as the *contrast set* (e.g. Reinhart, 2004). The crucial difference is that 'the rest', implicitly introduced through the use of the term *only*, behaves differently in a sloppy reading than in a strict reading. Whereas in the former each individual member of the set is evaluating his own cooking (and they don't like it!), the hidden set in the latter consists of members who, more or less as a group, evaluate Alfred's cooking (which is pretty bad!). One way of explaining why people prefer a strict interpretation in *only*-sentences is then to suggest that the hidden set is less complex and, hence, preferred. However, another explanation could be that the hidden set of the strict reading in the sentences tested by Frazier and Clifton simply fitted the context better. On this latter view, a strict interpretation emerges in example (14) because it makes much more sense that we are talking about Alfred's cooking, which is explicitly mentioned, than about the cooking of the entire world (e.g. in *Referential Theory*, an important assumption is that people choose the reading with the fewest unsatisfied presuppositions, see Crain & Steedman, 1985). In other words, the lack of context could very well bias participants to a strict interpretation regardless of whether the parser initially prefers a sloppy reading or not.

I favour the latter explanation. My hypothesis is that in an isolated sentence like example (14) the parser initially prefers a sloppy reading as predicted by the POB approach. This bound dependency involves the representation of a hidden reference set in which each member thinks about his own cooking. However, this interpretation of the set does not fit well with the context (or rather the lack of it) and therefore, the next discourse step changes the bound interpretation into a strict interpretation with a reference set containing members that do not think of themselves but of Alfred's abilities as a cook. Thus, on this construal it is predicted that some sort of re-analysis takes place before a strict interpretation emerges. Obviously, an offline questionnaire does not give us enough information to describe the full picture. Especially potential processes of re-analysis cannot be detected, as the questionnaire only provides information about the person's final interpretation. Therefore, to get more detailed information about the underlying mechanisms it is necessary to explore the processing of ambiguous *only*-sentences online, for example, by measuring the eye movements of people while reading.

The main aim of the next two experiments is to examine the LF-only hypothesis further, or in terms of the POB framework, its third economy prediction: *'if a pronominal is ambiguous between a semantic or discourse interpretation, the former is (initially) preferred, since it reflects the most economical option'.* Hence, both accounts predict that in ambiguous ellipsis and *only*-structures sloppy interpretations are initially preferred over strict interpretations. I will present both classes of sentences within one experimental design in order to explore whether readers process anaphoric ambiguity within elliptic and *only*-structures essentially in the same way, or alternatively, that these structures affect anaphor resolution rather differently, as suggested by Frazier and Clifton.

3.5.2. The stimuli

To address the issues above an offline questionnaire and an online eye-tracking experiment were conducted, in which short stories were presented with a critical sentence that was ambiguous between a sloppy and strict reading as illustrated in examples (15) to (18).

(15) Sloppy-bias, *only*-operator

Lisa en Anouk zijn dol op de muziekzender MTV. *Zij* konden hun geluk niet op toen zij mee mochten doen aan het programma 'Pimp My Room', waarin hun kamers werden opgeknapt. *Maar helaas, alleen Lisa vindt dat haar gepimpte kamer klasse heeft.* Smaken verschillen nu eenmaal.

(Lisa and Anouk love the music channel MTV. They were very happy when they were selected for the show 'Pimp My Room', in which their rooms were redecorated. Sadly, only Lisa thinks that her pimped room has a touch of class. *Oh well, to each their own taste.)*

(16) <u>Strict-bias, *only*-operator</u>

Lisa en Anouk zijn dol op de muziekzender MTV. *Lisa* kon haar geluk niet op toen zij mee mocht doen aan het programma 'Pimp My Room', waarin haar kamer werd opgeknapt. *Maar helaas, alleen Lisa vindt dat haar gepimpte kamer klasse heeft.* Smaken verschillen nu eenmaal.

(Lisa and Anouk love the music channel MTV. Lisa was very happy when she was selected for the show 'Pimp My Room', in which her room was redecorated. Sadly, only Lisa thinks that her pimped room has a touch of class. *Oh well, to each their own taste.)*

(17) <u>Sloppy-bias, ellipsis</u>

Lisa en Anouk zijn dol op de muziekzender MTV. *Zij* konden hun geluk niet op toen zij mee mochten doen aan het programma 'Pimp My Room', waarin hun kamers werden opgeknapt. *Maar helaas, Lisa vindt dat haar gepimpte kamer klasse heeft, maar Anouk niet.* Smaken verschillen nu eenmaal.

(Lisa and Anouk love the music channel MTV. They were very happy when they were selected for the show 'Pimp My Room', in which their rooms were redecorated. Sadly, Lisa thinks that her pimped room has a touch of class, but Anouk does not. *Oh well, to each their own taste.)*

(18) <u>Strict-bias, ellipsis</u>

Lisa en Anouk zijn dol op de muziekzender MTV. *Lisa* kon haar geluk niet op toen zij mee mocht doen aan het programma 'Pimp My Room', waarin haar kamer werd opgeknapt. *Maar helaas, Lisa vindt dat haar gepimpte kamer klasse heeft, maar Anouk niet.* Smaken verschillen nu eenmaal.

(Lisa and Anouk love the music channel MTV. Lisa was very happy when she was selected for the show 'Pimp My Room', in which her room was redecorated. Sadly, Lisa thinks that her pimped room has a touch of class, but Anouk does not. *Oh well, to each their own taste.)*

The story was either biased towards a sloppy (ex. (15) and (17)) or strict interpretation (ex. (16) and (18)) and, furthermore, the critical sentence contained the *only*-operator[5] (ex. (15) and (16)) or, alternatively, was an ellipsis that closely resembled the meaning of the *only*-sentence (ex. (17) and (18)). The bias of the story was created in the second sentence by giving some information about both story characters or by giving information about only one story character. The idea is that if you provide information for both characters the interpretation of the

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[5] I also used equivalent structures such as *Paul was de enige die* ('Paul was the only who'), to create more diversity in the materials.

ambiguous third sentence is biased towards a sloppy interpretation, but if you provide the same information for only one character the story is biased towards the strict interpretation. For instance, if we look at example (15) we notice that the second sentence tells us something about both *Lisa and Anouk*, namely that their rooms were redecorated in a popular television show. Bearing this in mind, the critical sentence *only Lisa thought that her pimped room had a touch of class* is most easily interpreted if it has the meaning that 'Lisa thought that Lisa's room (i.e. her own room) had a touch of class' but that 'Anouk thought that Anouk's room (i.e. her own room) did not have a touch of class'. This reading, in which both girls are thinking about their own room, represents the sloppy or bound interpretation. On the other hand, if you provide the same information for only one character, as in example (16), the interpretation of the critical sentence changes. In this case the preceding context tells us that only Lisa's room is redecorated. Therefore, the critical sentence is more easily interpreted if it means that 'Lisa thought that Lisa's room had a touch of class' but that 'Anouk thought that Lisa's room did not have a touch of class'. This latter interpretation of the critical sentence in which Anouk is thinking about Lisa's room and not her own room represents the strict reading. The advantage of this design is that we can use exactly the same critical sentences in a minimally different context. Moreover, we do not need a specific biasing verb in the ellipsis conditions to elicit a sloppy or strict identity, which could confound the results.

3.5.3. Experiment 2: A sloppy questionnaire

The main objective of the questionnaire experiment was to pretest the materials for the eye-tracking experiment. I examined whether the manipulation to bias the stories towards a sloppy or strict interpretation was successful by presenting the different conditions followed by the two possible interpretations formulated as an inference of the critical sentence (ex. (19) and (20)).

(19) Anouk does not think her own pimped room has a touch of class. *(sloppy interpretation)*

(20) Anouk does not think Lisa's pimped room has a touch of class. *(strict interpretation)*

The participants were instructed to indicate first how well both interpretations fitted a story context by rating them on a 5-point scale (1= 'very good', 5 = 'very bad') after which they gave their final preference for a particular story. In addition, difficulty and plausibility ratings for the stories as a whole were obtained (1 = 'very easy' and 'very plausible', 5 = 'very difficult' and 'not plausible at all').

Although not the main objective of the offline experiment, the results are also relevant for the discussion on whether the bound-variable preference of the parser is much weaker or even reversed in *only*-sentences as compared to ellipses (Frazier & Clifton, 2000). If this is indeed the case we should expect that for *only*-sentences participants are either less likely to establish a sloppy interpretation in sloppy-biased stories, or more likely to establish a strict interpretation in strict-biased stories (or perhaps both these effects become visible). In addition, the results can also be related to the general hypothesis that binding dependencies are preferred over coreference dependencies. This hypothesis predicts that participants more easily construct a sloppy reading in the sloppy-biased stories than a strict reading in strict-biased stories. However, because the stories are specifically designed to have either a sloppy or strict bias, the results may be somewhat difficult to interpret. For instance, if the results are consistent with the variable binding preference hypothesis, this cannot unequivocally be attributed to a default preference of the parser to construct bound dependencies: the results could also indicate that the strength of the manipulation was not completely balanced across conditions. Be that as it may, I will report and discuss the relevant results as there is no a priori reason that the manipulation would be less effective in the strict stories than in the sloppy stories.

3.5.3.1. Method.

Participants. Participants were 20 members from the Utrecht University community (18 female, mean age 20, range 18-22) who received money for their participation.

Materials and procedure. I constructed 36 short stories using scenarios that were expected to be of interest to the average participant (see Appendix II for all Dutch originals). Each experimental story occurred in four versions as illustrated above in examples (15) to (18). The first and the last sentences were held constant across conditions. In the first sentence a particular situation or event involving two story characters was sketched and the last sentence contained a final comment. The latter made the discourse more cohesive, but was primarily included to protect the critical regions in the eye-tracking experiment (Experiment 3) from unwanted noise due to end-of trial events (e.g. final 'wrap up'). The second sentence created the bias by saying something about both story characters (sloppy bias) or by giving information about only one story character (strict bias). The third sentence was the critical ambiguous sentence, which contained the *only*-operator or, alternatively, was an ellipsis.

The stories were directly followed by two inferences of the story that were consistent with either a sloppy or strict interpretation. In half of the cases the consistent inference appeared above the inconsistent inference, in the other half the order was reversed. After participants had rated both inferences, they had to indicate which one they preferred. Finally, participants rated the stories on difficulty and plausibility.

The stimuli were divided into four lists, with only one version of each story in a particular list. Thirty-six stories of an unrelated experiment were included as fillers. The stories were presented in random order, and a new randomization was used for each participant.

The entire experiment ran on the internet. The CGI-script WWSTIM was used to create the relevant web pages.[6] Participants started by filling out a registration form after which they received instructions for the experiment. Before the actual experiment started, two practice trials were presented. A full session was generally completed within 90 minutes. However, participants could pause the experiment whenever and for as long as they liked.

3.5.3.2. Results

Difficulty and plausibility ratings

On average participants rated the stories as 'fairly easy' (grand mean 2.12) and 'fairly plausible' (grand mean 2.35, see Table 6 for plausibility and difficulty ratings for each condition separately). Repeated Measures ANOVAs were performed on the difficulty and plausibility ratings with two-level factors *Structure* (i.e. *only-sentences* versus *ellipses*) and *Story-bias* (i.e. *sloppy-biased* versus *strict-biased*). For the difficulty rating, neither the by-subject nor the by-items analysis returned a significant main effect or interaction. However, planned Paired-Sample T-Tests revealed that strict-biased stories in the *only*-condition were rated more difficult than

[6] I thank Theo Veenker for making this software available. For more information you can visit his personal website at: www.let.uu.nl/~Theo.Veenker/personal.

strict-biased stories in the ellipsis condition (t_1 (19) = 2.247, p = .037; t_2 (35) = 2.193, p = .035) For the plausibility rating, the by-subjects ANOVA showed a significant main effect for the factor *Structure* (F_1 (1,19) = 4.803, *Mse* = .0869, p =.041; F_2 (1, 35) = 2.570, *Mse* = .292, p =.118). The *only*-conditions were rated less plausible than the ellipsis conditions. If we examine the relevant means in Table 6 it appears that this difference mainly arises due to the difference in plausibility rating for the stories biased towards a strict interpretation. Planned Paired-Sample T-Tests confirm this contrast because, whereas strict-biased stories in the *only*-condition were rated less plausible than strict-biased stories in the ellipsis condition (t_1 (19) = 2.660, p = .015; t_2 (35) = 2.171, p = .037), no rating differences emerged between the sloppy-biased stories. The difficulty and the plausibility ratings therefore suggest that in the stories with the *only*-operator, the strict reading is more difficult to obtain and is therefore less plausible than in stories with elliptic structures. Because, on the other hand, no difference exists between the two structures for establishing a sloppy interpretation, these results are inconsistent with an account in which the preference for a bound-variable dependency (i.e. sloppy interpretation) is stronger in ambiguous ellipses than in ambiguous *only*-structures. In fact, the ratings suggest the opposite, that is, the preference for establishing a bound-variable dependency may even be somewhat stronger in the latter.

Table 6. Mean difficulty and plausibility ratings for the stories in Exp. 2.

	Structure			
	Only		Ellipsis	
Story-bias	Difficulty	Plausibility	Difficulty	Plausibility
Sloppy	2.11	2.38	2.11	2.36
Strict	2.23	2.46	2.02	2.20

Sloppy versus strict interpretation

The manipulation to bias readers towards either a sloppy or strict interpretation of the critical ambiguous sentence was successful. Participants indicated that they preferred a sloppy reading in the sloppy-biased stories (81%) and a strict reading in the strict-biased stories (72%). Repeated Measures ANOVAs, again with the two-level factors *Structure* (i.e. *only-sentences* versus *ellipses*) and *Story-bias* (i.e. *sloppy-biased* versus *strict-biased*), revealed a significant effect for the factor *Story-bias*, but only in the by-subjects analysis (F_1 (1, 19) = 5.204, *Mse* = 294.245, p =.034; F_2

(1, 35) = 2.274, *Mse* = 1211.964, p =.141). If this effect is genuine it suggests that the bias towards the consistent interpretation (*consistent interpretation*: a sloppy interpretation in a sloppy-biased story, and similarly, a strict interpretation in a strict-biased story) is somewhat stronger in the sloppy-biased stories. This finding would be in line with the economy hierarchy of the POB model, because it suggests that it is somewhat easier (i.e. more economic) to obtain a sloppy interpretation than a strict interpretation. Furthermore, planned Paired-Sample T-Tests showed that in *only*-sentences participants preferred the consistent interpretation in a sloppy-biased story more often than the consistent interpretation in a strict-biased story (t_1 (19) = 2.505, p = .022; t_2 (35) = 2.129, p = .040; see Table 7 for the relevant percentages). This difference, on the other hand, was absent in the ellipsis stories. As such, the results are inconsistent with an account that assumes that the preference for a sloppy interpretation is weaker in *only*-sentences than in ellipses. In fact, a direct comparison between the sloppy-biased stories in the ellipsis and *only*-version revealed the opposite: the preference for a consistent sloppy interpretation seemed to be stronger in sentences with the *only*-operator (t_1 (19) = 2.117, p = .048; t_2 (35) = 2.002, p = .053). Hence, these results show a similar pattern to the difficulty and plausibility ratings and suggest that at least within the context of my stories the preference for a sloppy dependency in *only*-sentences is as strong as (or even stronger than) in ellipses.

Table 7. Mean bias towards consistent interpretation for the stories in Exp. 2.

	Structure	
Story-bias	Only	Ellipsis
Sloppy	85%	77%
Strict	71%	73%

In addition, the ratings for the sloppy and strict interpretation in the different story contexts for the most part confirmed the results discussed above. Repeated Measures ANOVAs with the two level factors *Interpretation* (i.e. *consistent* versus *inconsistent*), *Structure* (i.e. *only-sentences* versus *ellipses*) and *Story-bias* (i.e. *sloppy-biased* versus *strict-biased*) revealed a significant main effect for the factor *Interpretation* (F_1 (1, 19) = 166.341, *Mse* = .613, p < .001; F_2 (1, 35) = 140.277, *Mse* = 1.309, p < .001). This indicates that the consistent interpretation (mean rating 1.89) fitted the story context better than the inconsistent interpretation (mean rating 3.48) and confirmed that the stories were biased towards the intended interpretation. The analysis also returned a significant main effect for the factor *Story-bias* (F_1 (1, 19) = 16.381, *Mse* = .100, p < .001; F_2 (1, 19) = 15.870, *Mse* = .187, p < .001). The mean rating collapsed over consistent and inconsistent interpretation ratings was higher in sloppy-biased stories (mean rating 2.58) than in strict-biased stories (mean rating 2.79). However, if we inspect the relevant means in Table 8 it appears that this effect mainly emerges due to rating difference between *consistent* sloppy and strict interpretations. Planned Paired-Sample T-Tests confirmed this, as in the *only*-sentences consistent sloppy interpretations fitted the story context better than consistent strict interpretations (t_1 (19) = 3.550, p = .002; t_2 (35) = 3.591, p < .001). The analysis for the ellipsis structures showed signs of a similar effect, though only in the by-subjects analysis (t_1 (19) = 2.095, p =.050; t_2 (35) = 1.429, p = .162). Since the ratings for the *inconsistent* conditions showed no significant differences at all (i.e. they were rated equally bad), the results are again in line with the predictions of the POB model. That is, due to a general binding preference participants more easily accept a sloppy reading in the sloppy-biased stories than a strict reading in the strict-biased stories.

Table 8. Mean ratings for the sloppy and strict interpretation of the stories in Exp. 2 (1 = good fit, 5 = bad fit).

		Structure	
Interpretation	*Story-bias*	Only	Ellipsis
Consistent	Sloppy	1.65	1.71
	Strict	2.20	1.97
Inconsistent	Sloppy	3.54	3.42
	Strict	3.53	3.44

In sum, the results of the questionnaire experiment showed that, while using a relatively simple manipulation and exactly the same critical sentence, participants were biased towards either a sloppy or strict interpretation of an ambiguous *only*-sentence or ellipsis. Furthermore, it was somewhat easier to create a bias towards a sloppy reading, which is consistent with the hypothesis that in the case of ambiguity the parser prefers a bound-variable dependency over a coreferential dependency. Finally, the results do not suggest that the *only*-operator has a very different effect on the interpretation of an ambiguous anaphoric dependency than an ellipsis structure and therefore go against an account that assumes a much weaker or even reversed preference in the case of the former (cf. Frazier & Clifton, 2000).

3.5.3.3. Selection procedure for eye-tracking stimuli

The finding that the bias towards the intended interpretation was stronger for the sloppy stories than for the strict stories, although consistent with the predictions of the POB model and LF-only hypothesis, presents a possible problem for the analysis of the eye-tracking experiment. That is, if the reading patterns show that people have more difficulty with a strict interpretation of a story than with a sloppy interpretation, I would like to attribute this contrast to the preference of the parser to construct a sloppy interpretation initially, irrespective of the story context. However, a critical reader may in this case correctly object to this conclusion by pointing out that I used stories that had a stronger sloppy bias at the outset. To rule out this possibility, 24 stories were selected out of the original 36, with the following characteristics: (i) the strength of the sloppy and strict bias was high and roughly the same in all four versions, and (ii) the rating difference between the consistent and inconsistent interpretation was high in all versions of an item. In other words, I did not only make sure that the final interpretation was strongly biased towards the intended reading, but I also ensured that the competing inconsistent interpretation was relatively weak.

Table 9. Mean bias towards consistent interpretation for eye-tracking stimuli (Exp. 3).

	Structure	
Story-bias	Only	Ellipsis
Sloppy	86%	79%
Strict	80%	86%

The items in the selected subset showed a strong bias for both the sloppy and strict direction, and, importantly, the strength of the bias was balanced across conditions (mean sloppy bias = 82%; mean strict bias = 83%). Moreover, Paired-Sample T-Tests revealed no significant differences between the bias strength for all four versions of the stimuli (see Table 9 for the associated means).[7] The difficulty and plausibility ratings for the eye-tracking subset, on the other hand, were not fully

[7] The absence of a significant effect does not rule out the possibility that the dependent variables differ from each other. In other words, formally I cannot state that the conditions are matched (see Tryron, 2001, for a discussion of statistical equivalence and the use of null hypothesis statistical tests).

balanced across conditions (see Table 10 for mean ratings for each version of the stories). Repeated Measures ANOVAs with the factors *Structure* (i.e. *only-sentences* versus *ellipses*) and *Story-bias* (i.e. *sloppy-biased* versus *strict-biased*) revealed a significant main effect for the factor *Structure* in both the difficulty (F_1 (1, 19) = 7.157, *Mse* = .122, *p* =.015; F_2 (1, 23) = 7.783, *Mse* = .134, *p* =.010) and the plausibility ratings (F_1 (1, 19) = 12.917, *Mse* = .080, *p* =.002; F_2 (1, 23) = 6.039, *Mse* = .232, *p* =.022). Stories with the *only*-operator were rated more difficult and less plausible than ellipses (mean ratings for *only*-sentences: difficulty = 2.24, plausibility = 2.40; mean ratings for ellipses: difficulty = 2.03, plausibility = 2.18). For the difficulty rating the interaction between *Structure* and *Story-bias* also returned a significant result for the by-subjects analysis (F_1 (1, 19) = 4.390, *Mse* = .363, *p* =.050; F_2 (1, 23) = 3.488, *Mse* = .122, *p* =.075). Paired-Sample T-Tests revealed that the strict-biased stories with the *only*-operator were rated more difficult than the strict-biased ellipsis stories (t_1 (19) = 3.198, *p* = .005; t_2 (23) = 3.125, *p* = .005) and sloppy-biased ellipsis stories (t_1 (19) = 2.151, *p* = .045; t_2 (23) = 2.204, *p* = .038). Because these contrasts were absent in the comparisons with the sloppy-biased *only*-stories, it seems that the interaction (and the main effect) in the difficulty rating is mainly due to a more difficult strict-biased story in the *only*-conditions. Thus, even if bias strength is balanced across the sloppy and strict conditions it may be a little bit harder to obtain a strict interpretation in structures with the *only*-operator. However, because (i) the main goal was to select items in which the bias was equally strong in the sloppy and strict conditions, (ii) the differences in the difficulty ratings are relatively small and (iii) no differences appeared *within* the ellipsis and *only*-conditions, I feel confident that the selected items are sufficiently controlled for.

Table 10. Mean difficulty and plausibility ratings for eye-tracking stimuli (Exp. 3).

	Structure			
	Only		Ellipsis	
Story-bias	Difficulty	Plausibility	Difficulty	Plausibility
Sloppy	2.15	2.37	2.08	2.21
Strict	2.33	2.44	1.99	2.14

3.5.4. Experiment 3: Sloppy eye tracking

In an eye-tracking experiment the selected stimuli were presented to healthy adults. The POB approach and LF-only hypothesis predict that readers prefer a sloppy interpretation regardless of the content of the preceding discourse. As a result, readers initially construct the 'wrong' interpretation in strict-biased stories. In the *only*-sentences this could result in longer first-pass reading times right at or, due to spillover, immediately after the critical pronominal. In ellipsis sentences, however, the ambiguity appears more downstream in the second conjunct (i.e. the conjunct containing the 'gap'). Thus, for the ellipses first-pass reading time differences are more likely to emerge in the second conjunct, rather than at the overt pronominal in the first conjunct, simply because in the first conjunct no real ambiguity exists. Furthermore, for the strict-biased stories in both ellipses and *only*-structures readers are expected to show signs of re-analysis or 'back-tracking'. That is, due to the initial wrong sloppy interpretation readers are in a way 'garden-pathed' and may need to re-examine the sentence that precedes the ellipsis and *only*-sentence (e.g. the sentence *Lisa was very happy when she was selected for the show 'Pimp My Room', in which her room was redecorated*, see ex. (16) and (18)) in order to change the sloppy into a more suitable strict reading. In that case second-pass reading times of the second sentence (i.e. the sentence containing the actual biasing information) should be longer in strict-biased stories.

3.5.4.1. Method

Participants. Participants were 32 members from the Utrecht University community (all female, mean age 21, range 17 - 42 years) who received money for their participation.

Materials and procedure. The 24 selected stimuli were divided into four lists, with only one version of each story in a particular list (see Appendix II for all Dutch originals). Another 24 stories were included as fillers. For a detailed description of the pseudo-randomization procedure, the general eye-tracking procedure and the inclusion of comprehension questions, I refer the reader to Paragraph 2.2.2 (Chapter 2). All participants scored above 67% correct (mean score 86%) on the comprehension questions. Each session was completed within 30 minutes.

Analysis. In addition to the critical third sentence the analyses also considered the second sentence, because this region contained the critical manipulation, i.e. the actual sloppy or strict bias of the story. These two sentences were divided into the following regions (illustrated with the relevant sections of example (17)).

1. They were very happy when they were selected for the show Pimp My Room, in which their rooms were 'redecorated'. *(second sentence)*
2. Sadly, *(initial region)*
3. Lisa *(proper name)*
4. thinks that *(pre-critical region)*
5. her *(pronominal)*
6. pimped room *(spillover region 1)*
7. has a *(spillover region 2)*
8. touch of class, *(end of conjunct)*
9. but Anouk does not. *(ellipsis)*

Thus, the first region consisted of the whole second sentence. The second region consisted of the words that made up the beginning of the critical third sentence up to subject. The third region was the subject character of the third sentence, i.e. in this case *Lisa*. The pre-critical region consisted of all the words between the proper name and the pronominal. Spillover region 1 included the two words following the pronominal and spillover region 2 included the third and fourth word following the pronominal. The end-of-conjunct region consisted of any remaining words of the sentence (if present) up to the ellipsis region. Note that the ellipsis region is absent in the *only*-conditions.

I will report mean reading times for six different eye movement measures, namely first fixation, first gaze, total first gaze, regression path, total fixation and second-pass durations (see Paragraph 1.4.2.1 of Chapter 1 for a discussion of the different measures). Prior to all analyses, 1.2% of the trials was removed because major tracker losses and eye blinks made it impossible to determine the course of fixations. For all different measures reading times of more than two standard deviations from both the participant's mean and the item's mean in a region in a particular condition were treated as missing data (< 1% for all measures).

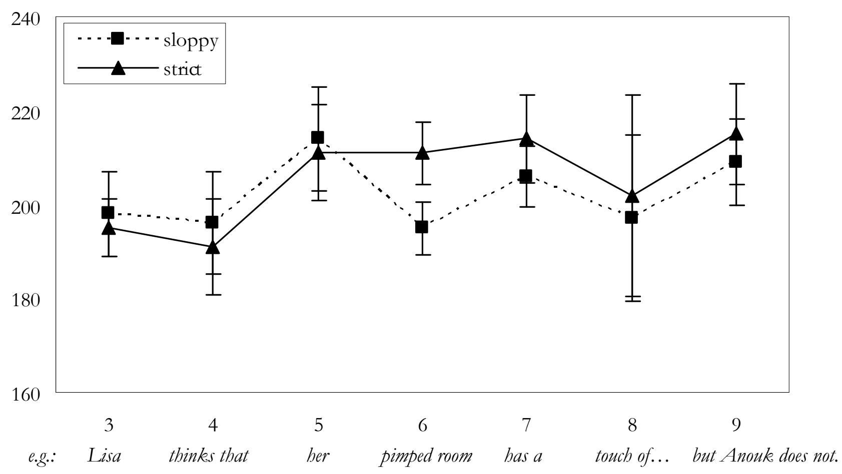
Repeated Measures ANOVAs with the two-level factors *Story-bias* (i.e. *sloppy-biased* versus *strict-biased*) and *Structure* (i.e. *only-sentence* versus *ellipsis*) were performed to compare the different conditions. I will, however, not discuss any main effect results for the factor *Structure* as it does not bear on the relevant issues. In addition to the ANOVAs, separate planned Paired-Sample T-Tests were performed for the ellipses and *only*-structures.

3.5.4.2. Results

First fixation duration

Table 11 reports the mean first fixation duration as a function of *Story-bias*, *Structure* and story region, and in addition includes the associated Repeated Measures ANOVAs and Paired-Sample T-Tests. The ANOVAs revealed a significant main effect for the factor *Bias* in the first spillover region (i.e. regions 6, note that the by-items result was marginally significant, p = .051). In this region the first fixation duration was shorter for the stories biased towards a sloppy interpretation. Furthermore, in the initial region (region 2) a significant *Bias* by *Structure* interaction emerged, but only in the by-items analysis. The same effect appeared in the first gaze and total first gaze durations. However, this interaction is not representative for the set of stories as a whole, because most of the stories did not contain an initial region, but simply started with the subject of the critical sentence (i.e. the proper name). Moreover, as in all three measures the interaction was clearly not significant in the by-subjects analysis I refrain from any further discussion of the effect.

Figure 9. Mean first fixation durations (in ms) for region 3-9 for the ellipsis stories in Exp. 3.



Similar to the ANOVA results, the planned T-Tests showed a significant difference in the first spillover region, but only for the elliptic structures. Again, first fixation durations were shorter in the sloppy-biased stories (see Figure 9). So, consistent with the predictions first fixation durations tend to be longer right after the critical overt pronominal of strict-biased stories. However, this effect was most pronounced in the ellipsis conditions and not, as expected, in the *only*-conditions.

Table 11. Mean first fixation durations (in ms), Repeated Measures ANOVAs and Paired-Sample T-Tests for Exp. 3.

	Region								
	1	2	3	4	5	6	7	8	9
e.g.:	*They …*	*Sadly*	*Lisa*	*thinks that*	*her*	*pimped room*	*has a*	*touch of class*	*but Anouk*
				First fixation duration					
total									
sloppy	204	208	195	202	212	198	207	193	-
strict	204	211	193	194	211	209	214	210	-
only									
sloppy	205	204	191	209	210	202	207	190	-
strict	209	215	191	196	211	207	215	218	-
ellipsis									
sloppy	202	211	198	196	214	195	206	197	209
strict	200	207	195	191	211	211	214	202	215
F1 (Bias)									
F	< 1	< 1	< 1	1.650	< 1	7.878	1.627	1.374	-
df	-	-	-	1, 30	-	1, 31	1, 31	1, 21	-
Mse	-	-	-	1346	-	465	1182	4552	-
p	-	-	-	.209	-	.009*	.212	.254	-
F2 (Bias)									
F	< 1	< 1	< 1	< 1	1.174	4.253	< 1	< 1	-
df	-	-	-	-	1, 22	1, 23	-	-	-
Mse	-	-	-	-	2329	922	-	-	-
p	-	-	-	-	.290	.051	-	-	-
F1 (Bias x Structure)									
F	< 1	< 1	< 1	< 1	< 1	1.465	< 1	< 1	-
df	-	-	-	-	-	1, 31	-	-	-
Mse	-	-	-	-	-	697	-	-	-
p	-	-	-	-	-	.235	-	-	-
F2 (Bias x Structure)									
F	< 1	9.023	< 1	< 1	< 1	1.561	< 1	2.258	-
df	-	1, 6	-	-	-	1, 23	-	1, 6	-
Mse	-	190	-	-	-	440	-	1005	-
p	-	.024*	-	-	-	.224	-	.184	-
t1 (Only)									
t	< 1	1.046	< 1	1.401	< 1	< 1	< 1	1.035	-
df	-	31	-	31	-	-	-	26	-
Se	-	10.90	-	8.18	-	-	-	17.93	-
p	-	.304	-	.171	-	-	-	.310	-
t2 (Only)									
t	< 1	< 1	< 1	< 1	< 1	1.082	< 1	< 1	-
df	-	-	-	-	-	23	-	-	-
Se	-	-	-	-	-	6.87	-	-	-
p	-	-	-	-	-	.291	-	-	-
t1 (Ellipsis)									
t	< 1	< 1	< 1	< 1	< 1	2.727	1.016	< 1	< 1
df	-	-	-	-	-	31	31	-	-
Se	-	-	-	-	-	5.99	7.79	-	-
p	-	-	-	-	-	.010*	.318	-	-
t2 (Ellipsis)									
t	< 1	< 1	< 1	< 1	< 1	2.227	1.058	< 1	< 1
df	-	-	-	-	-	23	17	-	-
Se	-	-	-	-	-	8.14	7.18	-	-
p	-	-	-	-	-	.036*	.305	-	-

First gaze duration
The mean first gaze durations and associated statistics are given in Table 12. The ANOVAs revealed a significant main effect for the factor *Bias* in the second sentence region (region 1). First gaze durations were longer in the sloppy-biased stories. The separate by-subjects T-Tests for region 1 in elliptic and *only*-structures confirm this result, but the by-items analyses fell short of significance. For the ellipses there was also a difference in the following initial region (note that the by-subjects result was marginally significant, p = .053). Again, the first gaze duration in this region was longer for sloppy stories.

In general, the second sentence in sloppy-biased stories contained more words than the second sentence in strict-biased stories (14.7 versus 14.0 words resp.), which could explain the longer first-pass reading times for the former. The precise explanation for the first-pass difference in region 1 and 2 is however of secondary interest, because readers have not yet encountered the ambiguous ellipsis or *only*-sentence.

Total first gaze
The mean total first gaze durations and associated statistics are given in Table 13. The ANOVAs revealed no significant main effect, nor any interesting significant interaction – apart from the interaction in region 2, which I already addressed above in the discussion of the first fixation durations. The by-items T-Tests revealed a significant effect in the ellipsis region (region 9). Although the by-subjects T-Test did not reach the required significance level (the relevant p-value was .085) it seems that participants spent less time in the ellipsis region if the story was biased towards a sloppy reading, which is consistent with the predictions of the POB model.

Table 12. Mean first gaze durations (in ms), Repeated Measures ANOVAs and Paired-Sample T-Tests for Exp. 3.

	Region								
	1	2	3	4	5	6	7	8	9
e.g.:	*They* …	*Sadly*	*Lisa*	*thinks that*	*her*	*pimped room*	*has a*	*touch of class*	*but Anouk*
				First gaze duration					
total									
sloppy	2950	874	209	517	220	341	388	297	-
strict	2709	811	206	486	230	349	404	289	-
only									
sloppy	2985	857	199	710	216	348	402	308	-
strict	2751	857	205	651	225	359	426	293	-
ellipsis									
sloppy	2915	890	218	323	224	333	373	286	565
strict	2667	766	208	321	235	340	381	286	562
F1 (Bias)									
F	13.37	1.343	< 1	< 1	1.682	< 1	< 1	< 1	-
df	1, 31	1, 31	-	-	1, 27	-	-	-	-
Mse	13907	92583	-	-	1662	-	-	-	-
p	.001*	.255	-	-	.206	-	-	-	-
F2 (Bias)									
F	4.502	< 1	< 1	< 1	< 1	< 1	< 1	2.585	-
df	1, 23	-	-	-	-	-	-	1, 6	-
Mse	25674	-	-	-	-	-	-	2643	-
p	.045*	-	-	-	-	-	-	.159	-
F1 (Bias x Structure)									
F	< 1	1.185	1.031	< 1	< 1	< 1	< 1	< 1	-
df	-	1, 31	1, 29	-	-	-	-	-	-
Mse	-	10429	1878	-	-	-	-	-	-
p	-	.285	.318	-	-	-	-	-	-
F2 (Bias x Structure)									
F	< 1	26.61	2.546	< 1	< 1	< 1	< 1	< 1	-
df	-	1, 6	1, 21	-	-	-	-	-	-
Mse	-	5984	3003	-	-	-	-	-	-
p	-	.002*	.125	-	-	-	-	-	-
t1 (Only)									
t	2.011	< 1	< 1	< 1	< 1	< 1	< 1	< 1	-
df	31	-	-	-	-	-	-	-	-
Se	116.4	-	-	-	-	-	-	-	-
p	.053	-	-	-	-	-	-	-	-
t2 (Only)									
t	1.367	1.215	< 1	< 1	< 1	< 1	< 1	1.189	-
df	23	14	-	-	-	-	-	7	-
Se	157.6	52.20	-	-	-	-	-	35.13	-
p	.185	.245	-	-	-	-	-	.273	-
t1 (Ellipsis)									
t	2.334	2.012	< 1	< 1	< 1	< 1	< 1	< 1	< 1
df	31	31	-	-	-	-	-	-	-
Se	106.2	61.87	-	-	-	-	-	-	-
p	.026*	.053	-	-	-	-	-	-	-
t2 (Ellipsis)									
t	1.700	2.507	1.221	< 1	< 1	< 1	< 1	< 1	< 1
df	23	9	21	-	-	-	-	-	-
Se	131.3	45.51	21.29	-	-	-	-	-	-
p	.103	.033*	.236	-	-	-	-	-	-

Table 13. Mean total first gaze durations (in ms), Repeated Measures ANOVAs and Paired-Sample T-Tests for Exp. 3.

					Region				
	1	2	3	4	5	6	7	8	9
e.g.:	*They …*	*Sadly*	*Lisa*	*thinks that*	*her*	*pimped room*	*has a*	*touch of class*	*but Anouk*
					Total first gaze duration				
total									
sloppy	3217	902	228	588	239	402	443	328	-
strict	3090	874	217	563	243	412	464	315	-
only									
sloppy	3249	891	214	801	234	420	475	341	-
strict	3085	892	218	725	225	428	472	339	-
ellipsis									
sloppy	3186	913	242	374	243	384	410	314	591
strict	3095	857	217	400	261	397	456	291	634
F1 (Bias)									
F	4.109	< 1	< 1	< 1	< 1	< 1	< 1	< 1	-
df	1, 31	-	-	-	-	-	-	-	-
Mse	12570	-	-	-	-	-	-	-	-
p	.051	-	-	-	-	-	-	-	-
F2 (Bias)									
F	1.074	1.735	2.832	< 1	< 1	< 1	< 1	5.459	-
df	1, 23	1, 6	1, 21	-	-	-	-	1, 6	-
Mse	24338	15916	2411	-	-	-	-	2866	-
p	.311	.236	.107	-	-	-	-	.058	-
F1 (Bias x Structure)									
F	< 1	< 1	2.747	1.922	1.379	< 1	< 1	< 1	-
df	-	-	1, 29	1, 30	1, 27	-	-	-	-
Mse	-	-	2228	42300	3702	-	-	-	-
p	-	-	.108	.176	.251	-	-	-	-
F2 (Bias x Structure)									
F	< 1	11.68	3.187	1.073	< 1	< 1	< 1	< 1	-
df	-	1, 6	1, 21	1, 19	-	-	-	-	-
Mse	-	7789	3674	10521	-	-	-	-	-
p	-	.014*	.089	.313	-	-	-	-	-
t1 (Only)									
t	1.845	< 1	< 1	< 1	< 1	< 1	< 1	< 1	-
df	31	-	-	-	-	-	-	-	-
Se	88.66	-	-	-	-	-	-	-	-
p	.075	-	-	-	-	-	-	-	-
t2 (Only)									
t	1.063	1.340	< 1	< 1	< 1	< 1	< 1	< 1	-
df	23	14	-	-	-	-	-	-	-
Se	132.6	41.46	-	-	-	-	-	-	-
p	.299	.202	-	-	-	-	-	-	-
t1 (Ellipsis)									
t	1.182	1.044	1.988	< 1	< 1	< 1	1.586	< 1	1.781
df	31	31	30	-	-	-	31	-	31
Se	76.61	53.81	12.15	-	-	-	28.52	-	24.66
p	.246	.305	.056	-	-	-	.123	-	.085
t2 (Ellipsis)									
t	< 1	1.207	1.904	< 1	< 1	< 1	1.374	1.125	3.068
df	-	9	21	-	-	-	17	6	23
Se	-	51.17	21.36	-	-	-	29.39	35.23	16.90
p	-	.258	.071	-	-	-	.187	.303	.005*

Regression path duration

The mean regression path durations and associated statistics are given in Table 14. The ANOVAs revealed a significant main effect in region 3 (the proper name region), but only for the by-items analysis. Since the by-subjects analysis was far from significant, I will refrain from further discussion. The analysis of region 7, the second spillover region, returned a significant main effect (note that the by-subjects ANOVA was marginally significant, i.e. p = .051). In this region there was a reading time advantage for the sloppy-biased stories. The T-Tests confirmed this latter result, but only for the elliptic stories (note that the by-items T-Test was marginally significant, i.e. p = .059). Most importantly, however, the T-Tests showed a significant difference in the ellipsis region. Consistent with the predictions of the POB model, regression path durations in this region were much shorter in the sloppy-biased stories (see Figure 10).

Figure 10. Mean regression path durations (in ms) for the ellipsis regions in Exp. 3.

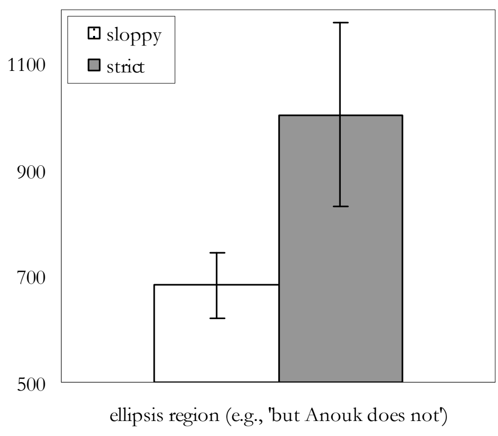


Table 14. Mean regression path durations (in ms), Repeated Measures ANOVAs and Paired-Sample T-Tests for Exp. 3.

	Region								
	1	2	3	4	5	6	7	8	9
e.g.:	*They …*	*Sadly*	*Lisa*	*thinks that*	*her*	*pimped room*	*has a*	*touch of class*	*but Anouk*
				Regression path duration					
total									
sloppy	3316	940	305	671	316	572	603	538	-
strict	3244	930	277	657	316	556	790	544	-
only									
sloppy	3372	940	303	879	304	616	668	564	-
strict	3230	957	285	780	256	599	762	724	-
ellipsis									
sloppy	3260	940	307	463	328	529	537	512	683
strict	3259	904	267	533	376	512	818	363	1003
F1 (Bias)									
F	1.018	< 1	< 1	< 1	< 1	< 1	4.116	< 1	-
df	1, 31	-	-	-	-	-	1, 31	-	-
Mse	16112	-	-	-	-	-	27196	-	-
p	.321	-	-	-	-	-	.051	-	-
F2 (Bias)									
F	< 1	3.079	5.155	< 1	< 1	< 1	4.588	3.171	-
df	-	1, 6	1, 21	-	-	-	1, 17	1, 6	-
Mse	-	20515	8482	-	-	-	90614	16712	-
p	-	.130	.034*	-	-	-	.047*	.125	-
F1 (Bias x Structure)									
F	1.331	< 1	< 1	3.472	2.694	< 1	1.348	1.599	-
df	1, 31	-	-	1, 30	1, 27	-	1, 31	1, 21	-
Mse	11792	-	-	64177	24130	-	20808	32959	-
p	.258	-	-	.072	.112	-	.254	.220	-
F2 (Bias x Structure)									
F	< 1	4.838	< 1	3.784	< 1	< 1	1.411	< 1	-
df	-	1, 6	-	1, 19	-	-	1, 17	-	-
Mse	-	21123	-	17105	-	-	15142	-	-
p	-	.070	-	.067	-	-	.251	-	-
t1 (Only)									
t	1.322	< 1	< 1	1.122	1.523	< 1	< 1	< 1	-
df	31	-	-	31	28	-	-	-	-
Se	107.0	-	-	82.49	30.53	-	-	-	-
p	.196	-	-	.271	.139	-	-	-	-
t2 (Only)									
t	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	-
df	-	-	-	-	-	-	-	-	-
Se	-	-	-	-	-	-	-	-	-
p	-	-	-	-	-	-	-	-	-
t1 (Ellipsis)									
t	< 1	< 1	< 1	1.223	1.052	< 1	2.734	1.403	2.806
df	-	-	-	30	29	-	31	26	31
Se	-	-	-	57.50	47.91	-	102.6	91.81	114.2
p	-	-	-	.231	.301	-	.010*	.172	.009*
t2 (Ellipsis)									
t	< 1	< 1	1.292	< 1	< 1	< 1	2.027	1.371	3.830
df	-	-	21	-	-	-	17	6	23
Se	-	-	40.43	-	-	-	128.7	120.3	79.81
p	-	-	.210	-	-	-	.059	.219	.001*

Table 15. Mean total fixation durations (in ms), Repeated Measures ANOVAs and Paired-Sample T-Tests for Exp. 3.

	Region								
	1	2	3	4	5	6	7	8	9
e.g.:	*They …*	*Sadly*	*Lisa*	*thinks that*	*her*	*pimped room*	*has a*	*touch of class*	*but Anouk*
				Total fixation duration					
total									
sloppy	3076	1008	327	692	285	517	487	346	-
strict	3220	1051	307	681	314	536	498	301	-
only									
sloppy	3126	893	322	903	286	533	515	365	-
strict	3224	970	297	877	320	527	504	316	-
ellipsis									
sloppy	3026	1124	332	480	284	500	459	326	675
strict	3216	1133	318	484	307	545	492	286	753
F1 (Bias)									
F	7.847	< 1	1.341	< 1	3.766	< 1	< 1	2.778	-
df	1, 31	-	1, 31	-	1, 31	-	-	1, 25	-
Mse	84341	-	9435	-	6768	-	-	18767	-
p	.009*	-	.256	-	.061	-	-	.108	-
F2 (Bias)									
F	1.936	3.270	2.464	< 1	2.264	1.266	< 1	3.717	-
df	1, 23	1, 6	1, 23	-	1, 23	1, 23	-	1, 6	-
Mse	36199	35139	6532	-	6000	9380	-	3905	-
p	.177	.121	.130	-	.146	.272	-	.102	-
F1 (Bias x Structure)									
F	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	-
df	-	-	-	-	-	-	-	-	-
Mse	-	-	-	-	-	-	-	-	-
p	-	-	-	-	-	-	-	-	-
F2 (Bias x Structure)									
F	< 1	2.211	< 1	< 1	< 1	< 1	1.266	< 1	-
df	-	1, 6	-	-	-	-	1, 17	-	-
Mse	-	21903	-	-	-	-	5777	-	-
p	-	.188	-	-	-	-	.276	-	-
t1 (Only)									
t	1.082	< 1	< 1	< 1	1.414	< 1	< 1	< 1	-
df	31	-	-	-	31	-	-	-	-
Se	90.06	-	-	-	23.77	-	-	-	-
p	.288	-	-	-	.167	-	-	-	-
t2 (Only)									
t	< 1	< 1	1.056	< 1	1.478	< 1	< 1	1.467	-
df	-	-	23	-	23	-	-	7	-
Se	-	-	24.37	-	21.25	-	-	23.31	-
p	-	-	.302	-	.153	-	-	.186	-
t1 (Ellipsis)									
t	2.637	< 1	< 1	< 1	1.483	1.229	< 1	< 1	2.089
df	31	-	-	-	31	31	-	-	31
Se	72.13	-	-	-	15.39	36.36	-	-	37.44
p	.013*	-	-	-	.148	.228	-	-	.045*
t2 (Ellipsis)									
t	1.490	< 1	1.245	< 1	< 1	1.085	< 1	< 1	2.664
df	23	-	23	-	-	23	-	-	23
Se	141.7	-	20.93	-	-	34.62	-	-	30.17
p	.150	-	.226	-	-	.289	-	-	.014*

Table 16. Mean second-pass durations (in ms), Repeated Measures ANOVAs and Paired-Sample T-Tests for Exp. 3.

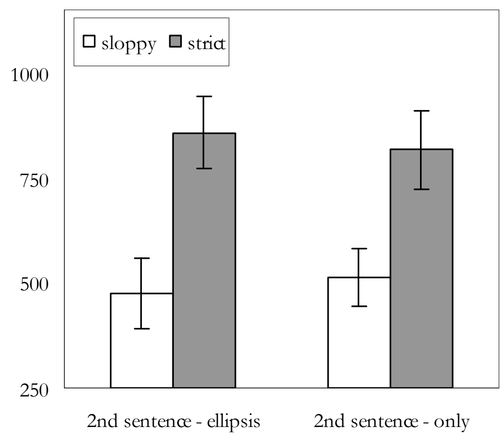
	Region								
	1	2	3	4	5	6	7	8	9
e.g.:	*They …*	*Sadly*	*Lisa*	*thinks that*	*her*	*pimped room*	*has a*	*touch of class*	*but Anouk*
				Second-pass duration					
total									
sloppy	493	285	151	234	94	202	124	60	-
strict	837	368	126	255	110	204	130	50	-
only									
sloppy	513	234	148	280	92	206	137	66	-
strict	817	285	111	296	116	175	123	73	-
ellipsis									
sloppy	474	337	153	188	95	197	111	53	177
strict	858	450	141	214	104	234	138	28	236
F1 (Bias)									
F	39.97	1.963	2.567	< 1	1.693	< 1	< 1	< 1	-
df	1, 31	1, 31	1, 31	-	1, 31	-	-	-	-
Mse	94756	11038	7479	-	5324	-	-	-	-
p	.001*	.171	.119	-	.203	-	-	-	-
F2 (Bias)									
F	10.92	< 1	3.819	< 1	1.309	< 1	< 1	< 1	-
df	1, 23	-	1, 23	-	1, 23	-	-	-	-
Mse	27658	-	3438	-	5050	-	-	-	-
P	.003*	-	.063	-	.246	-	-	-	-
F1 (Bias x Structure)									
F	< 1	< 1	< 1	< 1	< 1	2.392	< 1	< 1	-
df	-	-	-	-	-	1, 31	-	-	-
Mse	-	-	-	-	-	15596	-	-	-
p	-	-	-	-	-	.132	-	-	-
F2 (Bias x Structure)									
F	< 1	< 1	< 1	< 1	< 1	1.576	1.089	1.728	-
df	-	-	-	-	-	1, 23	1, 17	1, 6	-
Mse	-	-	-	-	-	16220	6436	2034	-
p	-	-	-	-	-	.222	.311	.237	-
t1 (Only)									
t	3.851	< 1	1.504	< 1	1.417	< 1	< 1	< 1	-
df	31	-	31	-	31	-	-	-	-
Se	79.00	-	24.33	-	17.29	-	-	-	-
p	.001*	-	.143	-	.166	-	-	-	-
t2 (Only)									
t	2.345	< 1	1.981	< 1	1.307	< 1	< 1	< 1	-
df	23	-	23	-	23	-	-	-	-
Se	137.4	-	17.69	-	18.40	-	-	-	-
p	.028*	-	.060	-	.204	-	-	-	-
t1 (Ellipsis)									
t	4.599	1.361	< 1	< 1	< 1	1.111	< 1	< 1	1.787
df	31	31	-	-	-	31	-	-	31
Se	83.45	83.28	-	-	-	32.85	-	-	33.26
p	.001*	.183	-	-	-	.275	-	-	.084
t2 (Ellipsis)									
t	2.679	< 1	< 1	< 1	< 1	1.075	1.123	1.101	2.104
df	23	-	-	-	-	23	17	6	23
Se	144.5	-	-	-	-	32.22	27.81	33.25	28.01
p	.013*	-	-	-	-	.293	.277	.313	.047*

Total fixation duration

The mean total fixation durations and associated statistics are given in Table 15. The ANOVAs revealed a significant main effect in region 1, that is, the second sentence region (note that only the by-subjects analysis returned a significant result). Sloppy-biased stories elicited shorter total fixation durations, which stands in contrast to the results for region 1 in the first-pass measures discussed above. In the next section, we will see that this contrast is caused by much longer second-pass reading times in the strict conditions.

The T-Tests for the elliptic structures revealed significant results for region 1 (only the by-subjects T-Test returned a significant result) and region 9. Again consistent with the predictions, the total fixation duration in both regions was shorter in the sloppy-biased stories.

Figure 11. Mean second-pass durations (in ms) for the second sentence (i.e. region 1) of the stories in Exp. 3.



Second-pass duration

The mean second-pass durations and associated statistics are given in Table 16. The ANOVAs revealed a highly significant main effect in region 1 (i.e. the second sentence region). Consistent with the third economy prediction of the POB approach, the second-pass reading times were much shorter in the sloppy conditions, which suggests that readers are more likely to re-examine the second sentence in strict-biased stories (see Figure 11). The T-Tests confirmed this finding as they all returned a significant result for this region as well. Furthermore, in the ellipsis region second-pass reading times were, again, shorter for sloppy-biased stories (note that the by-subjects T-Test was marginally significant, i.e. $p = .084$).

3.5.4.3. Discussion

I will discuss the findings for the three main regions of interest (i.e. the second sentence region, the ellipsis region, and the pronoun plus spillover regions) separately.

The second sentence region revealed a clear contrast between first-pass and second-pass eye movement measures. Whereas first-pass measures revealed longer reading times for the sloppy-biased stories, the second-pass durations were much longer (almost twice as long) for the strict-biased stories. I attributed the shorter first-pass reading times for the second sentence of strict-biased stories to a difference in sentence length, a factor unrelated to the main issue. The second-pass reading time difference between sloppy and strict-biased stories, on the other hand, directly bears on the main issue. Apparently readers need to re-examine the second sentence, containing the critical manipulation, longer if they process a strict-biased story, even if on average this sentence contains fewer words than the second sentence of sloppy-biased stories. Interestingly, this was true for both ellipses and *only*-structures, which suggest that the preference for sloppy interpretations is not restricted to ellipses, but a general property of the language processor. The POB approach can easily account for the striking second-pass contrast between sloppy and strict-biased stories. Regardless of the context, the processor should initially prefer a sloppy reading, since binding reflects the cheaper option in the processing hierarchy. Consequently, when the larger context forces a strict reading instead, perceivers have to re-examine the story to change their initial sloppy reading into the more suitable strict reading. The crucial biasing information in my stories is given in the second sentence, which explains why readers resort to that part to resolve the mental inconsistency.

In the ellipsis region (recall that this region is absent in the *only*-conditions) different eye movement measures revealed a clear advantage for sloppy interpretations as well. The effect was most pronounced in the regression path duration, but was also reliable in the total fixation duration. First of all, these results replicate the findings of the self-paced reading experiments reported by Frazier and Clifton (2000). Hence, across methodologies and languages there is online evidence that readers prefer the sloppy identity of ambiguous elliptic structures. Furthermore, as the regression path measure is often discussed in relation to integration processes (or more specifically, interpreted as the time necessary for a reader to process the text to a sufficient degree that he or she is prepared to input new information, see Pickering, Frisson, McElree & Traxler, 2004), the results seem consistent with the idea that in strict-biased stories readers experience problems, because they initially try to integrate a sloppy interpretation into a strict context. Before moving on, they have to change their interpretation to resolve this inconsistency and longer regressions path durations are therefore expected.

So far, the interpretation of the results is relatively straightforward. They demonstrate what happens while readers encounter the sloppy-strict ambiguity or more speculative, how they resolve it. On the other hand, the interpretation of the effects in the possessive pronoun plus spillover regions is less clear-cut. The analyses revealed an early effect in the first spillover region. As predicted by the POB model first fixation durations tend to be longer in the strict condition. However, the difference was significant in the ellipsis stories and not, like I expected, in the *only*-stories. This contrast is particularly surprising, since in ellipsis sentences the sloppy-strict ambiguity appears more downstream in the elided conjunct and, hence, is not a plausible cause for any early reading time differences in the first conjunct. Assuming that the difference nevertheless reflects the resolution process of the possessive pronoun, we are left with the question why this pronoun is apparently more difficult in strict-biased ellipsis stories.

Before we turn to my view on the matter, we have to rule out a possible explanation which is unrelated to the main issue. Recall that the bias in the stories was created by giving information about both story characters (sloppy bias) or by giving information about only one story character (strict bias). For instance, in examples (17) and (18) – the ellipsis stories – the crucial information is whether only *Lisa* or both *Lisa and Anouk* have a 'pimped room'. As a result, the overt NP *her pimped room* in the first conjunct of the ellipsis is ambiguous in the sloppy-biased story, but not in the strict-biased story: whereas in the former it can mean both 'Lisa's pimped room' and 'Anouk's pimped room', the latter only allows the reading 'Lisa's pimped room'. Thus, assuming that unambiguous NPs elicit longer reading times than ambiguous NPs the early effect in the first spillover region could be explained. However, previous studies suggest the exact opposite, as referentially ambiguous (pro)nouns cause a delay in reading times, rather than their unambiguous counterparts (e.g. Garnham, 2001; MacDonald & MacWhinney, 1990;

Myers & O'Brien, 1998; Nieuwland, Otten & Van Berkum, 2007). I therefore reject this explanation.

Instead, consider the following. First of all, I assume that in both the strict and sloppy context the overt possessive pronoun refers to the subject of the first conjunct of the ellipsis (i.e. *Lisa* in ex. (17) and (18)). However, the first-pass reading time difference in the spillover region indicates that readers apparently put more effort into the resolution of the pronoun in strict-biased stories than in sloppy-biased stories. According to the POB framework, such a difference in effort is expected, assuming that the mental representation of the dependency varies between conditions. More specifically, if readers are more likely to represent the pronoun as a bound variable in sloppy-biased stories, yet co-value the pronoun in the discourse in the strict-biased stories, reading times for the latter should be longer since discourse representations require more processing. However, if this reasoning is correct, two questions come to mind. First, why do readers immediately decide to take the discourse route in the first conjunct of strict-biased ellipses, that is, before there is any need to do so, since the sloppy-strict ambiguity emerges more downstream? Second, why do readers nevertheless slow down in the ellipsis region of strict-biased stories? After all, if the dependency in the first conjunct is coreferential, the assumed copy-and-paste operation will give rise to a strict identity of the ellipsis sentence, which would be entirely consistent with the preceding context.

To account for these intriguing issues I present a speculative, yet appealing line of thought in which two factors play a role. First of all, to save precious processing resources the language processor only decides to establish a coreferential representation if sufficient information in the discourse points to one unique antecedent, otherwise the bound dependency is retained. The strict and sloppy stories differ in that respect as the strict stories provide at least more information of the sort than the sloppy stories. For instance, even though in both example (18) and (19) the overt possessive pronoun in the first conjunct refers to *Lisa*, the strict-biased context of (19) contains more information, since *Lisa* is obviously the topic and, more importantly, the only person with a pimped room. So, in strict-biased stories like (19) the processor may be more willing to co-value the pronominal in the discourse storage, which would explain why first-pass reading times immediately following the pronoun tend to be longer than in sloppy-biased stories. This, however, does not solve – or in fact creates – the second problem. That is, why do readers slow down both in the first and second conjunct of the ellipses?

Because an accumulating body of evidence suggests that individual differences of participants should not be ignored (Daneman & Carpenter, 1980; Just & Carpenter, 1992; Nieuwland & Van Berkum, 2006a), I examined whether this would provide a plausible explanation for the paradoxical reading pattern in Experiment 3. As suggested above, readers only establish a coreferential dependency if sufficient discourse information is available. However, what constitutes sufficient information might vary between participants. As a result some but not all readers establish a costly coreferential interpretation of the overt pronoun in strict-biased ellipsis stories. The 'energetic' readers who do so should experience fewer problems in the elided region of strict biased stories, because *copy-and-pasting* the coreferential interpretation of the pronoun in the first conjunct results automatically in a strict interpretation. Quite the opposite is expected for the 'lazy' group of readers. Because they simply take the binding route in all conditions, an early disadvantage in the first conjunct of strict-biased ellipses is not expected, but a later disadvantage in the elided region is.

To test this hypothesis the participants were divided into two groups. One group consisted of 16 readers exhibiting the largest early difference in the first spillover region (the energetic group). Hence, according to my proposal this group of readers immediately opts for the discourse route in the first conjunct of strict-biased ellipses. The other group consisted of the 16 readers that showed a smaller or no early difference (the lazy group). This group of readers simply takes the binding route and does not immediately compute a coreferential dependency. I predicted that the later effect in the ellipsis region, which was most pronounced in the regression path measure, should be attenuated for the energetic group, but not for the lazy group. Interestingly, the predictions were borne out by the data. As can be seen in Table 17 the lazy group still slowed down in the ellipsis region of strict-biased stories (t_1 (15) = 3.239, p = .006; t_2 (23) = 4.381, p < .001), but the energetic group clearly did not (t_1 (15) = .309, p = .762; t_2 (23) = .237, p = .815).[8] Thus, if readers decide to establish a coreferential interpretation right at the moment they encounter the possessive pronoun in the first conjunct of strict-biased ellipses, they slow down for a couple of milliseconds. More downstream, however, they benefit from the decision as it is relatively easy for them to establish a strict interpretation for the sentence as a whole.

[8] Similar results were found for total first gaze, total fixation and second-pass durations.

Table 17. Mean regression path durations (in ms) for the ellipsis region for the 'energetic' and 'lazy' group (Exp.3).

	Group	
Story-bias	energetic	lazy
Sloppy	708	657
Strict	732	1275

At this point I would like to draw two conclusions from the results of Experiment 2 and 3. First, and most importantly, the binding preference of the parser is not restricted to ellipsis structures, but generalizes to structures with the *only*-operator. Hence, these results are consistent with the POB approach, which predicts a general binding preference. The second, more tentative, conclusion is that the choice between the binding and the coreferential route is intrinsically free and seems to depend on the information provided by the context and, perhaps, the strategy of the reader. That is, if sufficient information is available a reader can rapidly decide to construct a coreference dependency and, importantly, does not have to wait until a sloppy-strict ambiguity emerges. Adopting this view, the binding route could be considered as a 'quick and dirty' initial solution. The discourse route is a more elaborate alternative which provides a more precise interpretation – i.e. not always a different one – at the expense of additional processing. I remain, however, agnostic to whether the coreferential dependency completely overwrites the bound dependency, or rather, that both are somehow kept active in working memory up to the elided region as suggested by Vasić (2006; see also Shapiro & Hestvik, 1995; Shapiro *et al.*, 2003). In other words, the crucial aspect of my proposal is that whereas semantic representations are computed more or less automatically, the discourse representations are much more subject to strategic and perhaps conscious control.

As a final point, note that this explanation of the results would be inconsistent with the original version of Rule-I, i.e. the rule that regulates whether coreference is allowed or not (see Chapter 1, Paragraph 1.2.2.3). In this version of the rule the language processor always compares the bound-variable interpretation to the coreference interpretation and opts for the former unless the interpretations of the two potential dependencies are different (Grodzinsky & Reinhart, 1993). This would imply that while processing the overt possessive pronoun in the first conjunct of an ellipsis, the coreference dependency should be blocked, since it gives the same interpretation as the bound reading, at least until the reader encounters the second conjunct. However, the data suggests that the choice between binding and coreference may already be made before the actual ambiguity emerges. Thus, this would suggest that we should abandon original Rule-I and embrace the revised version in which the comparison is only made in potentially ungrammatical structures. I will return to the latter issue in the subsequent eye-tracking experiment.

3.6. Experiment 4: Binding versus coreference, and Rule-I

So far, I have discussed the resolution of ambiguous structures that allow both a sloppy and strict interpretation. The results showed a preference for sloppy identities in English ellipses (Frazier & Clifton, 2000), Dutch ellipses, and Dutch *only*-structures. Although consistent with the third economy prediction of the POB approach, these results do not tell us exactly *why* variable binding has precedence in an ambiguous situation. I already mentioned that, given the logic of the POB framework, the initial preference for binding dependencies may actually stem from two (interrelated) sources. First of all, the assumed economy hierarchy implies that variable binding is more economic than coreference and is therefore the first choice in an ambiguous situation. However, another explanation that does not necessarily hinge on cross-modular economy is at hand. That is, an initial binding preference is also expected due to a time course effect of the sequential architecture of the POB model: simply because semantic computations are performed prior to discourse computations perceivers will initially prefer bound-variable interpretations over coreferential interpretations.

A study relevant to the former explanation (i.e. the explanation based on economy considerations) was conducted by Piñango *et al.* (2001). Using a cross-modal interference paradigm (see Chapter 1, Paragraph 2.1.3 for a detailed description of this technique) they examined whether unambiguous bound-variable pronouns induce a smaller processing load than unambiguous coreferential pronouns, that is, they directly addressed the second economy prediction of the POB model: *'the construction of semantic anaphoric dependencies requires less effort than the construction of discourse anaphoric dependencies'*. Examples of their stimuli are given in (21) and (22).

(21) *Everyone$_i$* hopes that the tenants will pay *him$_i$* the rent before the last day of the month.(*variable binding dependency*)

(22) *The landlord$_i$* hopes that the tenants will pay *him$_i$* the rent before the last day of the month. (*coreference dependency*)

In (21) the pronoun *him* refers to the quantified antecedent *everyone* and, because the antecedent is quantified, only variable binding is available. In (22) *the landlord* is not quantified and Piñango *et al.* assume this will result in a coreferential dependency between the pronoun and its antecedent. In the experiment the lexical decision target was presented at two points in the sentence: at a control position just before the pronoun and at the critical position immediately after the pronoun. Piñango *et al.* reported no difference in reaction times at the control position, yet the reaction times at the experimental position were shorter in the case of bound-variable pronouns (i.e. ex. (21)). Hence, consistent with the second economy prediction of the POB model the processing of bound-variable dependencies appears to require fewer resources.

There is, however, an alternative explanation for their results. Recall that variable binding is always licensed in structures with a c-commanding antecedent. This implies that variable binding is also allowed in sentences like (22) in which the antecedent NP *the landlord* is a 'sister' of the complement clause that contains the pronominal *him* and, consequently, both variable binding and coreference are possible in principle. On this view the critical difference between the two sentences is not that in (21) only variable binding is available and in (22) only coreference, but rather that in the former only one of the two routes is available and in the latter both. Furthermore, bear in mind that according to the original version of Rule-I the language system always compares the bound-variable interpretation to the coreference interpretation and opts for the former unless the two potential dependencies yield different interpretations (Grodzinsky & Reinhart, 1993). This version of the rule predicts a costly comparison between two derivations in (22), but not in (21), because in the latter case there is only one possible derivation and nothing to compare. So, temporarily setting aside the results of Experiment 3, which seemed inconsistent with the predictions of original Rule-I, this version of the rule would present an alternative explanation for the results of Piñango *et al.*

Moreover, Burkhardt (2005) failed to replicate the results in a Dutch equivalent of the Piñango *et al.* study. In fact she reported quite the opposite, namely longer reaction times just after pronouns referring to *iedereen* 'everyone'. An eye-tracking study in English revealed similar results. Although the experiment was not specifically designed to examine the contrast in processing costs between binding and coreference, Carminati, Frazier and Rayner (2002) compared the reading times for pronouns depending on binding antecedents like *every British soldier* to the reading times for pronouns referring to coreferential antecedents like *the old British soldier* and reported longer reading times for the former. With these results and the remarks that were made about the Piñango *et al.* study in mind, the evidence that suggests that binding elicits a smaller processing load than coreference is rather limited.

The aim of Experiment 4 is threefold. Again, the main goal is to further explore the hypothesis that during the online comprehension of ambiguous anaphoric dependencies bound-variable interpretations are preferred over coreferential interpretations. Although Experiment 3 presented evidence consistent with this third economy prediction, it is necessary to examine the resolution of ambiguous dependencies in other quantificational structures as well, to strengthen the idea that the binding preference truly reflects a general tendency of the parser.

Furthermore, the second economy prediction of the POB model will be addressed. As pointed out above, the preference for binding dependencies in ambiguous structures can be explained in two ways, (i) by assuming that semantic computations are cheaper than discourse computations, and/or (ii) by assuming that the preference reflects a time course effect, i.e. the semantic module is simply accessed before the discourse module. As we have seen, Piñango *et al.*, (2001) reported some evidence in favor of the former explanation. However, it also became clear that the reported processing differences between bound-variable pronouns and coreferential pronouns could not unequivocally be attributed to the processing advantage for the former, as the possible execution of original Rule-I could also be the underlying cause of the reported difference. In order to overcome this concern we need to construct and compare dependencies that can only be resolved through variable binding on the one hand, and only through coreference on the other, thereby ruling out any interference of Rule-I (and other unknown effects that emerge if both routes are available).

Finally, Experiment 3 of the present chapter suggested that we may need to abandon original Rule-I. This conclusion, however, was based on rather speculative lines of thought. The following experiment therefore more directly addresses the distinction between the original and revised version. Recall that the main difference between the two versions is that in original Rule-I the language system always makes a comparison between bound-variable and coreference interpretations (Grodzinsky & Reinhart, 1993), yet, the revised version only prevents coreference from bypassing variable binding when grammar rules out a bound-variable interpretation and, hence, is only executed in potentially ungrammatical cases (Reinhart, 2000).

3.6.1. The stimuli and predictions

In an eye-tracking experiment Dutch participants read a series of short stories in which I manipulated the resolution of ambiguous and unambiguous pronouns to examine the three issues discussed above. According to Frazier and Clifton (2000), not only the structural configuration (i.e. c-command) defines the relation between a pronominal and its antecedent, but also the nature of the pronominal itself matters. Specifically, they believe possessive pronouns typically take a structurally identifiable (i.e. locally c-commanding) antecedent, but phrasal pronouns (e.g. a pronoun like *he* constitutes a full NP) typically take discourse antecedents. In other words, the 'vehicle' itself matters. As the pronouns in Experiment 2 and 3 were of the possessive type, it might be possible to explain the preference for binding dependencies by adopting Frazier and Clifton's approach, i.e. without assuming a general binding preference. To rule out this possibility I decided to use Dutch phrasal pronouns like *hij* 'he' in the present experiment.

To test the general binding preference hypothesis further (the third economy prediction), Dutch stories like (23) and (24) were presented.

(23) Biased towards variable binding antecedent (VB-bias)
Een werkdag in de fabrieken langs het Noordzeekanaal is altijd erg zwaar. Vooral vandaag konden veel arbeiders, waaronder de oude Paul, het nauwelijks aan. *Iedere arbeider die net als Paul bijna geen energie meer had, vond het heel erg fijn dat hij wat eerder naar huis mocht vanmiddag.* Een hete douche zou de pijn hopelijk verzachten.
(A working day in the factories alongside the North Sea Canal is always very tough. Especially today a lot of workers, among them the old Paul, could barely cope. Every worker who just like Paul was running out of energy, thought it was very nice that he could go home early this afternoon. *Hopefully a hot shower would ease the pain.)*

(24) Biased towards coreference antecedent (CR-bias)
Een werkdag in de fabrieken langs het Noordzeekanaal is altijd erg zwaar. Vooral vandaag kon de oude arbeider Paul het nauwelijks aan. *Iedere arbeider die zag dat Paul bijna geen energie meer had, vond het heel erg fijn dat hij wat eerder naar huis mocht vanmiddag.* Een hete douche zou de pijn hopelijk verzachten.
(A working day in the factories alongside the North Sea Canal is always very tough. Especially today the old worker Paul could barely cope. Every worker who noticed that Paul was running out of energy, thought it was very nice that he could go home early this afternoon. *Hopefully a hot shower would ease the pain.)*

In both stories the critical sentence contains the ambiguous pronoun *he* with two potential antecedents (i.e. *every worker* and *Paul*). In story (23) the context preceding the pronoun supports a reading in which *he* refers to the c-commanding and quantified antecedent and, as a result, the reader constructs a bound-variable dependency (i.e. *he* = *every worker*). In story (24), on the other hand, the preceding context strongly supports a reading in which *he* refers to the proper name antecedent (i.e. *he* = *Paul*). The antecedent *Paul* does not c-command the pronoun and, hence, this reflects a coreferential dependency. However, the POB approach predicts that in the latter case initially the 'wrong' antecedent *every worker* is chosen, because this dependency can be established semantically and hence is initially preferred. As a result, readers have to re-analyze their initial interpretation to construct the more suitable coreference dependency. In stories like (24) longer reading times are therefore expected at the critical pronoun, or, due to spillover, rapidly thereafter. If readers really have to reconsider their initial interpretation more consciously we can also expect them to regress to earlier parts of the text and show signs of back tracking.

To evaluate the second economy prediction which states that variable binding requires less processing resources than coreference, I presented stories such as (25) and (26), containing unambiguous pronouns.

(25) Variable binding only (VB-only)
Een werkdag in de fabrieken langs het Noordzeekanaal is altijd erg zwaar. Vooral vandaag konden veel arbeiders het nauwelijks aan. *Iedere arbeider die bijna geen energie meer had, vond het heel erg fijn dat hij wat eerder naar huis mocht vanmiddag.* Een hete douche zou de pijn hopelijk verzachten.
(A working day in the factories alongside the North Sea Canal is always very tough. Especially today a lot of workers could barely cope. Every worker who was running out of energy, thought it was very nice that he could go home early this afternoon. *Hopefully a hot shower would ease the pain.)*

(26) Coreference only (CR-only)
Een werkdag in de fabrieken langs het Noordzeekanaal is altijd erg zwaar. Vooral vandaag kon de oude arbeider Paul het nauwelijks aan. *Paul had bijna geen energie meer. Het was heel erg fijn dat hij wat eerder naar huis mocht vanmiddag.* Een hete douche zou de pijn hopelijk verzachten.
(A working day in the factories alongside the North Sea Canal is always very tough. Especially today the old worker Paul could barely cope. Paul was running out of energy. It was very nice that he could go home early this afternoon. *Hopefully a hot shower would ease the pain.)*

In both stories the pronoun *he* has only one possible antecedent (i.e. *every worker* in ex. (25) and *Paul* in ex. (26)), but the process that assigns the antecedent to the pronoun differs between conditions. In (25) the pronoun can only be resolved at the semantic level because the antecedent is quantified, and therefore, by definition not referential. On the other hand, in (26) no c-command relation exists between *Paul* and *he*, because they appear in different sentences and, hence, the pronoun cannot be bound but can only receive its value through coreference. If coreference is indeed a more costly process than variable binding we should expect longer reading times in (26) right at the critical pronoun, or, due to spillover, rapidly thereafter.

I included stories like (27) and (28) to check whether the original or revised version of Rule-I should be preferred.

(27) Both routes are available (VB/CR-all)
Een werkdag in de fabrieken langs het Noordzeekanaal is altijd erg zwaar. Vooral vandaag konden veel arbeiders het nauwelijks aan. *Alle arbeiders die bijna geen energie meer hadden, vonden het heel erg fijn dat zij wat eerder naar huis mochten vanmiddag.* Een hete douche zou de pijn hopelijk verzachten.
(A working day in the factories alongside the North Sea Canal is always very tough. Especially today a lot of workers could barely cope. All the workers who were running out of energy, thought it was very nice that they could go home early this afternoon. *Hopefully a hot shower would ease the pain.)*

(28) Both routes are available (VB/CR-proper-name)
Een werkdag in de fabrieken langs het Noordzeekanaal is altijd erg zwaar. Vooral vandaag kon de oude arbeider Paul het nauwelijks aan. *Paul, die bijna geen energie meer had, vond het heel erg fijn dat hij wat eerder naar huis mocht vanmiddag.* Een hete douche zou de pijn hopelijk verzachten.
(A working day in the factories alongside the North Sea Canal is always very tough. Especially today the old worker Paul could barely cope. Paul, who was running out of energy, thought it was very nice that he could go home early this afternoon. *Hopefully a hot shower would ease the pain.)*

Although the stories are minimally different from (25) and (26), both routes to connect a pronoun to its antecedent are now available. First of all, note that because the critical sentences in story (27) and (28) contain a c-commanding antecedent, variable binding is licensed in both structures. Furthermore, the antecedents in both stories have a referential status in the discourse module as they do not contain the universal quantifier *every* and, therefore, can also be resolved through coreference. According to the original version of Rule-I, a costly comparison between variable binding and coreference should be made in (27) and (28) because both routes are available in principle. In contrast, in (25) and (26) this comparison is not predicted because only one route is available. Consequently, shorter reading times in the pronoun region are predicted for the latter two. Revised Rule-I, on the other hand, does not predict a difference in reading times, because in this more recent version, Rule-I is only executed if potentially ungrammatical dependencies could emerge (e.g. in structures like *the clown$_i$ adores *him$_i$*), which is not the case in any of the stories.

3.6.2. Method

Participants. Participants were 36 members from the Utrecht University community (32 female, mean age 21, range 18-40) who received money for their participation

Materials. I constructed 36 short stories using scenarios that were expected to be of interest to the average participant (see Appendix III for all Dutch originals). Each experimental story occurred in six versions as illustrated above in examples (23) to (28). Although the constraints on variable binding (i.e. c-command and quantification) forced me to create somewhat different sentence structures across conditions, I tried to make the six versions of the stories as similar as possible. First of all, the first and the last sentence were held constant, and following the critical pronoun the six versions were all exactly the same. In the first sentence a particular situation or event was sketched and the last sentence contained a final comment. The latter was primarily included to make the discourse more cohesive and, in addition, protected the critical regions from unwanted noise due to end-of trial events (e.g. final 'wrap up').

The critical manipulation in the *ambiguous* versions (see ex. (23) and (24)) was that either the variable binding antecedent was the topic of the preceding discourse (VB-biased) or, alternatively, that the coreference antecedent was the topic (CR-biased). This was done by focusing on a group of characters in the VB-biased version (e.g. *a lot of workers*, cf. second sentence of ex. (23)) and by focusing on one particular male individual in the CR-biased version (e.g. *the old worker Paul*, see ex. (24)). The critical third sentence always started with a quantified antecedent in subject position (e.g. *every worker*) followed by a relative clause that contained the competing proper name (e.g. *Paul*). This sentence structure was chosen to ensure that the critical pronoun *he* was c-commanded by the quantified antecedent but not by the proper name. However, this sentence structure introduces a potential concern. As discussed previously, a variety of different factors can affect the processing costs associated with the resolution of a pronoun, an antecedent in subject position being one of them (e.g. MacDonald & MacWhinney, 1995). Consequently, one might suggest that the quantified antecedent (e.g. *every worker*) is initially preferred in both conditions just because it is in subject position, and not as I would like to show, because variable binding is always the first option regardless of any other constraints. To control for this potential confound as far as possible, I made sure that in both versions the coreference antecedent was highly accessible by using proper names (see Sanford *et al.*, 1988, for discussion), placing the coreference antecedent linearly closer to the critical pronoun (Clark & Sengul, 1979; Streb *et al.*, 2004) and mentioning the coreference antecedent one extra time in the preceding context of the VB-biased story (e.g. *a lot of workers, among them the old Paul*, cf. second sentence of ex. (23)). To keep the stories coherent, the relative clauses were constructed in such a way that in the VB-biased version the quantified antecedent was the most salient antecedent for the ambiguous pronoun, and in the CR-biased version the coreference antecedent was the most salient one. For this reason, the relative clauses were not always exactly the same. Therefore, I made sure that at least four words intervened between the ending of the relative clause and the position of the critical pronoun in order to create a 'buffer region' to pick up any unwanted processing consequences that could arise as a result of the dissimilarities. From the relative clause onwards the ambiguous stories were exact copies and continued with the main clause followed by another subordinate clause, which contained the critical pronoun.

The four *unambiguous* versions closely resembled the two ambiguous versions except that only one antecedent was introduced instead of two. The critical manipulation was that the pronoun could only be resolved through variable binding (VB-only), only through coreference (CR-only) or that both routes were available (VB/CR-all and VB/CR-proper-name).[9] The structure of the critical sentence was exactly the same in all four unambiguous stories except for the CR-only version. In the latter the critical part of the story (i.e. normally the third sentence) was divided into two separate sentences, one containing the antecedent and the other the critical pronoun (to ensure there was not a binding relationship between the antecedent and pronoun). To keep the stories minimally different, the third sentence of the CR-only version (e.g. *Paul was running*

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[9] It might be worth pointing out that *all* also resembles quantification and that we should, therefore, expect the variable binding route to be the only one available. However, the use of *all* (Dutch *alle*) differs significantly from *every* (Dutch *iedere*) as is illustrated by the observation that it is possible to refer to *all workers* with a pronoun that appears in a different sentence (i.e. coreference is possible), which is (at least in Dutch) not allowed with *iedere* (see ex. (iii) and (iv)).

(iii) Alle arbeiders$_i$ hadden bijna geen energie meer. Zij$_i$ wilden naar huis.
(*All the workers$_i$ were running out of energy. They$_i$ wanted to go home.*)

(iv) Iedere arbeider$_i$ had bijna geen energie meer. *Zij$_i$ /*Hij$_i$ wilde(n) naar huis.
(*Every worker$_i$ was running out of energy. *They$_i$ /*He$_i$ wanted to go home.*)

out of energy) contained the information that normally occurred in the relative clause of the critical sentence (e.g. *who was running out of energy*). Furthermore, I also made sure that the critical pronoun in the fourth sentence of the CR-only condition was part of a subordinate clause (e.g. *It was very nice that he…*).

The materials were post-tested in two web-based questionnaires and one web-based completion task. The participants in the main eye-tracking experiment were excluded from taking part in the post-tests. To rule out any accidental biases and gain insight into the general interpretation of the pronouns in the ambiguous versions, I conducted a questionnaire and a completion task. In the questionnaire the different ambiguous stimuli were presented in their entirety and I asked 62 native speakers of Dutch (54 female, mean age 24, range 16-52) to indicate how they interpreted the pronoun by giving them a 2-choice option between the variable binding antecedent and the coreference antecedent. The results showed that the stories were interpreted as intended. In the VB-biased condition participants were much more likely to select the variable binding antecedent as the appropriate antecedent for the ambiguous pronoun (88% of the cases). This bias was reversed in the CR-biased condition in which participants interpreted the pronoun preferably as referring to the coreference antecedent (90% of the cases).

In the completion experiment I checked whether the context before the critical pronoun was strong enough to induce the bias reported above, or alternatively, that the story as a whole was needed. This was done by presenting the ambiguous stories up to the critical pronoun and instructing 55 native speakers of Dutch (38 female, mean age 23, range 18-48) to finish the story with the first ending that came to mind. To avoid any interpretation difficulties during the analysis they had to indicate whether the pronoun in their story referred to the quantified referent or to the proper name. Again, the results showed that the pronouns in my stories were predominantly interpreted as intended. In the VB-biased condition participants were strongly biased to continue the story with the variable binding antecedent as the topic (89% of the cases). In the CR-biased condition participants continued the story more often by supplying information about the coreference antecedent (79% of the cases). However, because the bias was somewhat stronger in the VB-biased condition, I performed a T-Test to investigate whether the conditions were equally constraining towards the intended interpretation of the pronoun, which was not the case as the analysis returned a significant result ($t_1(54) = 3.36, p < .001$ and $t_2(35) = 2.61, p = .013$). To rule out the possibility that any differences in reading times between the VB-biased and CR-biased condition could be attributed to 'just a more ambiguous' pronoun in the latter, I selected a subset of 24 (out of the original 36) stories with an equally strong bias in the VB-biased (88%) and CR-biased version (90%) for the analyses of the eye-tracking experiment.[10]

In a second questionnaire, 18 native speakers of Dutch (16 female, mean age 20, range 18-22 years) rated the stories on difficulty and plausibility on a 5-point scale (5 = very difficult and not plausible). The stories were rated as fairly easy (grand mean 1.86) and fairly plausible (grand mean 2.39). More importantly, Repeated Measure ANOVAs and planned pair wise comparisons revealed no potentially confounding significant differences between the different versions.

The stimuli (i.e. including the ambiguous stories that were excluded from the final analysis) were divided into six lists, with only one version of each story in a particular list. Fourteen stories were included as fillers, with eight of them specifically designed to avoid strategic processing in the ambiguous conditions. For a detailed description of the pseudo-randomization procedure, the general eye-tracking procedure and the inclusion of comprehension questions, the reader is referred to Paragraph 2.2.2 of Chapter 2. All participants scored above 60% correct (mean score 83%) on the comprehension questions. Each session was completed within 45 minutes.

Analysis. The analysis only considered the critical section in the discourse. In the CR-only condition the critical section consisted of sentences 3 and 4. In the other conditions the critical section was sentence 3. The sentences were divided into the following regions (illustrated by the critical sections of the VB-bias and CR-only conditions).

[10] I checked the results for this subset of 24 stories in the first questionnaire. The final interpretation of the pronoun (i.e. after digesting the whole story) was still as intended. In the VB-bias condition participants mainly interpreted the pronoun as referring to the quantified referent (85% of the cases) and in the CR-bias condition participants mainly interpreted the pronoun as referring to the proper name (90% of the cases).

VB-bias condition
1. Every worker who just like Paul was running out of energy, *(initial region)*
2. thought it was very nice *(pre-critical or 'buffer' region)*
3. that he *(critical region)*
4. could go *(spillover region 1)*
5. home early *(spillover region 2)*
6. this afternoon. *(final region)*

CR-only condition
1. Paul was running out of energy. *(initial region)*
2. It was very nice *(pre-critical or 'buffer' region)*
3. that he *(critical region)*
4. could go *(spillover region 1)*
5. home early *(spillover region 2)*
6. this afternoon. *(final region)*

The initial region consisted of the beginning of the sentence up to the end of the embedded clause (note that in the CR-only condition the initial region consisted of the entire third sentence). The pre-critical or 'buffer' region consisted of all words between the embedded clause and the complementizer (note that in the CR-only condition the pre-critical buffer region consisted of the main clause of the fourth sentence). The critical region included the complementizer and the pronoun. Spillover region 1 included the two words following the pronoun. Spillover region 2 included the third and fourth word following the pronoun and the final region consisted of any remaining words of the sentence.

Prior to all the analyses, I removed the trials in which major tracker losses made it impossible to determine the course of fixations at or directly around the critical pronoun (3.2%). In addition, fixations longer than 1200 ms were excluded (< 1%), as they usually indicate tracker loss. Furthermore, if a fixation was shorter than 80ms and within one character space of the previous or next fixation, it was assimilated to this fixation. After these procedures I computed the different reading time measures. As regions 1 and 2 sometimes contained a different number of characters across conditions, reading time per character in a particular region was calculated for all the measures. The analyses were performed using these reading times per character as the dependent variable. For all the different measures reading times of more than 2 standard deviations from both the participant's mean and the item's mean in a region in a particular condition were treated as missing data (1.4% for second-pass reading times; for all other measures < 1%).

I will report mean reading times for four different eye movement measures, namely first gaze, regression path, total fixation and second-pass durations (see Paragraph 1.4.2.1 of Chapter 1 for a discussion of the different measures).

3.6.3. Results

The results regarding the *ambiguous* VB-biased and CR-biased conditions are discussed first, followed by the results for the unambiguous conditions. For the ambiguous stories I predicted that when a pronoun is ambiguous between a bound-variable and coreference interpretation the language processor initially prefers a bound-variable construction (i.e. the third economy prediction of the POB model). As a result, in instances in which the story context strongly supports a coreference interpretation (i.e. the CR-bias condition) the language system will be slowed down because it has to re-analyze the structure. We, therefore, expected longer reading times (especially longer second-pass durations) in the ambiguous CR-biased condition as compared to the VB-biased condition. The reading time patterns closely matched these predictions (see Table 18 for the associated means). Whereas readers did not have obvious processing difficulties during the initial interpretation of the CR-biased pronoun as indicated by the absence of significant first-pass differences in any of the regions, they clearly slowed down during later stages of processing as significantly longer reading times emerged in the CR-biased condition in the second-pass measure (see Figure 12). Specifically, readers re-fixated the critical region (i.e. region 3, containing the pronoun) and pre-critical region (region 2) longer in the CR-biased condition than in the VB-biased condition (critical region: t_1 (35) = 2.27, p = .029, t_2 (23) = 2.97 p = .007; pre-critical region: t_1 (35) = 2.06, p = .047, t_2 (23) = 1.98, p = .059).[11] The regression path and total reading durations in the critical region showed a numerical difference in the same direction but only approached significance in the by-subjects (t_1(33) = 1.71, p = .097) and

[11] I only included second-pass fixations made after participants had encountered the critical region to maximize the possibility that any differences in the durations of these re-fixations were caused by the ambiguous pronoun and not by the small differences in the sentence structure between the two conditions prior to the pronoun.

by-items analyses ($t_2(23) = 1.85, p = .077$) respectively.[12] Thus, the results are clearly consistent with the predictions of the POB model. In particular the longer second-pass reading times around the critical pronoun in the CR-biased condition suggest that the parser initially binds the pronoun and only later in time changes this binding dependency into a more suitable coreferential dependency.

Table 18. Mean first gaze, regression path, second-pass and total fixation durations (in ms per character) for the VB-bias and CR-bias condition in Exp.4.

	Region					
	1	2	3	4	5	6
e.g.:	*Every worker...*	*thought it...*	*that he*	*could go*	*home early*	*this afternoon*
			First gaze duration			
VB-bias	39.5	40.6	38.7	30.7	32.7	36.6
CR-bias	35.5	38.6	37.7	30.6	36.3	31.6
			Regression path duration			
VB-bias	42.5	41.8	43.5	37.6	40.9	40.7
CR-bias	42.0	41.3	59.9	42.6	45.7	37.7
			Total fixation duration			
VB-bias	37.2	37.8	43.8	39.1	38.0	35.3
CR-bias	36.9	38.9	46.5	36.7	41.3	32.3
			Second-pass duration			
VB-bias	1.1	2.6	7.4	10.2	6.8	3.8
CR-bias	2.0	5.3	13.3	8.0	7.1	4.3

To test the second economy prediction and to examine whether Rule-I is always executed in cases where both routes are available in principle, stories were included containing *unambiguous* pronouns that could only be resolved through variable binding (VB-only condition), only through coreference (CR-only condition), or through both routes (VB/CR-all and VB/CR-proper-name condition). If coreference requires more resources than variable binding we should expect longer reading times around the critical pronoun in the CR-only condition than in the VB-only condition. As is illustrated by the reported means in Table 19, no significant differences were observed in the first-pass, regression path and total reading durations in any of the regions. The analysis of the second-pass durations, on the other hand, revealed a reliable difference in the first spillover region (region 4), that is, the region that contained the two words following the critical pronoun (t_1 (35) = 2.30, $p = .027$ and

[12] In addition, participants seemed more likely to regress from the critical region in the CR-bias condition (16.3%) than from the critical region in the VB-bias condition (7.6%), however, this difference was also not significant.

t_2 (35) = 2.32, p = .026). Inspection of the relevant means showed that the second-pass reading times were longer in the VB-only condition (see Figure 13). As such, this result provides no evidence in favor of the hypothesis that variable binding requires fewer processing resources than coreference. In fact, the reliable difference in the second-pass durations seems to point in the opposite direction: the semantic process seems to be more costly than the discourse process.

Figure 12. Mean second-pass durations (in ms per character) for the VB- and CR-bias conditions in Exp. 4.

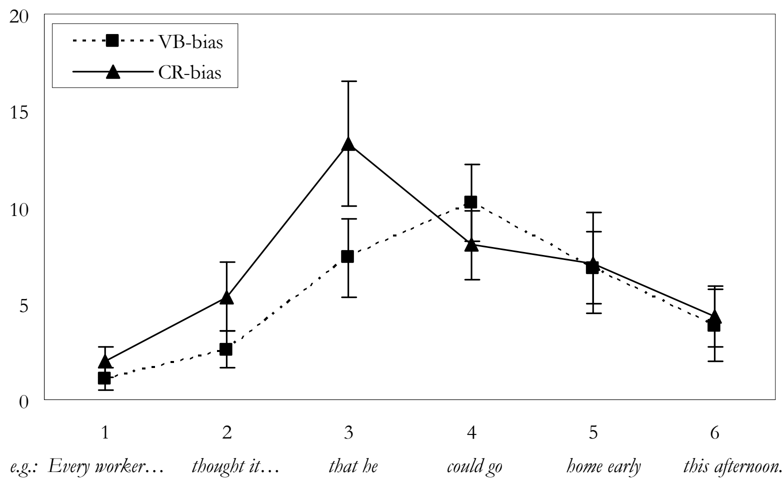


Figure 13. Mean second-pass durations (in ms per character) for the VB- and CR-only conditions in Exp. 4.

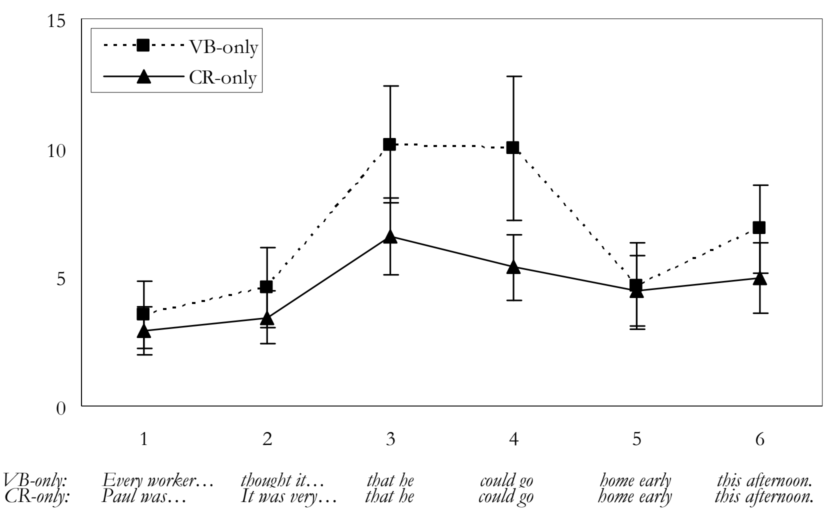


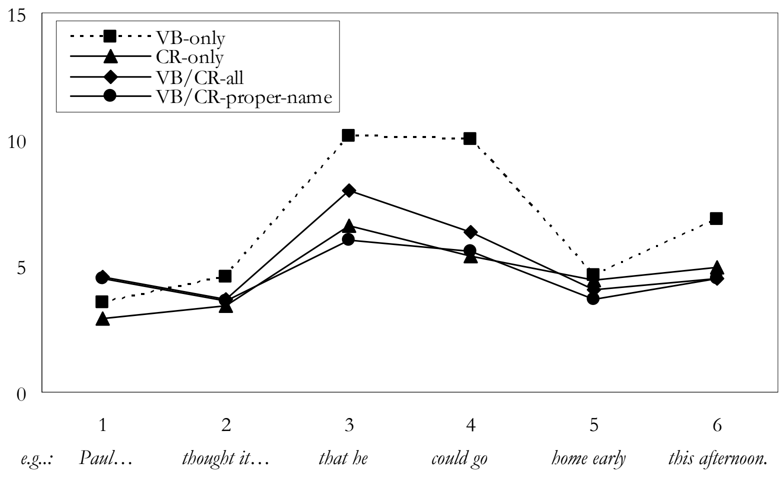
Table 19. Mean first gaze, regression path, second-pass and total fixation durations (in ms per character) for the *unambiguous* conditions in Exp. 4

	Region					
	1	2	3	4	5	6
e.g.:	*Every worker..*	*thought it..*	*that he*	*could go*	*home early*	*this afternoon*
			First gaze duration			
VB-only	39.1	38.8	37.5	30.6	32.3	34.7
CR-only	38.3	41.6	36.3	31.1	32.3	31.8
Mean	38.7	40.2	36.9	30.8	32.3	33.2
VB/CR-all	36.3	39.6	38.8	30.3	33.3	33.5
VB/CR-name	36.6	39.6	37.7	31.8	32.4	32.3
Mean	36.4	39.6	38.2	31.0	32.9	32.9
			Regression path duration			
VB-only	42.2	40.8	42.7	37.8	41.4	40.9
CR-only	41.2	43.1	39.6	34.8	36.7	42.3
Mean	41.7	42.0	41.2	36.3	39.1	41.6
VB/CR-all	41.8	42.0	43.8	36.2	38.1	44.1
VB/CR-name	41.5	41.3	41.6	36.1	37.6	38.1
Mean	41.6	41.6	42.7	36.1	37.9	41.1
			Total fixation duration			
VB-only	37.3	38.0	44.9	38.9	35.0	36.6
CR-only	35.8	38.9	41.2	34.0	34.8	33.4
Mean	36.5	38.4	43.0	36.4	34.9	35.0
VB/CR-all	36.1	37.7	45.6	35.3	35.2	34.2
VB/CR-name	35.7	37.3	43.2	36.2	34.9	33.0
Mean	35.9	37.5	44.4	35.7	35.0	33.6
			Second-pass duration			
VB-only	3.5	4.6	10.1	10.0	4.7	6.9
CR-only	2.9	3.4	6.6	5.4	4.5	5.0
Mean	3.2	4.0	8.3	7.7	4.5	5.9
VB/CR-all	4.6	3.7	8.0	6.3	4.0	4.5
VB/CR-name	4.5	3.6	6.0	5.6	3.7	4.5
Mean	4.5	3.6	7.0	5.9	3.8	4.5

It is possible that the longer second-pass reading times in the VB-only condition resulted from a difference in antecedent length in the VB-only and CR only condition, rather than from a difference in processing cost for variable binding and coreference. In the VB-only condition the antecedent was always relatively long (e.g. *every worker who was running out of energy*) compared to the antecedent in the CR-only condition (e.g. '*Paul*'). Another possibility is that the difference in reading times is caused by the fact that the critical pronoun in the VB-only and CR-only conditions appeared in different structural contexts. In the VB-only condition the structural environment of the embedded pronoun was relatively complex (e.g. *every worker who was running out of energy, thought it was very nice that he*) as compared to the CR-only condition (e.g. *it was very nice that he*). To explore whether these factors might have caused the longer reading times in the VB-only condition, I compared the VB-only and CR-only condition separately to the VB/CR-all and VB/CR-proper-name condition. In these latter conditions the antecedent length and structural context in which the pronoun appeared closely matched the VB-only condition (e.g. *all workers who were running out of energy, thought it was very nice that they* and *Paul, who was running out of energy, thought it was very nice that he*). For the VB-only condition no differences appeared in first-pass, regression path and total duration in any of the comparisons. However, in the second-pass measure, the VB-only condition showed the same contrast with the two VB/CR conditions as with the CR-only condition, that is, longer second-pass durations around the critical pronoun (see Figure 14). First of all, the comparison between the VB-only and VB/CR-all condition revealed significantly longer second-pass reading times in the by-items analysis in the first spillover region ($t_2(35) = 2.42$, $p = .021$ and the by-subjects analysis approached significance, $t_1(35) = 1.76$, $p = .087$). Furthermore, the comparison between the VB-only condition and VB/CR-proper-name condition revealed a very similar pattern, as the second-pass durations for the former were again longer in the region directly following the pronoun ($t_1(35) = 2.09$, $p = .044$ and $t_2(35) = 2.14$, $p = .040$) and in addition in the critical region itself ($t_1(35) = 2.17$, $p = .037$ and the by-items analysis approached significance, $t_2(35) = 1.92$, $p = .063$). As the comparisons between the CR-only condition and the two VB/CR conditions on the other hand revealed no significant differences in any of the measures, it is unlikely that antecedent length or structural complexity elicited the longer second-pass reading times in the VB-only condition. Thus, at least in my stimuli, it appears that binding occasionally requires more processing resources than coreference.

To examine the predictions of the different versions of Rule-I, I compared the mean reading times collapsed over the conditions in which only one route was available (the *only* conditions) to the mean reading times collapsed over the conditions in which both routes were available (the *VB/CR* conditions). Original Rule-I predicts longer reading times in the latter because a costly comparison between the variable binding and coreference interpretation should be made in structures where both routes are available in principle, but not in structures where only one route is available. Revised Rule-I, on the other hand, does not predict a difference in reading times as this version suggests that the Rule-I is only executed if an antecedent in a potential binding position is ruled out by the grammar, which is not the case in any of the conditions. The analyses revealed one significant difference. In the initial region (region 1) readers showed longer first-pass reading times in the conditions that allowed for only one route (F_1 (1, 35) = 4.05, p = .052 and F_2 (1, 35) = 5.26, p = .028). However, this finding does not directly bear on Rule-I because these differences emerged before the participants had encountered the critical pronoun that potentially elicits its execution. Furthermore, as the pre-critical region (region 2, the 'buffer' region) did not show the same difference it is unlikely that whatever may have caused the reported difference affected the actual pronoun resolution process. Based on the results that the reading time patterns did not show signs of processing differences between the one and two-route conditions, I conclude that no comparison is made between the variable binding and coreference interpretation in the conditions that allow both routes, which is consistent with the predictions of revised Rule-I, but not with the predictions of the original version.[13]

Figure 14. Mean second-pass durations (in ms per character) for the *unambiguous* conditions in Exp. 4.



[13] The analyses of the four unambiguous conditions separately (reported above) points to the same conclusion. First of all, the CR-only condition (one route) did not differ from the VB/CR-proper-name condition (two routes) in any of the measures, and the VB-only condition (one route) actually showed longer second-pass reading times than the VB/CR-all condition (two routes), contrary to the predictions of the original Rule-I.

3.6.4. Discussion

From the results we can conclude the following. First, the binding preference of the parser is not restricted to sloppy readings of ellipses and *only*-structures, but generalizes to other contexts as well. Moreover, and contrary to what Frazier and Clifton (2000) suggested, the anaphoric 'vehicle' did not matter. Even though phrasal pronouns were used instead of possessive pronouns, a significant preference to connect the pronoun to the c-commanding antecedent, rather than to the competing discourse antecedent, was still observed. Second, the preference for binding dependencies in the ambiguous stories cannot exclusively be explained by assuming that they are cheaper than discourse dependencies, since the results for the unambiguous pronouns suggested that binding to a quantified antecedent is more costly. Third, the results are inconsistent with the original Rule-I, which (again) suggests that the revised version (Reinhart, 2000) should be preferred.

Thus, on the one hand an essential prediction of the POB framework was borne out, namely that in case of ambiguity readers initially prefer a bound dependency. On the other hand, this preference could not be attributed to the economy hierarchy as, at least in the unambiguous stories, bound dependencies appear to require more processing resources than coreference dependencies. As discussed previously however, the economy hierarchy is not the sole origin for a binding preference, since the prediction naturally follows from the sequential architecture of the POB system as well. In fact, it seems the present results are consistent with a sequential model. That is, even while in the ambiguous stories the competing coreferential antecedent may well be a relatively cheap antecedent, most likely even cheaper than the c-commanding quantified antecedent, the parser nevertheless seems to prefer the latter. A sequential model can easily account for such a striking result as it predicts that bound dependencies simply emerge earlier in time, regardless of whether the overall costs are high or not.

The rather puzzling question remains, however, why my results are the exact opposite of those reported by Piñango *et al.* (2001), and moreover, why they are inconsistent with the second economy prediction of the POB model. In the remainder of this section and the next eye-tracking experiment I will focus on these issues.

A number of factors could explain the contrast between the results of Piñango *et al.* and Experiment 4. First of all, one of my main concerns with respect to the Piñango *et al.* study was that their manipulation allowed a bound-variable dependency in the coreference condition, because the alleged coreference antecedent in fact c-commanded the pronoun. I made sure that this syntactic relationship was absent, primarily to rule out the possibility that the differences in processing costs between the bound-variable and coreferential condition could be attributed to the execution of Rule-I. However, as the results of Experiment 3 and 4 suggest that Rule-I is only relevant in potentially ungrammatical structures (e.g. structures like *the clown*$_i$ *adores *him*$_i$), an appealing conclusion would be that in the Piñango *et al.* experiment binding is indeed more economic than coreference, consistent with the second economy prediction of the POB framework. Although I advocate the POB model, I am hesitant to embrace this conclusion, because even if Rule-I is irrelevant, it still remains unclear what kind of dependency is under investigation in the case of a c-commanding antecedent like *the landlord*. As it allows both a bound-variable and coreferential dependency, we do not exactly know whether Piñango *et al.* are comparing variable binding with coreference or two bound-variable dependencies instead. This casts some doubt on whether their results truly reflect the processing difference between the two mechanisms or, alternatively, are a consequence of other factors. One of those potential factors is a difference in the 'internal complexity' of the antecedents. What this means will be discussed below.

Recall that Piñango *et al.* used the bare quantifier *everyone* for all their bound-variable dependencies, while I used more elaborate quantified antecedents such as *every worker* or *every dwarf*. In a recent proposal Burkhardt (2005) addressed the difference in complexity between these two types of quantified antecedents and, furthermore, described how they relate to non-quantified antecedents. She distinguishes between three types of antecedents, namely 'light quantifiers' like *everyone*, 'referential quantifiers' like *every worker* and referential antecedents like *the landlord* or *Paul*. Furthermore, the processing resources that are required to establish a dependency with these antecedents are directly related to what kind of (and how much) information needs to be transferred between the pronoun and antecedent. A light quantifier like *everyone* requires the smallest amount of processing resources because it "only allows for transfer of variable-like information pertaining to the general set" (Burkhardt, 2004, p.174). A referential antecedent like *the landlord* or *Paul* is a bit more expensive because it requires the transfer of more specific information, which by hypothesis is more costly than the transfer of general (variable-like) information. The most expensive dependency is established in the case of referential quantifiers like *every worker*. The crucial difference between light and referential quantifiers is that while both denote a set of individuals, only the latter provides specific information about the set, through its nominal restrictor (e.g. *worker* in *every worker*). The construction of an anaphoric dependency between a pronoun and referential quantifier thus requires the transfer of both general set and specific information. As a consequence a referential quantifier is a relatively expensive antecedent, not only compared to light quantifiers but to plain referential antecedents like *the landlord* as well.

Hence, the main difference between the POB's economy hierarchy and Burkhardt's ranking is that whereas the former focuses on the structural c-command constraint, the latter focuses more on the internal complexity of the antecedent. More specifically, according to Burkhardt light quantifiers require less processing resources than plain referential antecedents, which in turn require less processing resources than referential quantifiers. Interestingly, both the results of Piñango *et al.* and my results are consistent with this ranking. Piñango *et al.* reported more processing interference with a secondary task if a pronoun referred to a referential antecedent compared to a pronoun that referred to a light quantifier. Furthermore, Experiment 4 showed that unambiguous pronouns that depended on referential quantifiers for their interpretation, elicited longer reading times than pronouns with plain referential antecedents. Similarly, the results of the eye-tracking study by Carminati *et al.* (2002) also revealed consistent results. They reported longer reading times for pronouns that depended on referential quantifiers like *every British soldier* than for pronouns referring to plain referential antecedents like *the old British soldier*. However, a Dutch replication study of the Piñango *et al.* experiment showed an inconsistent pattern (Burkhardt, 2005). Pronouns referring to the Dutch light quantifier *iedereen* 'everyone' interfered more with the secondary lexical decision task than pronouns referring to plain referential antecedents like *de bakker* 'the baker'. Burkhardt explains the inconsistency by suggesting that *iedereen* and *everyone* do not share the same morphological features and as a result *iedereen* falls in the referential quantifier category.

Even though the rather puzzling pattern can be explained by adopting Burkhardt's complexity hierarchy for antecedents, I do want to raise some concerns regarding the studies conducted so far, including my own experiments. First of all, it should be pointed out that the primary goal of the studies above was not to evaluate the antecedent complexity hierarchy. In fact, it is quite the reverse. The complexity hierarchy is merely used as a post hoc explanation for the reported observations, some of which were unexpected. Moreover, the studies so far only considered two antecedent categories in one experimental design. Piñango *et al.* and Burkhardt compared light quantifiers with plain referential antecedents. Carminati *et al.* and I compared plain referential antecedents with referential quantifiers. It may therefore be useful, perhaps even necessary, to compare all three antecedent categories within one single experiment.

To some extent I already addressed a second concern. Especially given the design of Piñango *et al.* and Burkhardt it seems impossible to disentangle the effects of antecedent complexity on the one hand, and the choice between binding and coreference on the other. Therefore, it remains unclear whether for instance *the landlord* is a more costly antecedent for a pronoun than *everyone* because (i) they differ in internal complexity, or because (ii) *everyone* binds the pronoun while *the landlord* can only establish a coreferential dependency.

In the next eye-tracking experiment the issues above will be addressed by comparing all three antecedent categories within a single design. Furthermore, I made sure that the possible effects could be attributed to either a difference in internal complexity of the antecedent or to a processing advantage for the binding route.

3.7. Experiment 5: Economy versus complexity

3.7.1. The stimuli and predictions

Dutch participants read a series of short stories in which the internal complexity of the antecedent of unambiguous pronouns was manipulated. Examples are given in (29) to (32) together with their approximate translations.

(29) <u>Light quantifier (LQ-condition)</u>
Het was oorlog in Soedan en de soldaten aan de frontlinie waren constant met de dood bezig. <u>Iedereen</u> was ontzettend bang dat <u>hij</u> zou sterven op het bloedige slagveld.
(A war was going on in Sudan and the soldiers at the front were constantly thinking about death. <u>Everyone</u> was very afraid that <u>he</u> was going to die on the bloody battlefield.)

(30) Referential quantifier (RQ-condition)
Het was oorlog in Soedan en de soldaten aan de frontlinie waren constant met de dood bezig. Iedere soldaat was ontzettend bang dat hij zou sterven op het bloedige slagveld.
(A war was going on in Sudan and the soldiers at the front were constantly thinking about death. Every soldier was very afraid that he was going to die on the bloody battlefield.)

(31) Referential c-commanding antecedent (RCC-condition)
Het was oorlog in Soedan en een soldaat aan de frontlinie was constant met de dood bezig. De soldaat was ontzettend bang dat hij zou sterven op het bloedige slagveld.
(A war was going on in Sudan and a soldier at the front was constantly thinking about death. The soldier was very afraid that he was going to die on the bloody battlefield.)

(32) Referential non-c-commanding antecedent (RnoCC-condition)
Het was oorlog in Soedan en een soldaat aan de frontlinie was constant met de dood bezig. De soldaat was ontzettend bang. Hij zou sterven op het bloedige slagveld.
(A war was going on in Sudan and a soldier at the front was constantly thinking about death. The soldier was very afraid. He was going to die on the bloody battlefield.)

The first sentence introduced a group (ex. (29) and (30)) or a single character (ex. (31) and (32)). This sentence was primarily included to create more interesting scenarios. In the first three conditions the second sentence contained the critical anaphoric dependency. The antecedent c-commanded the critical pronoun and was either a light quantifier (LQ) (i.e. *iedereen* 'everyone'), a referential quantifier (RQ) (i.e. *iedere soldaat* 'every soldier') or a plain referential antecedent (RCC and RnoCC) (i.e. *de soldaat* 'the soldier').

As discussed, I do not agree with the idea that a referential antecedent can only be interpreted through coreference, an assumption made by both Piñango *et al.* and Burkhardt. Instead, I assume that binding is always available if the antecedent c-commands the pronoun, regardless of its form or complexity – otherwise it seems hard or even impossible to account for the sloppy and strict ambiguity in for instance ellipsis structures. For this reason a fourth condition was included (see ex. (32)) in which the referential antecedent and pronoun appeared in different sentences. As a result, the binding route is blocked and, hence, it is clear that the language processor can only establish a coreferential dependency. This creates the opportunity to disentangle the effects of antecedent form and its structural relation to the pronoun. Namely, the results for the three c-command conditions provide information about the effects of the former and, alternatively, a comparison between the third (RCC) and fourth condition (RnoCC), lacking a c-command configuration, provides information about the effects of the latter. Note that the latter comparison directly addresses the second economy prediction of the POB framework.

Burkhardt's complexity ranking predicts the longest reading times for the critical pronoun in RQ-stories, intermediate reading times in RCC- and RnoCC-stories and the shortest reading times in LQ stories. Alternatively, if Dutch *iedereen* indeed constitutes a referential quantifier (see Burkhardt, 2005), the reading times of the pronoun in the LQ and RQ-conditions should be the same. The POB model, on the other hand makes no strong predictions for the three c-command conditions. Nevertheless, the most likely outcome in terms of this approach is that, since the antecedents are all in a position to bind the pronominal, no differences in reading times will emerge at all. The predictions of the two accounts critically diverge for the RCC and RnoCC comparison. According to the second economy prediction of the POB model binding requires less effort than coreference, and thus anticipates longer reading times for the pronoun in the RnoCC stories. A contrast between RCC and RnoCC stories is not expected in Burkhardt's account, as she assumes that both antecedents establish the same coreference relationship with the pronoun.

3.7.2. Method

Participants. Participants were 32 members from the Utrecht University community (all female, mean age 21, range 17 - 42 years) who received money for their participation.

Materials and procedure. I constructed 24 quadruplets as illustrated in examples (29) to (32) (see Appendix IV for all the Dutch originals). The stimuli were divided into four lists, with only one version of each story in a particular list. Another 24 stories were included as fillers. For a detailed description of the pseudo-randomization procedure, the general eye-tracking procedure and the inclusion of comprehension questions, the reader is referred to Paragraph 2.2.2 of Chapter 2. All participants scored above 67% correct (mean score 86%) on the comprehension questions. Each session was completed within 30 minutes.

Analysis. The analysis only considered the critical section in the discourse. In the non RnoCC condition the critical section consisted of sentences 2 and 3. In the other conditions the critical section was sentence 2. These sentences were divided into the following regions.

1. Everyone/Every soldier/The soldier *(antecedent region)*
2. was very *(antecedent-spillover region)*
3. afraid *(pre-critical region)*
4. that *(connective region, absent in non-c-commanding condition)*
5. he/He (*pronoun region)*
6. was going *(spillover region 1)*
7. to die *(spillover region 2)*
8. on the bloody (*remaining-words region)*
9. battlefield *(final-word region)*

Thus, the first region consisted of the antecedent. The second region consisted of the two words following the antecedent. The third region consisted of all the words that appeared between region 2 and the connective region. Note that the connective region is absent in the non-c-commanding condition. Region 5 contained the critical pronoun. Spillover region 1 included the two words following the pronominal and spillover region 2 included the third and fourth word following the pronominal. Region 8 consisted of any remaining words of the sentence up to the final word region.

I will report mean reading times for six different eye movement measures, namely first fixation, first gaze, total first gaze, regression path, total fixation and second-pass durations (see Paragraph 1.4.2.1 of Chapter 1 for a discussion of the different measures). Prior to all analyses, 1% of the trials was removed because major tracker losses and eye blinks made it impossible to determine the course of fixations. For all the different measures, reading times of more than 2 standard deviations from both the participant's mean and the item's mean in a region in a particular condition were treated as missing data (< 1% for all measures).

Repeated Measures ANOVAs (Huynh-Feldt corrected) with the four-level factor *Antecedent Complexity* were performed to compare the different conditions. The pair-wise post-hoc analyses of the main effects are Bonferonni adjusted for multiple comparisons.

3.7.3. Results

First fixation duration

Table 20 reports the mean first fixation duration as a function of *Antecedent Complexity* and sentence region. The results of the associated Repeated Measures ANOVAs revealed a significant main effect in the first spillover region (region 6). Pair-wise post-hoc comparisons showed a marginally significant difference between the RCC and RnoCC condition (p_1 = .053, p_2 = .051). The reading times in the RCC condition appear to be shorter, which suggests that pronouns referring to a referential c-commanding antecedent (i.e. *de soldaat*) are easier to process than pronouns referring to the same antecedent in a non-c-commanding position. Due to spillover this effect becomes visible a little bit further downstream in the sentence.

A second main effect emerged in the final word region (region 9), but only in the by-subjects analysis. Post-hoc analysis revealed a difference between the LQ and RCC condition (p_1 = .043, p_2 = 1.000). I am, however, inclined to interpret this as a chance effect, in particular because the by-items analysis was far from significant.

Table 20. Mean first fixation durations (in ms) and Repeated Measures ANOVAs for Exp. 5.

	Region								
	1	2	3	4	5	6	7	8	9
e.g.:	*Every soldier*	*was very*	*afraid*	*that*	***he***	*was going*	*to die*	*on the bloody*	*battlefield*
					First fixation duration				
condition									
LQ	214	207	207	203	205	207	205	193	271
RQ	222	216	202	197	191	210	200	206	243
RCC	210	211	205	196	208	199	192	197	222
RnoCC	223	199	203	-	192	218	199	207	232
F1									
F	< 1	1.898	< 1	< 1	1.013	2.646	< 1	1.685	3.626
df	-	3.0, 93.0	-	-	2.6, 41.8	3.0, 93.0	-	3.0, 93.0	2.5, 78.2
Mse	-	838	-	-	1426	765	-	890	4584
p	-	.135	-	-	.389	.054	-	.176	.022*
F2									
F	1.011	2.076	< 1	< 1	< 1	2.931	< 1	1.655	2.003
df	3.0, 69.0	2.9, 66.3	-	-	-	2.9, 67.3	-	3.0, 69.0	1.6, 35.6
Mse	964	977	-	-	-	586	-	652	24116
p	.393	.114	-	-	-	.041*	-	.185	.158

First gaze duration

Table 21 reports the mean first gaze duration for each region and the associated Repeated Measures ANOVAs. The analyses returned significant main effects for the antecedent region (region 1), pre-critical region (region 3) and the first spillover region (region 6).

The post-hoc analysis for the antecedent region showed the following. The reading times for the LQ antecedent were shorter than for the RQ antecedent ($p_1 < .001$, $p_2 < .001$), RCC antecedent ($p_1 < .001$, $p_2 = .060$) and RnoCC antecedent ($p_1 = .010$, $p_2 = .015$). Furthermore, RQ antecedents required longer reading times than RCC antecedents ($p_1 < .001$, $p_2 < .001$) and RnoCC antecedents ($p_1 < .001$, $p_2 < .001$). The latter two were read equally fast. Undoubtedly, this ranking is due to the word length of the antecedents. The LQ antecedent *iedereen* contains fewer characters and is therefore read more quickly than RCC and RnoCC antecedents like *de soldaat*. In turn, the latter two are read faster than a RQ antecedent like *iedere soldaat*, simply because this is the longest antecedent.

Table 21. Mean first gaze durations (in ms) and Repeated Measures ANOVAs for Exp. 5.

	Region								
	1	2	3	4	5	6	7	8	9
e.g.:	*Every soldier*	*was very*	*afraid*	*that*	***he***	*was going*	*to die*	*on the bloody*	*battlefield*
					First gaze duration				
condition									
LQ	259	367	615	207	222	364	281	1375	342
RQ	463	399	655	199	200	351	277	1233	299
RCC	320	374	643	196	215	339	261	1146	313
RnoCC	338	339	900	-	207	405	271	1276	308
F1									
F	33.103	2.599	18.020	< 1	< 1	3.007	< 1	1.204	1.034
df	2.6, 79.8	3.0, 93.0	3.0, 92.5	-	-	2.7, 82.8	-	2.6, 79.4	2.5, 78.5
Mse	8261	7573	31295	-	-	10023	-	282327	12791
p	.001*	.057	.001*	-	-	.040*	-	.311	.374
F2									
F	34.337	2.024	12.213	< 1	< 1	5.906	< 1	2.019	< 1
df	3.0, 69.0	2.6, 60.6	1.8, 40.3	-	-	2.8, 64.3	-	2.9, 66.7	-
Mse	4851	7779	63687	-	-	3958	-	104491	-
p	.001*	.127	.001*	-	-	.002*	-	.122	-

As expected, the post-hoc analyses for the pre-critical region revealed no differences between the LQ, RQ and RCC conditions because the pre-critical regions were exactly the same. However, these three conditions elicited significantly shorter reading times than the RnoCC condition (all p-values $< .012$). This effect is most likely due to sentence wrap-up effects in the RnoCC condition. In the latter condition, the critical second sentence was split into two separate ones, to avoid a c-command relation between the antecedent and the pronoun. Thus, the pre-critical region in the RnoCC condition is in fact the end of sentence two. As readers have a tendency to slow down at the end of a sentence and often regress to earlier parts, presumably to integrate the sentence into the representation of the whole story, longer reading times in this region are expected (e.g. Rayner, Kambe & Duffy, 2000).

The post-hoc analyses for the first spillover region showed a contrast between the RCC and RnoCC condition (p_1 = .082, p_2 = .004). Although only the by-items analyses returned a significant result, the same pattern emerged as in the first fixation measure. That is, reading times right after the critical pronoun tend to be shorter if the antecedent c-commands the pronoun.

Total first gaze duration

Table 22 reports the mean total first gaze duration for each region and the associated Repeated Measures ANOVAs. The pattern of the total first gaze durations replicated the pattern of the first gaze durations. Significant main effects emerged for the antecedent region (region 1), pre-critical region (region 3) and the first spillover region (region 6).

First of all, the post-hoc analysis for the antecedent region revealed exactly the same ranking as found in the first gaze measure. The relatively short LQ antecedent was read more quickly than an RQ antecedent (p_1 < .001, p_2 < .001), RCC antecedent (p_1 < .001, p_2 = .026) and RnoCC antecedent (p_1 = .003, p_2 = .006). Furthermore, RQ antecedents again required longer reading times than RCC antecedents (p_1 < .001, p_2 < .001) and RnoCC antecedents (p_1 < .001, p_2 < .001). No difference existed between the latter two. As discussed previously, this ranking is attributed to a difference in word length.

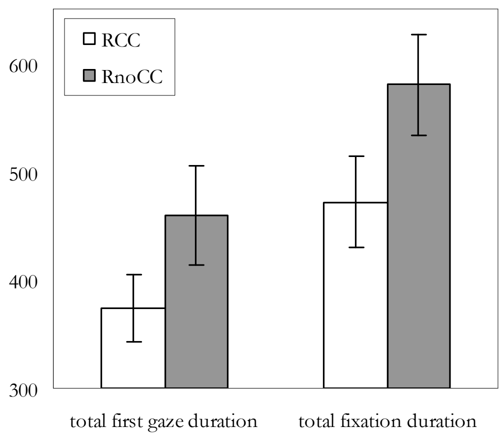
The post-hoc analyses for the pre-critical region showed no difference between the LQ, RQ and RCC conditions. However, the pre-critical region in these conditions was again read more quickly than the pre-critical region in the RnoCC condition (all p-values < .001). As discussed, I attribute this difference to wrap up effects.

Similar to the first fixation and first gaze results, the post-hoc analyses for the first spillover region revealed longer reading times for the RnoCC condition in comparison to the RCC condition. However, whereas the previous analyses returned marginally significant results, the present analysis was significant both for by-subjects and by-items (p_1 = .027, p_2 < .001). Taken together, these results suggest that reading times in the region immediately following the critical pronoun are shorter if the antecedent c-commands the pronoun (see Figure 15).

Table 22. Mean total first gaze durations (in ms) and Repeated Measures ANOVAs for Exp. 5.

	Region								
	1	2	3	4	5	6	7	8	9
e.g.:	*Every soldier*	*was very*	*afraid*	*that*	***he***	*was going*	*to die*	*on the bloody*	*battlefield*
					Total first gaze duration				
condition									
LQ	268	427	757	207	227	402	301	1783	397
RQ	505	410	750	202	204	400	299	1718	386
RCC	348	414	710	196	218	374	286	1703	386
RnoCC	355	382	1023	-	214	459	297	1684	387
F1									
F	46.803	1.287	25.702	< 1	< 1	4.241	< 1	< 1	< 1
df	2.7, 83.3	2.9, 90.0	2.5, 77.5	-	-	2.9, 91.1	-	-	-
Mse	7486	9427	30916	-	-	9737	-	-	-
p	.001*	.284	.001*	-	-	.008*	-	-	-
F2									
F	41.611	< 1	23.410	1.061	< 1	6.893	< 1	< 1	< 1
df	3.0, 69.0	-	1.4, 30.3	1.9, 37.1	-	3.0, 69.0	-	-	-
Mse	5419	-	55285	2038	-	4615	-	-	-
p	.001*	-	.001*	.352	-	.001*	-	-	-

Figure 15. Mean total first gaze and total fixation durations (in ms) for the first spillover region (region 6) of the RCC and RnoCC conditions in Exp. 5.



Regression path duration

Table 23 reports the mean regression path duration for each region and the associated Repeated Measures ANOVAs. The pattern partly replicated the pattern of the first gaze and total first gaze durations. Significant main effects emerged in the antecedent region (region 1) and pre-critical region (region 3).

The post-hoc analysis for the antecedent region again revealed an antecedent length effect, yet the differences were less pronounced. The RQ antecedent required the longest reading time. It was read more slowly than LQ antecedents ($p_1 < .001$, $p_2 < .001$), RCC antecedents ($p_1 = .130$, $p_2 = .008$) and RnoCC antecedents ($p_1 < .001$, $p_2 < .001$).

The post-hoc analyses for the pre-critical region replicated the first gaze and total first gaze results (all p-values < .003). As discussed, the difference reflects sentence wrap-up effects.

Table 23. Mean regression path durations (in ms) and Repeated Measures ANOVAs for Exp. 5.

	Region								
	1	2	3	4	5	6	7	8	9
e.g.:	*Every soldier*	*was very*	*afraid*	*that*	***he***	*was going*	*to die*	*on the bloody*	*battlefield*
	Regression path duration								
condition									
LQ	297	486	851	253	265	452	337	2308	1590
RQ	572	431	806	228	215	474	360	2368	1765
RCC	436	478	770	291	289	447	385	2238	1638
RnoCC	382	448	1199	-	288	505	331	2107	1777
F1									
F	14.694	1.283	19.012	1.063	1.308	1.133	< 1	< 1	< 1
df	2.2, 69.0	2.5, 77.5	2.1, 64.4	1.1, 28.6	2.2, 35.7	2.8, 87.9	-	-	-
Mse	39119	20094	95009	42042	21034	20895	-	-	-
p	.001*	.286	.001*	.321	.285	.339	-	-	-
F2									
F	13.766	1.094	34.484	< 1	< 1	1.497	< 1	< 1	< 1
df	2.9, 66.3	2.5, 58.4	2.1, 47.1	-	-	2.7, 61.7	-	-	-
Mse	22042	18903	45084	-	-	13984	-	-	-
p	.001*	.352	.001*	-	-	.227	-	-	-

Total fixation duration

Table 24 reports the mean total fixation duration for each region and the associated Repeated Measures ANOVAs. Significant main effects emerged in the antecedent region (region 1), pre-critical region (region 3), pronoun region (region 5; note that only the by-subjects analysis returned a significant result) and first-spillover region (region 6).

The post-hoc analysis for the antecedent and pre-critical region revealed the same patterns as previously discussed (antecedent region all p-values < .081; pre-critical region all p-values < .092). The patterns reflect word length and wrap-up effects respectively.

The post-hoc analyses for the pronoun region showed a difference between the LQ and RnoCC condition, but only in the by-subjects analysis ($p_1 < .001$, $p_2 = .336$). If this effect is genuine it suggests that readers spend more time reading a pronoun referring to a light quantifier like *iedereen* than to a referential antecedent like *de soldaat*. This would go against the hypothesis that a dependency between a pronoun and a light quantifier requires the least processing resources.

The post-hoc analysis for the first spillover region revealed longer reading times for the RnoCC condition in comparison to the RCC condition (p_1 = .011, p_2 = .007; see Figure 15). This replicates the findings for first fixation, first gaze and total first gaze durations. The analysis revealed in addition a difference between the RQ and RnoCC condition (p_1 = .004, p_2 = .034). Reading times were shorter in the RQ condition than in the RnoCC condition. Hence, the first spillover region showed a clear processing advantage for pronouns referring to c-commanding antecedents compared to pronouns referring to a non-c-commanding referential antecedent. Moreover, these results are inconsistent with the idea that establishing a dependency between a referential quantifier and a pronominal requires the most processing resources.

Table 24. Mean total fixation durations (in ms) and Repeated Measures ANOVAs for Exp. 5.

	Region								
	1	2	3	4	5	6	7	8	9
e.g.:	*Every soldier*	*was very*	*afraid*	*that*	***he***	*was going*	*to die*	*on the bloody*	*battlefield*
					Total fixation duration				
condition									
LQ	331	502	819	248	311	492	328	1712	389
RQ	565	476	784	231	280	478	332	1693	378
RCC	419	488	753	222	273	472	342	1671	378
RnoCC	452	486	1036	-	228	580	371	1666	378
F1									
F	30.236	< 1	16.378	1.589	3.983	5.535	1.371	< 1	< 1
df	3.0, 93.0	-	2.6, 80.3	1.7, 50.1	3.0, 78.0	2.9, 91.4	3.0, 93.0	-	-
Mse	9888	-	37091	4208	7994	14885	8813	-	-
p	.001*	-	.001*	.216	.011*	.002*	.256	-	-
F2									
F	19.854	< 1	10.463	1.071	1.935	5.240	2.326	< 1	< 1
df	3.0, 69.0	-	1.5, 32.0	1.9, 41.6	2.8, 61.3	2.8, 63.9	2.6, 59.6	-	-
Mse	11141	-	84976	10558	6970	13039	6068	-	-
p	.001*	-	.001*	.349	.137	.003*	.092	-	-

Second-pass duration

Table 25 reports the second-pass duration for each region and the associated Repeated Measures ANOVAs. Significant main effects emerged in the antecedent region (region 1), antecedent spillover region (region 2) and pronoun region (region 5). Note that in all three regions only the by-subjects analysis returned a significant result.

The post-hoc analysis for the antecedent region suggested, although not robustly, that readers re-fixate referential quantifiers longer than light quantifiers (p_1 = .017, p_2 = .126). This could reflect a processing advantage for the latter. However, because the light quantifiers were shorter than the referential quantifiers, and furthermore, only the by-subjects analysis was significant, I avoid drawing a strong conclusion.

The post-hoc analysis of the antecedent spillover region revealed, again not convincingly, a difference between the RQ and RnoCC condition (p_1 = .037, p_2 = .415). Readers were less likely to re-fixate this region, located very closely to the antecedent, in the RQ condition. Although the exact cause of the difference is uncertain, a safe conclusion would be that pronouns that depend on referential quantifiers are at least not more difficult to process than pronouns with non-c-commanding referential antecedents.

Post hoc analyses for the pronoun region showed a difference between the LQ and RnoCC condition, but only in the by-subjects analysis (p_1 = .029, p_2 = .298). Similar to the result for the total fixation duration, it appears that readers spend more time re-reading a pronoun referring to a light quantifier than to a referential antecedent. Although I avoid making a strong claim here, I tentatively conclude that this finding is at least inconsistent with the hypothesis that light quantifiers incur the fewest processing costs.

Table 25. Mean second-pass durations (in ms) and Repeated Measures ANOVAs for Exp. 5.

	Region								
	1	2	3	4	5	6	7	8	9
e.g.:	*Every soldier*	*was very*	*afraid*	*that*	***he***	*was going*	*to die*	*on the bloody*	*battlefield*
					Second-pass duration				
condition									
LQ	94	166	254	46	82	147	87	514	31
RQ	141	105	209	41	69	154	91	625	65
RCC	127	137	192	45	63	153	112	693	49
RnoCC	150	162	228	-	42	194	113	568	58
F1									
F	3.124	3.887	1.189	< 1	2.923	1.420	< 1	1.424	1.712
df	2.8, 88.1	3.0, 93.0	2.6, 82.0	-	2.9, 89.8	3.0, 93.0	-	2.7, 85.2	2.7, 83.6
Mse	6479	6414	22101	-	3081	10313	-	143379	4370
p	.032*	.011*	.317	-	.040*	.242	-	.243	.176
F2									
F	2.246	1.660	< 1	< 1	2.141	1.071	1.142	< 1	1.512
df	3.0, 69.0	2.9, 66.8	-	-	2.4, 55.5	2.6, 58.8	3.0, 68.8	-	2.9, 66.4
Mse	6084	11868	-	-	3667	12616	3718	-	3266
p	.091	.185	-	-	.118	.362	.338	-	.221

3.7.4. Discussion

When we combine the results of the various eye-tracking measures, a clear picture emerges. Three regions showed reliable results. The first and for present purposes least interesting pattern emerged in the antecedent region. The light quantifier *iedereen* was read more quickly than referential antecedents like *de soldaat* and, similarly, antecedents like *de soldaat* were read faster than referential quantifiers like *iedere soldaat*. This ranking is expected as the antecedents clearly differ in word length. A second reliable effect was found in the pre-critical region. No differences emerged for the three c-command conditions in which the regions were exactly alike. However, in the non-c-command condition readers clearly slowed down. The important difference between the conditions was that in the latter condition the pre-critical region included the end of a sentence, which was not the case in the other conditions. As readers have a tendency to slow down at the end of a sentence, due to end of sentence wrap-up, longer reading times are in fact expected in the non-c-command condition (e.g. Rayner *et al.*, 2000). The third and most interesting robust effect appeared in the first spillover region, right after the critical pronoun. The analysis showed that pronouns referring to a referential antecedent like *de soldaat* consistently elicited longer reading times if the binding route was not available.[14]

Recall that the aim of the experiment was twofold. First, I wanted to evaluate Burkhardt's complexity hierarchy for antecedents. In addition, pronouns that could be variable-bound were compared to pronouns that could not, to tease apart the effects of antecedent form and its structural

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[14] The critical reader might point out that the difference in the first spillover region is not due to spillover from the pronoun, but rather reflects spillover from the wrap-up effects in the pre-critical region. However, according to Rayner *et al.* (2000) it is unlikely that wrap-up effects carry over into the next clause or sentence. In fact, wrap-up seems to be 'designed' to ensure that the information from the sentence is fully integrated, and all within-sentence comprehension problems are settled before the reader moves on. This provides a way to clear the workspace memory and allows more new information to be brought in.

More challenging might be the observation that readers tend to read more quickly while they proceed through a sentence (Ferreira & Henderson, 1993). As in the RCC condition the critical pronoun and spillover region are more downstream than in the RnoCC condition, the longer reading times in the latter could reflect the tendency to speed up, rather than a processing advantage for pronouns with a c-commanding antecedent. Then, however, we should also expect longer reading times for the RnoCC condition in the second spillover and subsequent region (i.e. region 7 and 8). As neither these regions nor the critical pronoun region showed any signs of such an effect, I doubt whether the potential tendency to speed within a sentence could explain the results.

relationship with the pronoun. In other words, the latter enabled me to examine whether binding is more economic than coreference.

According to Burkhardt, pronouns referring to light quantifiers like *everyone* should require less processing resources than pronouns referring to plain referential antecedents (e.g. *the soldier*). Similarly, pronouns referring to referential antecedents should require less processing resources than pronouns referring to referential quantifiers (e.g. *every soldier*). However, since the experiment was conducted with Dutch sentences, another pattern could arise as well. Burkhardt proposed that Dutch *iedereen* should be analyzed as a referential quantifier rather than a light quantifier (due to its morphological make-up). Then we should expect that pronouns referring to Dutch light and referential quantifiers are read equally fast, or at least, both should elicit longer reading times than pronouns referring to plain referential antecedents. None of these patterns emerged from the eye-tracking data. In fact, for the three c-command conditions, the various dependent measures revealed no reliable differences at all. In other words, nothing in the data suggested that light quantifiers are most easily connected to a pronoun, or that it is particularly hard to establish a dependency with a referential quantifier. Although the POB model does not make strong predictions for the three c-command conditions, the results are easily explained if the crucial characteristic is not the complexity of the antecedent, but rather its structural relation with the pronoun. In that case we expect that the pronoun will be bound in all three c-command conditions and, hence, similar processing costs should emerge.

The reason for including a fourth condition, in which the referential antecedent and pronoun were not in a c-command configuration, was to disentangle the effects of antecedent complexity and the possibility (or impossibility) of binding the pronoun. By comparing this condition to the minimally different condition in which the same antecedent (e.g. *de soldaat* 'the soldier') c-commanded the pronoun, I could focus exclusively on the difference between binding and coreference. As we have seen, the results showed a processing advantage for pronouns with c-commanding antecedents. Hence, this finding is consistent with the second economy prediction of the POB model, stating that binding induces a smaller processing load than coreference. Furthermore, in my opinion it seems hard to maintain the position that referential antecedents like *the soldier* are always identified through coreference and never through binding. This assumption would predict no contrast between pronouns with an antecedent in a binding position and pronouns referring to the same antecedent in a non-binding position. As this contrast emerged, the data cast some doubt on the validity of the studies conducted by Piñango *et al.* and Burkhardt, or at least on how they addressed the difference in processing load for variable binding and coreference.

Although the results of this final experiment of Chapter 3 fit the predictions of the POB model remarkably well, they do raise a concern for the interpretation of the results of Experiment 4. The latter experiment showed that perceivers have an initial preference for the bound-variable interpretation of an *ambiguous* pronoun (i.e. the pronoun could either be connected to a c-commanding antecedent such as *every worker,* or to a coreferential proper name such as *Paul*). Yet, the reading times for the *unambiguous* conditions, in which the pronoun could only be resolved through binding, or alternatively, only through coreference, suggested that coreferential dependencies do not necessarily put a higher processing load on the comprehension system than bound-variable dependencies (see ex. (33) and (34) for approximate translations of the relevant stimuli).

(33) <u>Variable binding only (VB-only)</u>
A working day in the factories alongside the North Sea Canal is always very tough. Especially today a lot of workers could barely cope. *<u>Every worker</u> who was running out of energy, thought it was very nice that <u>he</u> could go home early this afternoon.* Hopefully a hot shower would ease the pain.

(34) <u>Coreference only (CR-only)</u>
A working day in the factories alongside the North Sea Canal is always very tough. Especially today the old worker Paul could barely cope. *<u>Paul</u> was running out of energy. It was very nice that <u>he</u> could go home early this afternoon.* Hopefully a hot shower would ease the pain.

In fact, second-pass reading times for the pronoun were longer in the VB-only condition. I proposed that Burkhardt's complexity hierarchy for antecedents may explain the latter finding, however, the results of Experiment 5 seem to speak against this solution: the predicted reading time effects of the complexity hierarchy did not emerge in the eye-tracking data.

Of course, one way out is to simply attribute the mixed results to a Type II error in Experiment 5, that is, I failed to observe the effects of the complexity hierarchy, when in truth they are there (or alternatively to a Type I error in Experiment 4, i.e. the results suggested a complexity hierarchy, yet in truth there is none) and stop there. However, this would be a rather dissatisfying conclusion. Moreover, I believe that at least a partial answer is at hand, which builds on the essence of Burkhardt's approach, i.e. antecedent complexity, yet places it in a broader context.

3.7.4.1. Cross-modular versus intrinsic economy

First of all, recall that in Chapter 1 we discussed a number of possible rationales for considering economy as an important organizing principle of the human language system (see Reuland, in prep.). A distinction was made between cross-modular and intrinsic processing costs, and I illustrated that the economy hierarchy of the POB model is predominantly based on the former. Thus, the intrinsic costs of actually forming an A-Chain within syntax, binding a pronoun within semantics, or co-valuing a pronoun in the discourse are left out of the equation. Alternatively, Burkhardt's complexity approach seems to focus more on intrinsic economy. That is, she assumes that regardless of the cross-modular processing differences of binding and coreference, processing costs will increase as a function of how much information needs to be transferred between a pronominal and its antecedent in order to establish a proper dependency. As we have seen, she proposed a more or less fixed antecedent ranking based predominantly on quantification. The results of my studies, on the other hand, suggest that we may consider a more liberal approach to intrinsic economy. For example, instead of adopting a fixed antecedent hierarchy, we could define intrinsic economy as follows: the intrinsic processing costs of variable binding vary as a function of the complexity of the semantic representation, and similarly, the intrinsic processing costs of coreference vary as a function of the complexity of the wider discourse, meaning more discourse cues (e.g. first mention, recency, implicit causality) need to be taken into account. Then, if we combine this definition of intrinsic economy with the idea of cross-modular economy, we create the groundwork from which we can, for the most part, explain the mixed results of Experiments 4 and 5.

In Experiment 4, I compared unambiguous pronouns that could only be bound to unambiguous pronouns that could only corefer (ex. (33) and (34)). In the former condition the bound-variable dependency between the complex quantified antecedent *every worker who was running out of energy* and the pronominal *he* in all likelihood involves extensive semantic processing. This is because the general set of individuals introduced through *every* is heavily constrained by its nominal restrictor *worker* and, more importantly, by the relative clause *who was running out of energy* (or in other words, the semantic properties of the noun *worker* are complex). Thus, on the basis of my definition of intrinsic economy we may now assume that variable binding is relatively costly. On the other hand, the discourse processing costs of linking *he* to *Paul* in the coreference condition are relatively low: *Paul* is the only possible entity in the discourse storage that can be co-valued, hence the coreference process is relatively cheap. Consequently, despite the definite cross-modular advantage of bound-variable dependencies, the binding process as a whole is more expensive than the coreference process, simply because the overall costs do not only consist of cross-modular costs, but include intrinsic costs as well. Adopting this view we can preserve the idea that in Experiment 4 binding requires less cross-modular steps than coreference, and is in a sense cheaper, but this advantage is obscured by a relatively expensive intrinsic semantic operation.

In that respect the stories in Experiment 5 may be more suitable to test predictions on cross-modular economy, because the relevant conditions more closely resemble minimal pairs (apart from the sentence boundary, see ex. (35) and (36) for approximate translations of the relevant stimuli).

(35) <u>Variable binding (RCC-condition)</u>
A war was going on in Sudan and a soldier at the front was constantly thinking about death. *<u>The soldier</u> was very afraid that <u>he</u> was going to die on the bloody battlefield.*

(36) <u>Coreference (RnoCC-condition)</u>
A war was going on in Sudan and a soldier at the front was constantly thinking about death. *<u>The soldier</u> was very afraid. <u>He</u> was going to die on the bloody battlefield.*

More specifically, exactly the same antecedent is used (i.e. *the soldier*) and, furthermore, the semantic context and wider discourse are also very similar. Hence, the differences in processing costs for the pronominals in all likelihood reflect cross-modular economy differences.

However, the observation that antecedent complexity had no effect *whatsoever* in the three c-command conditions of Experiment 5, remains rather mysterious. The main difference between my experiment and previous studies on the subject is that I presented mini stories consisting of two sentences, whereas Piñango *et al.*, Carminati *et al.* and Burkhardt used single-sentence stimuli. So, it is possible that the introductory sentences in my stories (see ex. (29)-(32)) attenuated antecedent-type effects, for example, because they already introduce a specific referent set before the reader encounters the light or referential quantifier. Then again, the stories in Experiment 4 contained similar introductory sentences, but in this case we *did* observe effects of antecedent type, thereby casting some doubt on the latter explanation. In all, with respect to the topic of antecedent complexity I can merely state that, apparently, the semantic representation of a referential quantifier is not complex per se, at least not to the extent that it always significantly affects the processing costs of a bound-variable pronoun. So again, given this view, a referential quantifier like *every worker who was running out of energy* (see ex. (33)) is a particularly expensive antecedent, not because it contains the quantifier *every*, but because it contains both a quantifier *and* a restrictive relative clause. These two factors combined induce intricate semantic set computations and measurable processing consequences for a later pronoun, not necessarily the quantifier in itself.

To sum up, the results of Experiment 5 are consistent with the second economy prediction of the POB model, namely, bound dependencies require less (cross-modular) processing than coreferential dependencies. Furthermore, I tentatively propose that, although antecedent complexity may play an important role in the course of pronominal resolution, Burkhardt's account may be too strict. A more liberal approach is therefore warranted in which the intrinsic processing costs of binding and coreference are not defined in terms of a fixed antecedent hierarchy, but instead in more general terms of semantic and discourse complexity.

3.8. Overview of the experimental results

In four experiments the second and third economy predictions of the POB model were tested and, in addition, I examined related issues such as the application of Rule-I (Grodzinsky & Reinhart, 1993; Reinhart, 2000) and Burkhardt's (2005) complexity hierarchy for antecedents. A short overview of the results is given below.

Experiment 2 and 3 showed that the preference for bound dependencies (i.e. the third economy prediction) is not restricted to ellipsis structures, as previously suggested by Frazier and Clifton (2000), but also emerges in structures with the *only*-operator. In addition, the results for ellipses seemed to suggest that the choice between the binding or coreferential route depends on the strategy of the reader, which makes sense as the choice should be intrinsically free – otherwise there would be no ambiguity to begin with. In general the binding route could then be considered as a 'quick and dirty' initial solution. The discourse route, on the other hand, reflects a more elaborate alternative providing a more precise interpretation, sometimes of the same c-commanding antecedent, at the expense of additional processing.

Experiment 4 offered further evidence in favour of the POB model. In quantificational contexts, very different from ellipsis and *only*-structures, readers preferred to bind an ambiguous pronoun as well. Furthermore, and again contrary to what Frazier and Clifton have suggested, the anaphoric vehicle did not play a decisive role. Recall that Frazier and Clifton argued that possessive pronouns (e.g. *his*) typically take local c-commanding antecedents, yet phrasal pronouns (e.g. *he*) typically take discourse antecedents. Even though in Experiment 4 phrasal pronouns were used instead of possessive pronouns, there was still a significant preference to connect the pronoun to the c-commanding antecedent rather than to the competing discourse antecedent. However, contrary to the expectations, the results for the unambiguous conditions did not suggest that binding dependencies are always cheaper than discourse dependencies, i.e. at first glance inconsistent with the second economy prediction. Furthermore, the results were also inconsistent with the original Rule-I, yet consistent with the predictions of its revised version (Reinhart, 2000).

In Experiment 5, I evaluated Burkhardt's complexity hierarchy for antecedents. According to Burkhardt, pronouns referring to light quantifiers like *everyone* should require less processing resources than pronouns referring to plain referential antecedents like *the soldier*. Similarly, pronouns referring to referential antecedents should require less processing resources than pronouns referring to referential quantifiers like *every soldier*. However, there were no signs of such a difference. In fact, light quantifiers, referential quantifiers and plain referential antecedents appeared to elicit similar processing costs for the dependent pronoun. In addition, I attempted in this experiment to disentangle the effects of antecedent complexity and its structural relation with the pronoun. The results showed a processing advantage for pronouns that depended on c-commanding antecedents for their interpretation. Consistent with the second economy prediction, this finding suggests that binding is more economic than coreference.

The diverging patterns of Experiment 4 and 5 were explained by adopting a slightly revised (i.e. more liberal) version of Burkhardt's complexity hierarchy for antecedents. Instead of assuming a fixed ranking, I merely proposed that the intrinsic costs of binding depend on the complexity of the semantic representation, and similarly, the intrinsic costs of coreference on the complexity of the wider discourse. Consequently, in some specific circumstances the binding process as a whole may induce a higher processing load than coreference, simply because the summation of intrinsic and cross-modular costs comes out higher.

3.9. General conclusion

The title of the present chapter posited a rather puzzling question: 'Strictly discourse or sloppy semantics?'. By now, most readers will probably recognize that 'strictly discourse' functions as a substitute for coreference and, similarly, 'sloppy semantics' as a substitute for variable binding. I promised to give you a straightforward answer and I believe the data permit me to do so. That is, if we pose the same question to the human language processor, both offline and online studies have shown the answer will be 'sloppy semantics, please'. On a more serious note, the prediction that when a pronominal is ambiguous between a bound or coreferential interpretation the former is initially preferred (i.e. the third economy prediction), is clearly borne out.

According to the second prediction of the economy hierarchy, the construction of semantic anaphoric dependencies requires less effort than the construction of discourse anaphoric dependencies. The results with respect to this prediction were somewhat mixed. Note, however, that the experiment containing the most closely matched conditions (i.e. Experiment 5) revealed a consistent pattern. Thus, it seems legitimate to conclude that, in general, the two economy predictions that apply to the semantic and discourse module are reflected in real time language comprehension.

CHAPTER 4

The building blocks of the POB model: Economy, sequentiality and modularity

4.1. Introduction

In the first part of this dissertation I set out to examine whether the POB framework and its regulating economy principle have psychological validity. That is, I asked the question whether the POB model is not only a comprehensive linguistic account, but could also be interpreted as an online processing model on anaphora resolution. The previous two chapters focused more or less exclusively on the economy hierarchy, one of the core features of the POB model. However, as discussed in Chapter 1, two additional features should be distinguished, namely modularity and sequentiality. The notion modularity refers to the idea that anaphora resolution involves three different subcomponents. More specifically, anaphoric dependencies are established in a syntactic, semantic or discourse component and since the POB model assumes a modular architecture, these different components are thought to operate independently of each other. In addition, the POB model also incorporates an inherent sequentiality. Since discourse representations are built upon semantic representations and the latter are in turn built upon syntactic representations, anaphora resolution entails three distinct phases. In the first syntactic phase reflexives are interpreted through A-Chain formation. In the second phase the output of the syntactic module is transmitted to the semantic module in which variable binding takes place and in the third phase the output of the semantic module enters the discourse module in which pronominals can be interpreted through coreference.

In this chapter I will extend the scope of my evaluation. In addition to the economy hierarchy the assumptions on modularity and sequentiality will be taken into account as well, thereby covering the full spectrum of the POB model. The structure of the chapter is as follows.

First, the concept of economy will be revisited. More specifically, I will discuss two issues: (i) how does economy shape the architecture of the comprehension system, and (ii) what is the actual purpose of economy? Second, I will address whether anaphora resolution is constrained by an inherent serial order of processing or, alternatively, whether syntactic and extra-syntactic constraints are evaluated in parallel. I will do so by discussing a number of experimental studies and discover that while some of them seem to provide evidence against a sequential approach (Badecker & Straub, 2002), most of them strongly support the view that syntactic processing precedes semantic and discourse processing (e.g. Nicol & Swinney, 1989; Sturt, 2003a). The third core feature of the POB, modularity, will be addressed subsequently. I take the position that modularity should not only apply at the functional level, but at the neurocognitive level as well, or more specifically, I adopt a correspondence hypothesis: "differences between major modules of the grammatical system correspond with differences in processes at the neural level and vice versa" (Reuland, 2003, p.4; cf. Jackendoff, 1997). Very interestingly, two ERP studies provide some striking evidence in favor of such an approach (Burkhardt, 2005; Harris, Wexler & Holcomb, 2000). Finally, after providing this overview of experimental studies directly bearing on the main assumptions of the POB model, I will conclude the chapter by comparing the online version of the POB model to a number of other proposals on real time anaphora resolution (e.g. Badecker & Straub; 2002; Gordon & Hendrick, 1998; Kennison, 2003; Sturt, 2003a) and elucidate why at present the POB model should be preferred.

4.2. Evaluating the POB model

4.2.1. Economy

The economy principle forms the heart of the POB model. On the one hand it presents a linguistic tool to explain the sometimes rather complex grammaticality pattern of anaphoric dependencies across languages. On the other hand it also makes clear predictions for real time anaphora resolution processes. As discussed extensively in Chapter 1, the economy hierarchy is primarily based on the number of cross-modular steps required to assign reference to an anaphoric element. The main hypothesis throughout this dissertation is that the economy hierarchy is 'psychologically real'. As a result, one should be able to pick up the difference in processing costs for syntactic, semantic and discourse dependencies using a range of behavioural techniques such as dual task, self-paced reading and eye-tracking paradigms. I embraced the latter methodology and put it to use by testing the three main predictions that naturally follow from the economy hierarchy. To refresh the reader's memory these predictions are repeated below.

1. The construction of syntactic anaphoric dependencies requires less effort than the construction of semantic and discourse anaphoric dependencies.
2. The construction of semantic anaphoric dependencies requires less effort than the construction of discourse anaphoric dependencies.
3. If a pronominal is ambiguous between a semantic or discourse interpretation, the former is (initially) preferred, since it reflects the most economical option.

The eye-tracking experiments of the previous chapters show that the first and third economy predictions of the POB framework are borne out in online measures of language processing. Especially the reality of a general binding preference (i.e. prediction 3) seems well-established, since in addition to my eye-tracking studies, both offline (Fiengo & May, 1994; Foley *et al.*, 1997; Guo *et al.*, 1996; Shapiro *et al.*, 2003; Vasić, 2006) and online self-paced reading studies (Frazier & Clifton, 2000), clearly suggest that in case of ambiguity people have a general tendency to (initially) choose the semantic option.

In the light of the economy hierarchy, the most straightforward explanation for a general binding preference is to assume that people prefer the semantic route simply because it presents the cheapest option. This implies that the construction of bound dependencies should require less effort than the construction of coreferential dependencies (i.e. the second prediction of the economy hierarchy). The experimental evidence with respect to this prediction is however somewhat mixed. First of all, some studies that have previously been interpreted as providing consistent results (e.g. Piñango *et al.*, 2001) are in fact unable to attribute their results unequivocally to a difference in processing cost for binding and coreference (see Chapter 3, Paragraph 3.6.4 for discussion). Furthermore, my own results in Chapter 3 also left a problem to be resolved. One eye-tracking experiment (Experiment 5) suggested that bound pronominals require less processing than coreferential pronominals, but another experiment (Experiment 4) did not allow this conclusion. I introduced the distinction between cross-modular and intrinsic economy to account for these seemingly conflicting results. In the next paragraph I will elaborate on the implications thereof. More specifically, I will present a number of ways showing how economy could be implemented in a real time POB processing system.

4.2.1.1. 'Weak', 'intermediate' and 'strong' economy

In Chapter 1 a rationale for positing intrinsic economy as an important organizing principle of the human language system was presented. Intrinsic economy builds on the idea that the modules differ in their demands on attentional resources. Especially syntax requires little monitoring, because its algorithms are fully deterministic. Framed in terms of economy, these automatic, blind processes are thought to be intrinsically cheap. Semantic operations are less constrained, require more attention and, hence, are less economic. Finally, the discourse component integrates information originating from numerous different sources and its elaborate algorithms are therefore plausibly the costliest. Thus, the crucial difference between intrinsic and cross-modular economy is that the former is based on the processing costs emerging *within* a module, whereas the latter is based on the processing costs emerging from the transfer of information *between* the modules.

Both intrinsic and cross-modular economy considerations entail the following ranking: syntax < semantics < discourse. However, as discussed frequently throughout this dissertation, irrespective of intrinsic and cross-modular processing costs, a similar ranking is also expected due to the sequential architecture of the POB system. This architecture is based on the idea that bound-variable relations require the representation of at least some basic syntactic structure, otherwise they are impossible to compute. Similarly, co-valuing a pronominal and its antecedent in the discourse requires that the nature of the relevant semantic objects is determined. In other words, semantic relations cannot be computed without a rudimentary syntactic structure, and discourse relations cannot be computed without a basic semantic structure (Reuland, in prep.; cf. Friederici, 2002; Friederici & Kotz, 2003; Grodzinsky & Friederici, 2006).

Bearing these comments on economy and sequentiality in mind, we may distinguish three versions of the POB framework, based on how strictly they incorporate the notion economy to account for the syntax-semantics-discourse processing hierarchy. In the 'weakest' hypothetical version of the POB model, the division of labor of the three modules is predominantly guided by the serial architecture of the language system, i.e. intrinsic and cross-modular processing costs do not play an important role. An 'intermediate' position is taken if one assumes that both the sequential architecture and cross-modular processing costs affect language comprehension (i.e. the starting point of my studies). Finally, in the 'strong' version, the serial order of processing, cross-modal economy and intrinsic economy all influence real time anaphora resolution.[1]

The results of Chapter 2 were consistent with the intermediate and strong version: (syntactic) coargument reflexives induced a smaller processing load onto the comprehension system than (extra-syntactic) logophors. The discussions in Chapter 3, on the other hand, illustrated that we should consider abandoning the strong version, at least concerning the economy differences of the semantic and discourse module, because the results of Experiment 4 showed that bound-variable dependencies are not by definition more economic than coreferential dependencies. The results were, however, not necessarily incompatible with the intermediate version, the version that retains the ranking of cross-modular economy, yet dispenses with the ranking of intrinsic economy. More specifically, I proposed that it is not inconceivable that under specific circumstances the intrinsic costs of binding are higher than the intrinsic costs of coreference, thereby obscuring the definite cross-modular advantage of bound pronominals (see Chapter 3, Paragraph 3.7.4.1, for discussion).

Obviously, the latter explanation builds heavily on the theoretical difference between intrinsic and cross-modular processing costs. For those readers who are not happy with this line of reasoning, I would like to reemphasize that all my findings were consistent with at least the weak sequential version. Ironically, the findings of Experiment 4 – the only experiment revealing some problematic results for the economy hierarchy – strongly suggested a serial architecture. The (unambiguous) stories in that experiment showed that bound-variable dependencies between *he* and antecedents like *every worker* are costly in comparison to coreferential dependencies between *he* and proper names like *Paul*. Nonetheless, while in the ambiguous stories, containing the same

[1] Another logical possibility is an 'intermediate' version in which the sequential architecture and intrinsic processing costs guide the division of labor. I will, however, not discuss this option.

antecedents, the competing coreferential antecedent (*Paul*) may therefore well have been a relatively cheap antecedent, most likely even cheaper than the c-commanding quantified antecedent (*every worker*), the language processor still prefers the latter. In my opinion this reflects particularly strong evidence in favor of a serial architecture, because it suggests that bound dependencies are always considered before coreferential dependencies, regardless of whether the overall processing costs are high or not.[2]

To conclude, although a POB-like framework can elucidate the results of the different eye-tracking experiments, it also appears to be the case that the processing consequences of the economy principle are not as uniform as expected beforehand. More specifically, economy differences seem to emerge more robustly when comparing syntactic to extra-syntactic anaphoric dependencies than when a comparison is made between semantic and discourse anaphoric dependencies. I will argue in the next section that this pattern makes sense, taking into account the actual (linguistic) purpose of the economy principle.

4.2.1.2. Blocking and preference

The main linguistic (or formal) purpose of the economy principle is to block ungrammatical dependencies. It blocks, for example, a dependency in sentence (1).

(1) **Peter*$_i$ defended *him*$_i$.

The most economical way of establishing a dependency in (1) is via A-Chain formation in the syntactic module, yet an A-Chain is not allowed, because the pronoun is not referentially deficient (see Chapter 1, Paragraph 1.2.2.1). Furthermore, the language system can neither use the semantic nor the discourse route to connect the pronominal to *Peter*, because these two routes are blocked through the economy principle. More specifically, because A-Chain formation would be the cheapest

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[2] Note that, from a slightly different point of view, the above also illustrates 'human laziness', the rationale Reuland (in prep.) put forward for assuming a cross-modular economy hierarchy. Namely, since human laziness may translate into 'if you are doing something, the easiest thing is to just keep doing it', perceivers first opt for a bound-variable interpretation and not for a coreferential interpretation – even if the overall costs for the coreferential interpretation turn out to be smaller – because the latter entails 'doing something else'.

option, it rules out a bound-variable interpretation and subsequently Rule-I rules out a coreferential dependency.

In sentence (2), on the other hand, matters are less clear-cut.

(2) *The clown*$_i$ thinks that *he*$_i$ is funny.

If we take the same approach as in (1), it follows that only a bound-variable interpretation can emerge, since this would reflect the most economical option. In other words, a coreferential dependency should be blocked. As we have seen, however, the choice between binding and coreference in sentences such as (2), should ultimately be free, otherwise the sloppy-strict ambiguity in ellipses and *only*-structures becomes rather mysterious (see ex. (3) and (4)).

(3) *The clown*$_i$ thinks that *he*$_i$ is funny and *the acrobat*$_j$ does <e> too.

(4) Only *the clown*$_i$ thinks that *he*$_i$ is funny.

Be that as it may, the eye-tracking results of Chapter 3 *do* suggest that a processing hierarchy exists in sentences like (3) and (4): perceivers (initially) prefer the bound-variable interpretation. In other words, even if Rule-I is irrelevant in these types of sentences (see Chapter 3, Experiment 4), the language processor seems to operate as follows: 'block the discourse route, unless...', which translates into a general binding preference.

The above suggests that, although economy is a very useful term to describe the division of labor of the three subcomponents of the POB architecture, it requires an annotation: the blocking effect between the syntactic and semantic module is final, whereas the blocking effect between the semantic and discourse is not, it reflects a preference. Interestingly, introducing this latter nuance presents a rationale for why more robust economy differences emerge when comparing syntactic to semantic anaphoric dependencies than when comparing semantic to discourse anaphoric dependencies. Informally, one could say that the blocking effect is 'stronger' between the syntactic and semantic module, because variable binding should always be ruled out if A-Chain formation presents the cheapest option. A less strict division of labor holds for the semantic and discourse module: the economy hierarchy reflects a preference for binding or, in other words, it only *temporarily* blocks the coreference algorithm. Then, under the assumption that the strength of blocking increases as a function of the magnitude of the economy difference between two modules, it makes sense that the experimental findings revealed more pronounced processing cost differences for the syntactic-semantic dichotomy than for the semantic-discourse dichotomy.

To sum up, generally speaking the economy predictions of the POB model are borne out in online measures of language comprehension. One should, however, distinguish between *blocking* and *preference*, where the former applies to the division of labor of the syntactic and semantic component, and the latter to the division of labor of the semantic and discourse component. Furthermore, putting the hierarchy in terms of processing costs aside for a moment, my eye-tracking results are at the very least consistent with a sequential ranking.[3]

4.2.2. Sequentiality

Although the results are consistent with a sequential processing system, my experiments were not explicitly designed to examine this second feature of the POB framework. In this paragraph I will therefore give an overview of studies that more directly addressed this issue, albeit from a slightly different perspective. Namely, most relevant experimental studies are based on the binding theory (Chomsky, 1981), that is, they were designed to establish when the comprehension system makes use of the classical binding principles, most notably Principle A. As such, the experiments were not specifically aimed at testing whether anaphora resolution entails a syntactic, semantic and discourse phase, as is assumed within the POB framework. For instance, in most reported studies the authors do not differentiate between a semantic and discourse phase, but rather collapse the two into one phase (e.g. Nicol & Swinney, 1989; Sturt, 2003a). Nevertheless, we will see that the results are still relevant, since they do provide important information pertaining to the order of syntactic and extra-syntactic processing steps.

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[3] However, as Reuland (in prep.) points out, it cannot be just a matter of intrinsic order, because if we want to explain, for example, the initial preference for bound dependencies we must assume that "as soon as an operation becomes available an economy principle requires it to apply". Reuland formulates this observation in a *Hierarchy of applicability:* "If a certain interpretation is blocked in a given subsystem of language you may not sneak in precisely the same interpretation for the given derivation, by using machinery available in a subsequent system in the hierarchy"(see also Reinhart, 2000).

One of the first studies was reported by Nicol and Swinney (1989) who presented a series of cross-modal priming experiments. Participants had to make a lexical decision to a visually presented word while listening to sentences like (5).

(5) *The boxer*$_j$ told *the skier*$_k$ that *the doctor*$_i$ for the team would blame *himself*$_{i/*j/*k}$ for the recent injury.

In this sentence the reflexive *himself* is syntactically linked to its antecedent *the doctor* (i.e. according to Principle A only *the doctor* is a grammatical antecedent for *himself*). If syntactic processing is independent of and precedes discourse processing, the other discourse entities (i.e. *the boxer* and *the skier*) should not be considered during the interpretation of the reflexive. To test this hypothesis, Nicol and Swinney presented probe words at the reflexive offset that were semantically related to one of the characters in the sentence. They reported facilitation of the lexical decision for structurally accessible antecedents only. In other words, in (5) participants reacted faster to semantic associates of *the doctor*, but not to semantic associates of *the boxer* or *the skier*. The authors interpreted these results as evidence in favor of a model that incorporates the classical binding principles as an *initial filter* on anaphoric processing, or put differently, the initial set of candidate antecedents for the reflexive contains all and only those referents that bear the appropriate structural syntactic relationship. The results are, furthermore, entirely compatible with the assumptions of the POB framework in which syntactic operations (i.e. A-Chain formation) are independent of and precede extra-syntactic operations (i.e. variable binding and coreference).

Further evidence for a syntax-first model was reported by Sturt (2003a). In a series of eye-tracking experiments he studied the resolution of a reflexive in a larger context containing two story characters as in examples (6) to (9).

(6) *Jonathan*$_j$ was pretty worried at the City Hospital. *He*$_j$ remembered that *the surgeon*$_i$ had pricked *himself*$_{i/*j}$ with a used syringe needle. There should be an investigation soon.

(7) *Jennifer*$_j$ was pretty worried at the City Hospital. *She*$_j$ remembered that *the surgeon*$_i$ had pricked *himself*$_{i/*j}$ with a used syringe needle. There should be an investigation soon.

(8) **Jonathan*$_j$ was pretty worried at the City Hospital. *He*$_j$ remembered that *the surgeon*$_i$ had pricked *herself*$_{*i/*j}$ with a used syringe needle. There should be an investigation soon.

(9) **Jennifer*$_j$ was pretty worried at the City Hospital. *She*$_j$ remembered that *the surgeon*$_i$ had pricked *herself*$_{*i/*j}$ with a used syringe needle. There should be an investigation soon.

In all the conditions only one character was structurally available (i.e. *the surgeon*, a profession with a stereotypically male gender), and the other distracting character (i.e. *Jonathan* or *Jennifer*) was highly prominent in the preceding discourse. By manipulating the (stereotypical) gender agreement relations between the reflexive, antecedent and distractor, the time course of the application of syntactic and discourse constraints was explored. The results showed that if the reflexive and structurally available antecedent differed in gender as in (8) and (9), this immediately slowed down the reading process. More importantly, at this point in time the distracting character (i.e. *Jonathan/Jennifer*) did not influence the resolution process. This suggests that the language system first attempts to link the reflexive to an antecedent that is structurally available – which will immediately fail in (8) and (9). However, later in the reading process the distracter did affect the resolution process. Namely, in the comparison between (6) and (7) second-pass reading times for the reflexive and preceding region were longer if the distracter and reflexive mismatched in gender features (i.e. ex. (7)). Sturt interpreted these findings as evidence in favor of a model in which the binding principles are applied as a *defeasible filter*. That is, initially only structurally available antecedents are considered, but during later stages information in the discourse can indeed affect the interpretation of the reflexive. Note that these results are again compatible with the POB model in which syntactic processing is assumed to precede discourse processing.

So far, I have discussed experimental studies that support the view that anaphoric processing in the syntactic module precedes anaphoric processing in extra-syntactic modules. There is, however, a notable exception to these results as Badecker and Straub (2002) report evidence against the syntax-first proposal in a series self-paced reading experiments. They presented, for example, sentences like (10) and (11).

(10) *Jane*$_j$ thought that *Bill*$_i$ owed *himself*$_{i/*j}$ another opportunity to solve the problem.
(11) *John*$_j$ thought that *Bill*$_i$ owed *himself*$_{i/*j}$ another opportunity to solve the problem.

The only difference between the two conditions was the gender of the initial name (i.e. *Jane* or *John*), which is structurally not available as an antecedent for the reflexive *himself*. Hence, according to the binding-as-initial-filter (Nicol & Swinney, 1989), binding-as-defeasible-filter (Sturt, 2003a) and the POB model these entities should (initially) not affect the resolution of the reflexive. Badecker and Straub, however, reported that the distracting character rapidly affected the processing of the reflexive, to be precise two words after the reflexive. The reading times were longer in the condition containing the two characters that matched in gender with the reflexive (i.e. ex. (11)).[4] Based on these results, they argued that although the effects of structural constraints on referential processing may emerge quickly in the comprehension process, these constraints exert their influence over time and in parallel with other interpretive mechanisms and, hence, do not function as a blind automatic filter.

Interestingly, however, Badecker and Straub also obtained results that were consistent with a syntax-first hypothesis. In two other self-paced-reading experiments they presented sentences like (12) to (15). These sentences closely resembled the previous sentences (10) and (11), with one important difference: the distracting and structurally inaccessible character (i.e. *Jane/John* in ex. (12)-(13) and *Beth/Bill* in ex. (14)-(15)) was moved from the subject position into another syntactic position.

(12) It appeared to *Jane*$_j$ that *Bill*$_i$ owed *himself*$_{i/*j}$ another opportunity to solve the problem.
(13) It appeared to *John*$_j$ that *Bill*$_i$ owed *himself*$_{i/*j}$ another opportunity to solve the problem.

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[4] Note that these results are at odds with the results of Sturt (2003a) who reported longer reading second-pass reading times if the distractor and reflexive *mismatched* in gender features.

(14) Jane thought that *Beth*$_j$*'s brother*$_i$ owed *himself*$_{i/*j}$ another opportunity to solve the problem.
(15) Jane thought that *Bill*$_j$*'s brother*$_i$ owed *himself*$_{i/*j}$ another opportunity to solve the problem.

As a result of this manipulation, Badecker and Straub observed no reading times differences at or directly following the reflexive, which suggests the distracting character is not considered as a potential antecedent of the reflexive. Even though this result is predicted by syntax-first models on anaphora resolution, the authors argued that it should not be interpreted as evidence in favor of such an approach. In their view it reflects the tendency of the language processor to compose a candidate set of potential antecedents for the reflexive, which only includes candidates with a prominent role (e.g. the subject role), thereby excluding for instance the possessor *Bill* in (15).

To me, however, it is not immediately obvious why for instance a possessor like *Bill* (see ex. (15)) is excluded from an initial candidate set, *if* one assumes that all the constraints on anaphora resolution exert their influence at the same time. Especially since the distracting possessor is introduced as a proper name, which we know elevates the prominence or accessibility of a story character considerably (Sanford *et al.*, 1988), you would certainly expect the distracter to affect the interpretation of the reflexive. On the other hand, a syntax-first model like the binding-as-initial-filter hypothesis or POB model can easily explain why such an effect is absent: the reflexive is already resolved before extra-syntactic information affects the resolution process. Thus, in my view the overall results as reported by Badecker and Straub are mixed at least. Whereas the first experiment possibly presents evidence against a syntax-first model on anaphora resolution, the two other experiments were entirely consistent with such an approach.

In addition to this latter objection, I would like to draw the reader's attention to another (methodologically based) concern. Self-paced reading, even when exercised in a word-by-word fashion, has a relatively low temporal resolution in comparison to for instance eye tracking. Therefore, it remains uncertain whether the reported reading delays in the first experiment really reflect early processing or, alternatively, somewhat later processing (see Sturt, 2003a, for a similar objection). Moreover, since the reading time delays emerged two words after the reflexive (i.e. on average some 800 ms later), I am hesitant to interpret this as a very rapid influence of extra-syntactic constraints on anaphora resolution.

To sum up, a number of studies addressed whether syntactic computations precede extra-syntactic computations during anaphora resolution. Two studies (Nicol & Swinney, 1989; Sturt, 2003a) provided strong evidence in favor of a syntax-first approach like the POB model. Another study (Badecker & Straub, 2002) presented evidence against such an approach, however, only superficially. A closer examination of the Badecker and Straub study revealed that the results were mixed at least. Moreover, they adopted the self-paced reading methodology, which seems inferior to eye tracking with respect to its temporal resolution. In conclusion, generally speaking the results appear to favour a syntax-first approach to anaphora resolution, i.e. consistent with the second core feature of the POB model: sequentiality.

4.2.3. Modularity

One of the most exciting and challenging areas of language research is to connect a functional model to the human brain. The hypothesis that is most appealing, especially if one assumes a modular architecture, is one of correspondence (Jackendoff, 1997; Reuland, 2003). For instance, according to Reuland (2003, p.4) "differences between major modules of the grammatical system correspond with differences in processes at the neural level and vice versa". So, in the light of the present discussion on the POB model this implies that a syntactic network should be dissociable from a semantic and discourse network, not only at a functional, but at the neurocognitive level as well (in the remainder of this section, the semantic and discourse route are again collapsed into one extra-syntactic component, because the relevant studies do not distinguish between the semantic and discourse component).

To the best of my knowledge, the first relevant ERP study, conducted more than a decade ago, examined the resolution of coargument reflexives by presenting sentences like (16) and (17) (Osterhout & Mobley, 1995).

(16) *The hungry guests* helped *themselves/*himself* to the food.
(17) *The successful woman* congratulated *herself/*himself* on the promotion.

The authors reported that, relative to their grammatical counterparts, the ungrammatical reflexives in (16) and (17) (i.e. *himself*) elicited a P600, which constitutes a brain waveform that is generally associated with syntactic violations or syntactic repair (e.g. Friederici, 1999, 2002; Hagoort, Brown & Groothusen, 1993; Hagoort, Brown & Osterhout, 1999; Osterhout & Holcomb, 1992). This finding could then be taken to suggest that coargument reflexives are indeed resolved syntactically, as predicted by the POB framework, because the absence of a proper coargument reflexive in the ungrammatical conditions has syntactic processing consequences. Note, however, that the reported P600 effect can also be explained by assuming that number and gender agreement violations are syntactically based, which was in fact exactly what Osterhout and Mobley tried to show. Moreover, they did not compare coargument to logophoric reflexives, and, hence, their study does not inform us about whether coargument reflexives trigger a qualitative different cortical network than logophoric reflexives, as would be predicted by the modularity principle of the POB framework.

Interestingly, however, two more recent ERP studies point exactly in this direction (Harris *et al.*, 2000; Burkhardt, 2005). Harris *et al.* visually presented sentences like (18)-(21).

(18) *The pilot's mechanics$_i$* brow-beat *themselves$_i$* after the race.
(19) **The pilot$_i$'s* mechanics brow-beat *himself$_i$* after the race.
(20) *The pilot's mechanics$_i$* brow-beat Paxton and *themselves$_i$* after the race.
(21) **The pilot$_i$'s* mechanics brow-beat Paxton and *himself$_i$* after the race.

The participants were instructed to rely on number agreement to determine to whom the anaphoric element referred. The authors argued that participants will therefore experience interpretation problems in sentences (19) and (21), however, for different reasons. Recall that the coargument reflexive in (18) is resolved syntactically. For the logophor in (20), on the other hand, extra-syntactic information is required to determine the proper referent. As a result, the interpretation problems of sentence (19) are thought to result from processing difficulties within the syntactic module, yet the interpretation problems of sentence (21) are the result of processing difficulties within extra-syntactic modules.

This difference was borne out. Compared to the reflexive in sentence (18) the reflexive in (19) elicited a P600 effect. The comparison of (19) and (21) on the other hand, did not yield a P600 but a different (nonspecific) waveform. These results suggest that at least two different processes are responsible for the processing of anaphoric dependencies (i.e. one syntactically based and another, in all likelihood, extra-syntactically based) and, furthermore, that this dichotomy has a natural bearing within the human brain.[5]

In addition, Harris *et al.* directly compared the grammatical interpretation of a coargument reflexive to the grammatical interpretation of a logophor by analyzing the difference between sentence (18) and (20). They report a positive shift that starts some 550 ms after stimulus onset and ends around 750 ms after stimulus onset. Yet, they argue that this does not constitute a P600 since the onset latency is relatively early and the distribution of the effect over the scalp is rather restricted. Furthermore, as they point out themselves, the two sentences do not represent a perfect minimal pair, which further complicates the interpretation of the effect.

In an attempt to make a valid *direct* comparison between a grammatical coargument and logophoric dependency Burkhardt (2005) conducted an ERP experiment in which she visually presented sentences like (22) to (25).

(22) Three participants said that *James*$_i$ had painted *himself*$_i$ during the class on charcoal drawing.
(23) Three participants said that *James*$_i$ had painted both *himself*$_i$ and Erin during the class on charcoal drawing.
(24) Three participants said that James had painted Linda during the class on charcoal drawing.
(25) James said that three participants had painted both Linda and Erin during the class on charcoal drawing.

In sentence (22) and (23) *himself* is a coargument reflexive and logophor respectively. Sentence (24) and (25) were included as controls. The results showed that the critical proper name in the two control sentences (i.e. *Linda*) elicited no different waveforms. Hence, the structural difference between these two sentences does not result in a different ERP signal and, therefore, a direct comparison between the coargument

[5] Note that this finding also suggests that the P600 effect of Osterhout and Mobley (1995) may not be solely due to agreement violations.

reflexive and logophor seems justified. The ERP data for a 300-450 ms time window revealed a more pronounced negativity with an anterior maximum for the logophor condition. According to Burkhardt, this ERP signature closely resembles the well-known LAN (Left Anterior Negativity) effect. She continues by stating that LAN-like effects have previously been discussed in relation to discourse-based processes (e.g. Streb, Rösler & Hennighausen, 1999; Van Berkum, Brown & Hagoort, 1999a, who more recently dubbed this the *Nref* effect, see Van Berkum, Koornneef, Otten & Nieuwland, 2007), which suggests that in her experiment logophors require more discourse-like processing than coargument reflexives. This finding therefore supports the idea that logophors and coargument reflexives are resolved in a different way: whereas for coargument reflexives syntactic information suffices, logophors require the integration of additional extra-syntactic information.

However, it should be noted that LAN-like effects have not exclusively been attributed to discourse processes, but might reflect syntactic processing (e.g. Friederici, 1999; Friederici, Hahne & Mecklinger, 1996) or verbal working memory as well (Fiebach, Schlesewsky & Friederici, 2001, 2002; Hagoort & Brown, 1994). Even though this does not invalidate the claim that logophors and coargument reflexives are resolved in a different manner, it does raise some questions regarding the exact source of the effect as reported by Burkhardt. For instance, we could just as easily reason that if the LAN reflects syntactic instead of discourse processing, logophors apparently put a bigger strain on the syntactic module than on the discourse module. In fact, the latter interpretation of Burkhardt's results makes perfect sense, because the language processor must somehow establish that a syntactic coargumenthood relationship is absent in the logophor condition, which in turn may affect processing demands on the syntactic module and, hence, elicits a LAN.

To conclude, and regardless of the exact explanation of the LAN-like effect in Burkhardt's study, the three ERP studies taken together suggest that, consistent with the predictions of the POB model, coargument reflexives and logophors are resolved by qualitatively different mechanisms, most likely a syntactic mechanism in case of the former and a discourse or semantic mechanism in case of the latter. Moreover, these differences are plausibly also reflected at the neural level: the human brain allocates different cortical networks to manage syntactic and extra-syntactic dependencies.

The ERP findings become particularly interesting in the light of a neurocognitive model presented some years ago by Friederici (2002; see also Friederici & Kotz, 2003; Grodzinsky & Friederici, 2006). Building on the findings of a range of neuro-imaging studies (i.e. ERP, MEG, PET and fMRI studies), she proposed a comprehensive model of language comprehension in general (i.e. not specific to anaphora resolution) which utilizes separate temporo-frontal circuits in the left hemisphere for the processing of syntactic and extra-syntactic information. Furthermore, the model also addresses the time course of language comprehension by assuming three core phases. The first phase is associated with syntactic structure building, similar to the syntactic phase in the POB model. During phase two semantically-based computations take place and the third phase is associated with higher levels of language comprehension like the integration of different types of information and processes of reanalysis and repair. Hence, the model of Friederici (and colleagues) closely resembles the modular and sequential architecture of the POB model and, furthermore, demonstrates the essence of the correspondence hypothesis: differences between major modules of the grammatical system really seem to correspond with differences in processes at the neural level. In other words, the neurocognitive model presents a perfect opportunity to connect the (functional) POB model to the human brain. Of course, future studies should establish whether the different modules in the POB model indeed resemble the different neural pathways as proposed in the neurocognitive model. Comparing the resolution of true reflexives to logophors and the resolution of bound to coreferential pronominals in a brain-imaging study could for instance shed some light on this issue. In fact, the results of these experiments can be used bi-directionally. On the one hand, the POB's modular approach to anaphoric processing is supported if physically distinct networks underlying syntactic, semantic and discourse anaphoric computations can be distinguished. On the other hand, the same results can be used to evaluate the neural circuits as proposed by Friederici. Hence, we then create the opportunity to cross-validate two comprehensive models that are very similar in many aspects, even though they evolved in quite distinct disciplines.

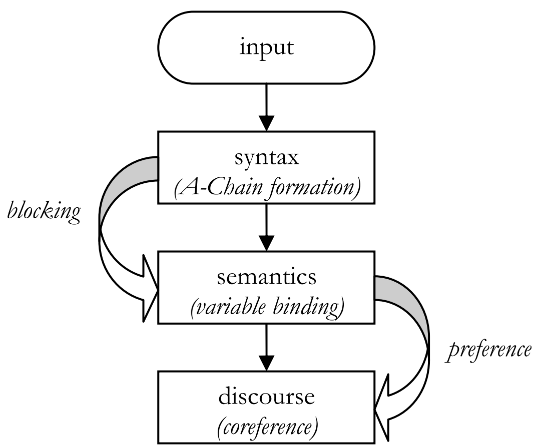
4.2.4. Conclusion

Based on the findings of numerous studies exercising a variety of methodologies, ranging from relatively simple offline questionnaires to more sophisticated eye-tracking and ERP paradigms, I conclude that real time anaphora resolution is constrained by an economy hierarchy (e.g. Burkhardt, 2005; Burkhardt *et al.*, 2008; Fiengo & May, 1994; Foley *et al.*, 1997; Frazier & Clifton, 2000; Guo *et al.*, 1996; Piñango *et al.*, 2001; Vasić, 2006; and my own work in Chapter 2 & 3), a sequential order of processing (e.g. Nicol & Swinney, 1989; Sturt, 2003a) and a modular architecture (e.g. Burkhardt, 2005; Harris *et al.*, 2000). Since these three features constitute the core of the POB model it seems legitimate to 'implement' the POB model as an online model and, hence, to present it as a strong contender to other accounts of real time anaphora resolution.

4.3. 'Implementing' the POB model

Figure 16 demonstrates the sequential architecture and the three processing phases of anaphor resolution. The *blocking* and *preference arrow* reflect the function of the economy principle, which further guides the division of labor between the three subcomponents.

Figure 16. The POB model.



In the syntactic phase A-Chains are formed, which means that coargument reflexives like *himself*, or Dutch *zich* and *zichzelf,* are linked to their antecedents. In the next semantic phase bound-variable dependencies are created. Thus, pronominals like *he* and *his*, or Dutch *hij* and *zijn* (and possibly logophoric reflexives) are interpreted, provided that the antecedent c-commands the anaphoric element. In the third phase discourse information is taken into account and at this moment the parser can build coreferential dependencies. Note that the syntactic phase blocks the semantic phase if A-Chain formation presents the cheapest available option (i.e. the *blocking arrow* in Figure 16). On the other hand, the choice between binding and coreference should be intrinsically free (as indicated by the *preference arrow*). In an ambiguous ellipsis, for example, an initial sloppy reading that emerges in the semantic phase can be changed, if necessary, into a more suitable strict reading. However, the POB model predicts additional processing costs when the language processor decides to do so.

In the next sections I will discuss some competing models on anaphora resolution and relate them to the real time version of the POB model. As we will see, the latter very naturally combines the most important features of two other models, the *defeasible filter* (Sturt, 2003a) and *syntactic prominence* model (Gordon & Hendrick, 1998).

4.3.1. Competing models on anaphora resolution

Most other accounts of anaphora resolution try to incorporate the classical binding constraints (i.e. Principle A, B and C), often by assuming a multi-stage processing mechanism. For instance, Nicol and Swinney (1989) argued that the binding principles function as an initial filter on subsequent processing, which means that some (ungrammatical) anaphoric interpretations are blocked at all times. Sturt adopted a similar although less radical view by assuming a defeasible filter, in which the binding principles operate at the earliest stages of processing, yet can be violated during later processing stages. He observed that, in a way, his two-stage model is similar to a proposal by Garrod and colleagues (e.g. Garrod, 1994; Garrod & Sanford, 1994; Garrod & Terras, 2000) who distinguished between stages of *bonding* and *resolution* (see Sturt, 2003a). During bonding an initial link is established between the pronominal (or reflexive) and one or more candidate antecedents. According to Sturt the bonding phase only applies to grammatically available antecedents. However, the later resolution phase involves a much richer integration of the interpretation with contextual information and allows the evaluation of grammatically inaccessible antecedents as well.

Building on these accounts, Kennison (2003) proposed a more elaborate model consisting of three stages, namely a bonding, resolution and decision stage. The decision stage operates after bonding and resolution and should be viewed as a separate stage to terminate the search for an antecedent, either when a highly satisfying link has been evaluated or, alternatively, when none of the links are sufficiently satisfying. However, the crucial difference between her account and the defeasible filter hypothesis (Sturt, 2003a) is not the additional decision stage, but rather the assumption that the initial candidate set is generated before the bonding phase. As a result the initial set consists of all discourse accessible antecedents including binding incompatible antecedents as well.

A different view on anaphor resolution is proposed in multiple-constrained based approaches. For instance, Badecker and Straub (2002) do not distinguish different stages of anaphor resolution but assume that the classical binding constraints are simply evaluated in parallel with other morphosyntactic (e.g. gender and number) and pragmatic or discourse constraints (e.g. first mention, implicit causality information). In their account the different constraints compete to determine the outcome of the resolution process. If most constraints point to the same antecedent, the competition process is relatively short and processing costs are kept to a minimum. On the other hand, if the constraints single out different antecedents, a lot of competition is expected and processing costs should increase.[6]

Gordon and Hendrick (1998; see also Gordon, Hendric, Ledoux & Yang, 1999; Yang, Gordon, Hendrick & Wu, 2003) put forward another very interesting approach. Building on concepts from centering theory (e.g. Grosz, Joshi & Weinstein, 1995) and discourse representation theory (Kamp & Reyle, 1993) they proposed that all (activated) discourse referents constitute an ordered set. Importantly, the order is heavily influenced by the syntactic prominence of the antecedent. The syntactic prominence of an antecedent is related to its height in a syntactic tree and therefore inversely related to its depth of embeddedness. Thus,

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[6] I agree with Sturt (2003a) that it might be difficult to distinguish some specific implementations of the multiple-constrained based approach from for instance the defeasible filter hypothesis. The predictions of the former crucially depend on the weights that are assigned to the different constraints. For instance, if binding constraints are stronger (i.e. carry more weight) than discourse constraints, a multiple-constrained based system in fact predicts behaviour closely resembling the behaviour of a system with an early or defeasible filter. This leads me to a general point I would like to make in regard to models in which all constraints are basically defined in the same way and only differ in their relative strength. That is, it seems rather difficult to falsify a model in which the designer can manipulate the strength of the different constraints as he or she likes, because there is always a specific parameter setting that will explain the experimental results.

syntactic prominence closely resembles the notion of c-command. The authors assume that finding a suitable match for a pronominal involves a search (based on factors like gender, number and animacy) through a list of potential antecedents. Consequently, establishing a dependency with a prominent entity is easier and faster than with a less prominent entity, simply because the former appears higher on the list.

To conclude, both the multi-phase model of Kennison (2003) and the single-phase model of Badecker and Straub (2002) differ fundamentally from the POB model, since both accounts assume that the initial candidate set for an anaphoric element may include binding incompatible and, hence, ungrammatical antecedents as well. However, as mentioned previously, the POB model does share some very important features with the defeasible filter (Sturt, 2003a) and syntactic prominence model (Gordon & Hendrick, 1998). In the remainder of this chapter I will compare the main characteristics of the POB model to the main characteristics of these latter two accounts, and attempt to illuminate the strengths of the POB approach.

4.3.2. The POB versus the defeasible filter model

The most obvious similarity of the defeasible filter (Sturt, 2003a) and POB model is their multi-stage architecture and the assumption that syntactic computations precede extra-syntactic computations. In the defeasible filter model, the first phase includes the application of the classical binding Principle A: the parser identifies the grammatical antecedents for a (coargument) reflexive, thereby temporarily ruling out any competing antecedents that do not obey the conditions set by the principle. Very similarly, in the POB model the first syntactic step resolves reflexives as well. However, this approach is not based on the application of Principle A, but on the idea that during the first phase A-Chains are formed. As only true reflexives are able to establish this syntactic relationship with an antecedent, the model predicts a similar time course for their resolution as the defeasible filter model.

However, the two models also differ substantially in some important aspects. First of all, the defeasible filter applies Principle A as an online constraint. We have seen in Chapter 1 that more recent linguistic theories, like the POB model, might be better descriptors of grammaticality patterns of anaphora use than the classical binding approach. Hence, adopting Principle A as a regulating device might be obsolete. Furthermore, the defeasible filter model addresses the time course of the resolution of reflexives, but the time course of pronoun resolution is not included. As a result, the difference between bound and coreferential pronominals remains unexplained. As a final point, even though the resolution phase (i.e. the final phase in the defeasible filter model) and the discourse phase (i.e. the final phase in the POB model) are comparable, since in both discourse constraints are taken into account and previously established dependencies can be reconsidered, these final phases are not completely alike. Sturt (2003a) seems to suggest the final resolution phase presents a sort of 'escape hatch' for reflexives that do not obey the conditions set by Principle A, but are nonetheless interpretable. In other words, a logophoric use of reflexives is possible since the resolution phase in the defeasible filter model allows the violation of syntactic constraints. In the POB model, however, it is unnecessary to assume potential violations of syntactic principles, simply because logophors are not liable to them. Logophors do not have to form an A-Chain with their antecedent (or in classical terminology, they are not subject to Principle A) to be interpretable.

To conclude, in my opinion the POB model presents a more comprehensive approach to anaphora resolution than the defeasible filter model. One of the most important limitations of the latter is that it only accounts for a subset of anaphor resolution: pronoun resolution is not part of the model. Consequently, the distinction between bound and coreferential pronouns is not specified and the model is unable to explain the preference of the parser to bind pronouns rather than establishing a coreferential dependency.

4.3.3. The POB versus the syntactic prominence model

The latter problem does not hold for the syntactic prominence model. That is, both the syntactic prominence (Gordon & Hendrick, 1998) and the POB model predict that antecedents with the ability to bind a pronominal constitute highly salient referents, albeit for slightly different reasons. Within the POB model, c-commanding antecedents should be preferred as they are already available in the semantic phase, that is, before other (coreferential) dependencies with non-c-commanding antecedents are computed. Alternatively, within the syntactic prominence framework the deciding factor is not whether the antecedent c-commands the pronominal (or not), but whether the antecedent is highly prominent (or not). However, since syntactic prominence is defined in such a way that c-command emerges as a maximal instantiation of prominence, the same prediction follows.[7] That is, given a choice between a c-commanding and non-c-commanding antecedent the syntactic prominence model predicts that the parser will opt for the former, because it is more prominent and therefore appears higher on the ordered antecedent list.

The crucial difference between the two accounts is that according to Gordon and Hendrick the syntactically prominent antecedent and the pronominal do not have to appear in the same sentence. Whereas most linguistic theories distinguish between bound (i.e. intrasentential) and coreferential (i.e. intersentential) pronominals, Gordon and Hendrick assume the same incremental processing mechanisms for establishing reference both within and between sentences.[8] However, I believe that their single-mechanism approach will run into problems, since it seems unable to account for the distinction between sloppy and strict interpretations of for instance ellipsis sentences. Recall that the availability of two mechanisms to connect pronominals to their antecedent, namely variable binding and coreference, provides a very elegant and plausible explanation for this interesting phenomenon.

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[7] Gordon and Hendrick's conception of syntactic prominence is related to the Reinhart's c-command configuration. They define syntactic prominence as follows:

(i) α is more prominent than β if α x-commands β, and β y-commands α where $x < y$.

(ii) α *n*-commands β if there is some node γ that dominates both α and β, and there are *n* many branching nodes that are dominated by γ and that dominate α.

Hence, according to this formula c-command emerges as maximal prominence: 0-command.

[8] Note that in their approach there is nothing special about c-command, apart from the fact that it presents a very powerful tool to increase the prominence of story characters or other entities in the discourse. In this sense their ideas are on a par with some other proposals on the function and nature of c-command. For instance, Van Hoek (1997) proposed that c-command is not a grammatical constraint, but rather reflects a discourse or cognitive concept which is sensitive to the prominence of the antecedent. Similarly, Harris & Bates (2002) take the position that c-command may correlate with grammatical intuitions, but that this does not imply that the parser has actual knowledge of the c-command principle. Ariel (2001), on the other hand, does not question whether the parser has knowledge of the principle, but she reinterprets it as a grammaticalization of a highly accessible context. On the basis of this latter view, the discourse equivalent of c-command was sufficiently strong to become a formal rule, encoded in syntax.

Another disadvantage of the syntactic prominence model is that, in my opinion, the authors fail to address adequately the question of how syntactic prominence influences the construction of the ordered list of antecedents. That is, should we set syntactic prominence apart from other factors that contribute to the accessibility of antecedents, such as first mention (e.g. Gernsbacher & Hargreaves, 1988, 1992), recency (e.g. Clark & Sengul; 1979; Ehrlich, 1983; Ehrlich & Rayner, 1983; Streb *et al.*, 2004) and implicit causality (e.g. Greene & McKoon, 1995; Long & De Ley, 2000), or do all these constraints affect antecedent prominence essentially in the same way, but in varying degrees?[9] The POB model does not incorporate such an ambiguity. Within this framework it is very clear that the c-command constraint should be set apart from other, discourse-based, constraints on pronoun resolution as only the former is applied within the semantic module. Even though it is not inconceivable that one of the side-effects of a c-command relationship between an antecedent and a pronominal is the elevation of the prominence level of the antecedent, the roots of such an effect are still structural and in the POB model clearly differ from discourse factors like first mention, recency and implicit causality.

To conclude, in my opinion the POB model presents a more comprehensive approach to anaphora resolution. In addition to the potential problems discussed above, the deciding difference is that the syntactic prominence model does not address the full range of anaphora resolution. A similar limitation was identified for the defeasible filter model. However, whereas the latter did not include pronoun resolution, the syntactic prominence model does not include the resolution of reflexives. Since one of the main goals of linguistic and psycholinguistic research is – or at least should be – to provide a unified account of anaphora resolution, the POB model constitutes a more promising starting point.[10] The model covers a broad range of linguistic and

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[9] They do suggest that a lot of "semantic information is required to override the structurally favored interpretation" and argue "that this effect is likely to occur subsequent to the immediate interpretations driven by the structural analysis of the input" (p. 414). Hence, this would imply a sequential architecture.

[10] I acknowledge the syntactic prominence model addresses issues that remain unexplained within the POB model. For instance, the former model presents a very elegant solution for the repeated name penalty effect. This effect emerges when the name of a highly prominent story character is used again to refer to the same character. In these cases most readers prefer a pronoun and, in fact, the more marked use of the full proper name results in an increase of the reading times.

psycholinguistic data and, in fact, very naturally combines the most important predictions of the defeasible filter and syntactic prominence model.

CHAPTER 5

Exploring the discourse phase: Implicit causality and accessibility

5.1. Introduction

I stated in the opening chapter that establishing a dependency between an anaphoric element and its antecedent entails the integration of both structural (i.e. syntactic) and pragmatic (i.e. discourse) information. In the previous chapters the focus was on the effects of the former. I presented an extensive evaluation of the POB model, which provides a detailed framework on how syntactic structure influences the time course of anaphora resolution. In general, the behavioural, ERP, and my eye-tracking studies conformed to the predictions of the POB model, which led me to introduce a three-phase processing system consisting of a syntactic, semantic and discourse phase. In the present chapter, we will shift our attention from the influence of syntactic structure to the influence of pragmatic information. According to the POB model pragmatic information can only enter the resolution process in the discourse phase. However, the model in its present form does not provide a detailed description of this final phase. That is, whereas the algorithms of the syntactic and semantic phase (i.e. A-Chain formation and variable binding respectively) are clearly defined in terms of coargumenthood and c-command, the discourse algorithm (i.e. coreference) remains rather underdetermined. Since the ultimate goal is to present a model with the power to elucidate every aspect of real time anaphora resolution, an attempt is made in this chapter to shed some light on the nature of the discourse phase.

Recall from Chapter 1 that many discourse factors may influence real time pronoun resolution. To name some, first mention (e.g. Gernsbacher & Hargreaves, 1988, 1992; MacDonald & MacWhinney, 1995), recency or distance (e.g. Clark & Sengul; 1979; Ehrlich, 1983; Ehrlich & Rayner, 1983; Streb *et al.*, 2004), and implicit causality information of interpersonal verbs (e.g. Caramazza *et al.*, 1977; Greene & McKoon, 1995; Long & De Ley, 2000) are known to affect the search for the referent of a pronominal. Although in this sense the term pragmatic or discourse factor captures a miscellaneous set of constraints, one unifying feature is present: all these different constraints are thought to influence the pronoun resolution process through altering the relative *accessibility* of potential antecedents (see Arnold, 1998, for review). In the pronoun resolution literature the term accessibility is often used as a metaphor to indicate the relative importance of a potential antecedent.[1] Whereas story characters with a leading role are highly accessible, story characters with a supporting role are less accessible and since pronouns tend to be used to refer to important story characters, readers and listeners connect a pronoun more quickly to a highly accessible antecedent.

In the present chapter a particular interesting accessibility cue will be addressed, namely *implicit causality*. Because it is assumed that accessibility factors apply at the discourse level, studies on implicit causality may offer valuable information pertaining to the nature of the discourse phase, specifically its time course. However, even though it has been suggested that implicit causality affects antecedent accessibility, studies on the matter in fact revealed mixed results concerning *when* and *how* implicit causality information influences sentence comprehension (cf. Greene & McKoon, 1995; Long & De Ley, 2000; McKoon *et al.*, 1993; Garnham *et al.*, 1996; Stewart *et al.*, 2000). Consequently, we should first try to unravel the nature of implicit causality information and establish that it indeed functions as an accessibility cue, before relating these findings to the discourse phase of the POB model.

5.1.1. What is implicit causality?

Implicit causality is a property of some interpersonal verbs in which one or the other of the verb's arguments is implicated as the underlying cause of the action or attitude (Au, 1986; Brown & Fish, 1983; Garvey & Caramazza, 1974; Garvey *et al.*, 1975; Greene & McKoon, 1995; Long & De Ley, 2000; Stewart *et al.*, 2000). For instance, if you *praise* somebody, you will typically do so because of *his or her* behaviour, not yours. However, if you *apologize* to somebody the most likely relevant cause is *your* behaviour, not theirs. Not surprisingly, we also recruit this

[1] There have been some linguistic attempts to formalize the notion 'accessibility' (e.g. see Ariel, 2001, 2004)

knowledge when particular interpersonal transactions are being described in language (Garvey & Caramazza, 1974). When asked to complete a sentence fragment such as *'David praised Linda because…'*, for example, readers or listeners will be inclined to continue the *because*-clause with something about *Linda*, as in example (1) below.

(1) David praised *Linda*$_i$ because *she*$_i$ had done well.

Alternatively, after *'David apologized to Linda because...'*, people tend to continue with providing some information about *David* (see ex. (2))

(2) *David*$_i$ apologized to Linda because *he*$_i$ forgot to mail the letter.

In the above constructions, interpersonal verbs like *praise* and *apologize* thus supply information about whose behaviour or state is the more likely immediate cause of the event at hand. Since it is conveyed implicitly as part of the meaning of the verb, this cue is usually referred to as *implicit causality*.

Early research on the comprehension of sentences with implicit causality verbs (e.g. Au, 1986; Brown & Fish, 1983; Caramazza *et al.*, 1977; Garvey & Caramazza, 1974; Garvey *et al.*, 1975) has shown that readers make use of this cue to arrive at the correct sentence interpretation. For instance, one consistent finding is that if the causality information explicitly provided in the remainder of the sentence goes *against* the bias of the verb at hand, as in example (3) below, people need more time to read the entire sentence (Caramazza *et al.*, 1977).

(3) *David*$_i$ praised Linda because *he*$_i$ was very proud.

Note that, as illustrated in (3), the bias of an implicit causality verb can be negated without rendering the sentence ungrammatical or incoherent. Thus, the fact that readers slow down on a bias-inconsistent sentence is therefore not the result of an overt anomaly, but instead reflects something more subtle about the way we use pragmatic information in everyday language comprehension.

5.1.2. Clausal integration versus immediate focusing account

The early studies on implicit causality unequivocally revealed that people are sensitive to the implicit causality information associated with particular interpersonal verbs. In the field of social cognition, these findings have led to a closer examination of the features of implicit causality, and of how these features might relate to models of social cognition (e.g. Brown & Fish, 1983; Semin & Fiedler, 1991; see Rudolph & Försterling, 1997, for review). For psycholinguists, however, an important unresolved issue is how and when verb-based implicit causality information is brought to bear on the actual processing of an unfolding sentence. Two contrasting accounts have been proposed, which I will denote as *clausal integration* and *immediate focusing* respectively. According to the clausal integration account (e.g. Garnham *et al.*, 1996; Stewart *et al.*, 2000), verb-based implicit causality information is brought to bear on comprehension relatively late in the unfolding sentence, at or towards the end of the subordinate clause. More specifically, implicit causality effects such as observed by Caramazza *et al.* are believed to emerge when people have read the main clause as well as the bulk of the subordinate clause, and subsequently combine the causal information provided by both clauses into a single representation. Such 'retroactive' integration would be more difficult if, as in (3), the causality information made explicit in the subordinate clause is inconsistent with the main verb's implicit causality bias.

On the other hand, proponents of the immediate focusing account (e.g. Greene & McKoon, 1995; Long & De Ley, 2000; McKoon *et al.*, 1993) have suggested that implicit causality information can be brought to bear on comprehension much more rapidly, at the beginning of the subordinate *because*-clause, and perhaps even as early as the verb itself. In this account, implicit causality is assumed to bring one of the persons referred to into focus immediately, at the expense of the other (i.e. the former is more highly accessible than the latter). Because readers and listeners prefer to relate a personal pronoun to the most focused (i.e. most accessible) antecedent, such an immediate modulation of focus would in turn affect the ease with which a subsequent pronoun is processed. In this account, the bias-inconsistent sentence (3) would take more time to read because *'David praised Linda because'* immediately brings *Linda* into focus, thereby making it more difficult to resolve the subsequent pronoun *he* in (3) than the pronoun *she* in (1). Of course, this early conflict at the pronoun may have additional processing consequences further downstream in the sentence. Thus, the immediate focusing account is not incompatible with an additional late processing delay at or towards the end of the bias-inconsistent subordinate clause. What distinguishes this account from the 'retroactive' clausal integration alternative is that only the former allows for much earlier, 'proactive' effects of implicit causality, right after the critical verb, its arguments, and a connective like *because*.[2]

To conclude, the immediate focusing account reflects the idea that implicit causality information functions as an accessibility cue. The meaning of the verb (in combination with the connective *because*) signals directly whether the subject or object of the main clause is the most likely cause of the event at hand, which, metaphorically speaking, results in an elevation of the *activation* of that particular discourse entity. Alternatively, the clausal integration account predicts a much later influence on real time language comprehension: implicit causality information is only important for the ease of integrating the main and subordinate clause and as such only affects the global coherence of a discourse.

5.1.3. The time course of the use of implicit causality information

To keep track of the use of implicit causality information in real time, studies have exploited a so-called probe (or probe verification) task. In this task, the participant is asked to decide as rapidly as possible whether or not a particular probe word (e.g. *Linda*) has appeared in the sentence fragment presented so far. By presenting the probe at various critical positions within the unfolding sentence, this method can be used to determine at what point(s) in the sentence a particular discourse referent is in focus. Using this probe task, Garnham *et al.* (1996) obtained support for the clausal integration account: they reported an effect of implicit causality on late probes presented at the end of a sentence, but no such effect on early probes presented right after *because he*. However, the results of three other studies with the probe task (Greene & McKoon, 1995; Long & De Ley, 2000; MacDonald & MacWhinney, 1995) suggest an earlier use of implicit causality, in line with immediate focusing. Thus,

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[2] The terms 'proactive' and 'retroactive' are taken from Garnham's (2001) review of implicit causality research.

findings obtained with the probe task are mixed, with some support for both accounts.

The advantage of a probe task is that it more or less directly queries the accessibility of the pronoun's antecedents (e.g. *Linda*), and thus provides a straightforward measure of focus. However, there is another side to this coin: such direct querying may also invite readers to memorize the content words of a sentence (see Gordon, Hendrick & Foster, 2000, for evidence that this can happen), and to invest an unrepresentative amount of attention in assigning antecedents to pronouns. More generally, people don't verify probes when they read or listen to linguistic input. Although neither of these concerns necessarily invalidates the results obtained with a probe task, they do point to the need for additional, less obtrusive measures.

To avoid some of the potential problems associated with the probe task, Stewart *et al.* (2000) used self-paced reading to study the use of implicit causality information during sentence comprehension. In the most relevant experiment (Experiment 4), people read sentences much like the examples (1) and (3) in two large fragments, one up to and including the critical pronoun and the other fragment containing the remainder of the sentence. Although the average reading times on bias-inconsistent first fragments like *'David praised Linda because he'* were 50 milliseconds longer than reading times on bias-consistent fragments like *'David praised Linda because she'*, this early difference was not significant. However, in the second fragment the inconsistent continuation did significantly delay the reading time, by some 206 milliseconds. These and related reading time findings have led Stewart *et al.* to strongly embrace the clausal integration account, in which implicit causality only becomes relevant "at the point where the interpretations of the two clauses are integrated into a single representation for the sentence as a whole" (p. 424). In a thorough review of implicit causality research, Garnham (2001) also arrives at the conclusion that verb-based implicit causality information is used towards the end of the sentence, during the 'retroactive' integration of main and subordinate clause.

If this conclusion is correct, however, it would set the influence of implicit causality information on sentence comprehension apart from a wide range of other sources of verb-based information that have been shown to affect the comprehension process very rapidly. For example, we know from ERP research (see Kutas & Van Petten, 1994, for review) that sentences such as *'He buttered the memo before he took a bite'* elicit an N400 effect right at the anomalous noun *memo*, which suggests an immediate use of the meaning of the verb. Verb-specific lexical information is also rapidly accessed and used in syntactic ambiguity resolution (Osterhout & Holcomb, 1992; Trueswell, Tanenhaus, & Kello, 1993). Furthermore, and particularly relevant to our present concerns, the meaning of a verb can immediately restrict the domain of reference within a particular context (Altmann & Kamide, 1999; Kamide, Altmann & Haywood, 2003; Nieuwland & Van Berkum, 2006b). Since implicit causality information is, at the very least, closely related to the meaning of a verb, it would be very hard to understand that other 'bits of verb-based meaning' may be used immediately, but the use of implicit causality is postponed to the end of the sentence.

In conclusion, both Stewart *et al.* and Garnham have suggested that implicit causality information is used during the integration of main and subordinate clauses only, which implies that implicit causality does not seem to function as an accessibility cue. However, since this claim is at odds with the findings of other studies on verb meaning and sentence comprehension, I set out to further test the clausal integration and immediate focusing hypothesis in one self-paced reading and two eye-tracking experiments. As we will see, the findings of all three experiments provide clear evidence against the clausal integration account, yet are fully consistent with the immediate focusing account.[3]

5.2. Experiment 6: Self-paced reading

As discussed before, the self-paced reading findings of Stewart *et al.* (2000) were taken to support the clausal integration account. However, in the Stewart *et al.* experiments the critical sentences were presented in two relatively large fragments, with the first part consisting of the main clause plus the connective and the anaphor (either a pronoun or proper name), and with the second part consisting of the remainder of the subordinate clause. Thus, a sentence like *'David praised Linda because he was very happy with the results'* would be presented as *[David praised Linda because he] [was very happy with the results]*. With only two such 'sample points' per

[3] The results of Experiment 6 and 7 have been published elsewhere: 'Koornneef, A.W. & Van Berkum, J.J.A. (2006). On the use of verb-based implicit causality in sentence comprehension: Evidence from self-paced reading and eye tracking. *Journal of Memory and Language, 54(4)*, 445-465'. Jos van Berkum played a vital role in the realization of the article and Chapter 5 of this dissertation. Experiment 6 was conducted in collaboration with Natalia Waaijer.

sentence, the temporal resolution of the Stewart *et al.* design is rather low. An important consequence is that the observed average reading times are very large, making it difficult to pick up on small reading time effects. Note that in the most relevant experiment (Experiment 4), fragments containing bias-inconsistent pronouns did delay reading by 50 milliseconds. However, the average total reading time of those first fragments exceeded 2000 milliseconds. The variance associated with such large reading times may well have masked a small pronoun effect.

Furthermore, recall from Chapter 1 (Paragraph 1.4.1) that spillover effects are very common in self-paced reading tasks. Because of the specific sentence partitioning used by Stewart *et al.* (i.e. the first fragment ended with the critical pronoun), some of the early processing consequences elicited by an inconsistent pronoun may actually have ended up in reading times at the first few words in the *second* fragment, and as such erroneously have been taken as evidence for the clausal integration account. With only three button presses per trial, the participants in the Stewart *et al.* self-paced reading experiments will probably have suffered somewhat less from the spillover of effects caused by a *task-induced* 'button-press rhythm'. However, recall that spillover may also have a much deeper *cognitive* cause. For instance, ERP research has revealed that the processing consequences of referential problems can last until over a second after pronoun onset, i.e. well beyond the average time that people look at such words (Van Berkum *et al.*, 2004). The implication is that the processing consequences of a bias-inconsistent pronoun in the Stewart *et al.* experiment may well have delayed reading of the first few words in the second fragment. In all, there is reason to believe that the large fragments used in the Stewart *et al.* self-paced reading experiments may have caused them to miss small effects on the pronoun itself, and confound true sentence-final clausal integration effects with earlier effects spilled over from the pronoun, making it impossible to determine whether implicit causality information enters the comprehension process early or late.

To solve the above problems and obtain the temporal resolution needed to detect potentially small sentence-medial effects, I used *word-by-word* self-paced reading in my experiment. As illustrated by the critical sentences (4) and (5) below, the pronoun was held constant across conditions. Instead of contrasting the Dutch equivalents of *he* and *she* (as in ex. (1) and (3)), I manipulated whether or not the fixed pronoun *he* was consistent with the verb's bias by swapping the argument position of the man and the woman involved. The Dutch equivalent of *she* was avoided, because it is ambiguous between a singular and a plural third-person pronoun. Furthermore, using the same pronoun across conditions allowed me to examine the claim (Garnham, 2001; Oakhill, Garnham, Reynolds, & Wilshire, 1998) that implicit causality effects observed in language comprehension would be artifacts of 'low-level' (e.g. word frequency) differences between the respective critical fragments used in bias-consistent and bias-inconsistent items.

(4) verb bias towards the 2nd NP, bias-consistent pronoun
Linda praised *David* because *he* had been able to complete the difficult assignment with very little help.

(5) verb bias towards the 2nd NP, bias-inconsistent pronoun
David praised Linda because *he* had been able to complete the difficult assignment with her help only.

As can be seen in examples (4) and (5), the end of the sentence was always consistent with the interpretation enforced by the pronoun, and a coherent interpretation was therefore always available. However, to ensure that any effects spilling over from a bias-inconsistent pronoun into the reading times of the immediately subsequent words would also not be confounded with the effects of the different sentence continuations that were required to achieve overall coherence, at least five words after the pronoun were held constant across conditions.

The critical issue is whether, relative to a consistent pronoun in sentences like (4), a bias-inconsistent pronoun in sentences like (5) causes a delay in self-paced reading at or shortly after the offending pronoun. Because the clausal integration account restricts the use of implicit causality information to clause-integration processes occurring at the end of the subordinate clause, this account does not predict an inconsistency effect at or shortly after the pronoun. According to immediate focusing account, however, fragments like *X praised Y because* immediately bring *Y* into focus, which should make it more difficult to resolve the subsequent pronoun *he* in (5) than in (4). We know from other research with online tasks (e.g. Arnold *et al.*, 2000; Boland, Acker & Wagner, 1998; Van Berkum *et al.*, 2004) that gender-dependent problems with pronoun resolution begin to emerge within only a few hundred milliseconds after pronoun onset. The immediate focus account therefore predicts that an inconsistency effect should appear at the pronoun, or, due to spillover, rapidly thereafter.

5.2.1. Method

Participants. Participants were 24 undergraduate psychology students (21 female, mean age 21, range 18-33 years) who received course credit or money for their participation.

Materials. Based on translations of English verbs used in previous research, 116 Dutch verbs were selected, of which 57 were expected to have a strong implicit causality bias towards the second noun phrase (henceforth NP2, e.g. the verb *prijzen*, 'praise') and 59 a strong bias towards the first noun phrase (NP1, e.g. the verb *teleurstellen*, 'disappoint'). In a written sentence completion pre-test, 45 native speakers of Dutch (23 female, mean age 22, range 18-61 years) were asked to complete the Dutch equivalent of fragments like *John disappointed Paul because he*___, and to subsequently denote the intended male antecedent of the pronoun *he* by encircling the name. If the participant marked NP1 the trial was scored as 1, and if he or she marked NP2 the trial was scored as 2. Calculating the mean score for every verb provides information about the direction of the verb's bias as well as its strength (indexed via the consistency of the bias across participants), with a strong NP1-bias giving a score close to 1, a strong NP2-bias giving a score close to 2, and the absence of a bias giving a score around 1.5. Twenty verbs with a strong NP1-bias and 20 verbs with a strong NP2-bias were selected for Experiment 6 (mean bias NP1-verbs: 1.14, NP2: 1.94; Table 26 contains the relevant verbs and their approximate English translation).

Following McKoon *et al.*, (1993), I constructed two different three-sentence stories for every verb for the main experiment, using scenarios that were expected to be of interest to the average participant. Examples that involve an NP1 verb are given in (6) and (7), together with their approximate translation. In the first sentence a situation was sketched in which a man and a woman were introduced by name. For half of the texts, the first-mentioned character was the man, and for the other half, the woman (balanced across the NP1 and NP2 stories). In the second sentence a pronominal (usually *they*) was used to keep both characters in focus to an equal extent. The main clause of the third sentence contained the critical verb and felicitously repeated the names of the two characters. The subordinate clause contained the critical pronoun *he* and was always adjoined to the main clause by the connective *because*.

(6) NP1-biased verb, bias-consistent pronoun
David en Linda reden allebei behoorlijk hard. Bij een druk kruispunt botsten zij met hun auto's stevig op elkaar. *David* bood zijn excuses aan Linda aan omdat *hij* volgens de getuigen van het ongeluk alle schuld had.
(David and Linda were both driving pretty fast. At a busy intersection they crashed hard into each other. David apologized to Linda because he according to the witnesses was the one to blame.)

(7) NP1-biased verb, bias-inconsistent pronoun
David en Linda reden allebei behoorlijk hard. Bij een druk kruispunt botsten zij met hun auto's stevig op elkaar. Linda bood haar excuses aan *David* aan omdat *hij* volgens de getuigen van het ongeluk geen schuld had.
(David and Linda were both driving pretty fast. At a busy intersection they crashed hard into each other. Linda apologized to David because he according to the witnesses was not the one to blame.)

Table 26. Implicit causality verbs used in Exp. 6, 7 and 8 with their bias.

NP1-biased verbs		NP2-biased verbs	
Verb	*Mean Bias*	*Verb*	*Mean Bias*
fascineren (*fascinate*)	1.00	minachten (*hold in contempt*)	2.00
excuses aanbieden (*apologize*)	1.00	benijden(*envy*)	2.00
bekennen aan (*confess*)	1.04	bewonderen (*admire*)	2.00
teleurstellen (*disappoint*)	1.04	vrezen (*fear*)	2.00
vervelen (*bore*)	1.05	waarderen (*appreciate*)	2.00
hinderen (*be in the way*)	1.09	bekritiseren (*criticise*)	2.00
oplichten (*swindle*)	1.13	prijzen (*praise*)	1.96
kwellen (*hurt*)	1.14	complimenteren (*compliment on something*)	1.96
storen (*disturb*)	1.14	haten (*hate*)	1.96
smeken (*beg*)	1.17	ontslaan (*fire*)	1.96
bellen (*call*)	1.18	respecteren (*respect*)	1.95
ergeren (*annoy*)	1.18	straffen (*punish*)	1.95
verbazen (*amazed*)	1.18	feliciteren (*congratulate*)	1.95
verontrusten (*worry*)	1.18	verantwoordelijk stellen (*hold responsible*)	1.91
winnen van (*win*)	1.18	aanklagen (*press charges against*)	1.91
misleiden (*mislead*)	1.22	troosten (*comfort*)	1.91
irriteren (*irritate*)	1.22	verafschuwen (*loathe*)	1.86
liegen tegen (*lie to*)	1.22	aanbidden (*adore*)	1.86
inspireren (*inspire*)	1.23	houden van (*love*)	1.86
intimideren (*intimidate*)	1.23	bedanken (*thank*)	1.82

The critical manipulation was whether or not the pronoun *he* was consistent with the verb's implicit causality bias. For NP1-biased verbs, *he* is consistent if the male character occupies the NP1-position of the main clause, as in (6), but inconsistent if the female character occupies that position, as in (7). For NP2-biased verbs, the mapping is reversed, as in example (4) and (5) given before. To accommodate for spillover, at least five words after *he* were held constant across conditions. After these five words the consistent and inconsistent versions diverged, and ended with explicit causal information that made the story coherent as a whole (see Appendix V for all the Dutch originals).

To rule out any accidental biases in the constructed materials, incomplete versions of the stories were presented to 20 native speakers of Dutch (18 female, mean age 24, range 19-41 years) in a second paper-and-pencil completion test. The participants (none of whom had participated in the sentence pre-test) read the stories in the form illustrated by '*David and Linda were both driving pretty fast. At a busy intersection they crashed hard into each other. ___ apologized to ___ because ___*', and they were asked to use the names in the story to fill in the blanks of the main clause, and to subsequently finish the story as they liked. There was no preference for a particular order of mention of the male or female character in the main clause of the critical sentence. In stories with an NP1-biased verb, participants used the man-verb-woman order – the order used in the bias-consistent version of these stories in the main experiments – about half of the time (53%). Similarly, in stories with an NP2-biased verb, participants used the woman-verb-man order – the order used in the bias-consistent version of these stories in the main experiments – also about half of the time (51%). This suggests that the specific way in which the two genders had been paired to the two verb arguments in the stories was deemed equally plausible for the consistent and inconsistent versions. In addition, the subsequent completion of subordinate clauses revealed that the wider story context had essentially not changed the bias of the verbs. Across the completions in which participants had used either *he* or *she* immediately after the connective *because* (95% of all completions), the NP1-verb stories showed a strong bias towards the subject of the main clause (mean bias 1.10) and the NP2-verb stories a strong bias towards the object (mean bias 1.90).

The stimuli were divided into two lists, with each list containing 20 bias-consistent and 20 bias-inconsistent stories, and with only one version of each story in a particular list. To avoid strategic processing, I used as many NP1-verbs as NP2-verbs (10 each) within each condition in each list. Forty stories of an unrelated experiment were included as fillers. One pseudo-randomization was used for both lists. The original randomization order was used for one half of the participants, the reversed order for the other half. A set of 40 2-choice questions was included to encourage discourse comprehension. Half of the questions followed the experimental items and half followed the filler items. Furthermore, half of the correct answers appeared on the left of the screen and half on the right. The questions never directly probed the referent of the pronoun.

Procedure. The stories were presented on a fast LCD screen (Iiyama TXA 3834 MT) and responses were collected with response boxes integrated in the armrests of the chair. The stories were presented in a standard non-cumulative moving-window self-paced reading paradigm. Subjects read through each story word by word, with each button press disclosing the next word while replacing all other letters in the story by hyphens. As they pressed their way through a story, subjects could see its overall sentential and formatting layout (including punctuation), as well as the position of the currently visible word. To prevent 'edge effects' in reading times, the critical region, which included the pronoun and five subsequent words, was always separated from the left and right paragraph edges by at least one word. Subjects were asked to process each story for comprehension, and to adapt their speed to this. Participants progressed through a text by pressing a button with the index finger of their dominant hand.

Each session started with a written instruction. The actual self-paced reading experiment consisted of four blocks. Block one was a practice block in which ten stories were presented, five followed by a question. This familiarized the participant with the procedure and in addition gave the experimenter the opportunity to monitor the reading speed of the participants. Participants who read extremely slowly were encouraged to speed up. The participant had an obligatory one-minute break between the different experimental blocks. Each experimental block started with two practice stories. After completion of the self-paced reading experiment, participants were presented with a Dutch version of the reading span task (Daneman & Carpenter, 1980). A full session was completed within 60 minutes, with an average time-on-task of 40 minutes.

Analysis. All participants scored above 75% correct (mean score 94%) on the comprehension questions. Reading times more than 2 standard deviations from both the participant's mean and the item's mean in a particular condition were treated as missing data (2.1%). I report means and statistical analyses for the factor Consistency for the critical pronoun, each of the four words following the pronoun (spillover region), and each of the four words preceding it (pre-critical region). I only discuss effects that are significant by subjects (F_1) and by items (F_2), and the associated *minF'* values are reported in tables (Clark, 1973; Raaijmakers, Schrijnemakers & Gremmen, 1999).

Because implicit causality results are customarily reported for NP1- and NP2-verbs separately, the analyses of variance will also take direction of the bias into account (Verb Bias). However, note that the comparison of inconsistency effects elicited by NP1 verbs and NP2 verbs is confounded with the effects of distance between pronoun and antecedent, of first mention, and of the antecedent's structural position (see Chapter 1, for an overview of the relevance of these factors). For this reason, the discussion and figures are focused on the main effects of Consistency.[4]

5.2.2. Results

As can be seen from the mean reading times (collapsed over Verb Bias) in Figure 17 and the associated F-tests displayed in Table 27, words in the pre-critical region were read equally fast across conditions. However, readers began to slow down right at the bias-inconsistent pronoun, with a significant main effect of Consistency emerging at the first two words after this pronoun. This effect was not significantly modulated by whether the verb was biased towards NP1 or NP2.

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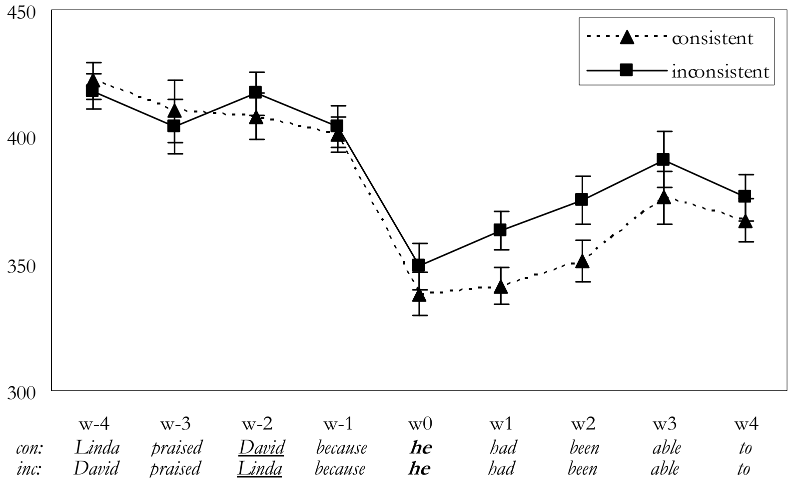
[4] Although the interaction of *Consistency* and *Verb Bias* should be interpreted with care, I note that whether the verb was biased towards NP1 (e.g. *disappoint*) or NP2 (e.g. *praise*) did not reliably modulate the size of the inconsistency effect in my data. As such, the results are different from those of Long and De Ley (2000), who observed a significant inconsistency effect for NP2-biased verbs only. In fact, if anything, my data tend to go the opposite way, with numerically larger delays after NP1-verbs than after NP2-verbs at all relevant word positions in Experiment 1 and Experiment 2. Again, I emphasize that the comparison of inconsistency effects elicited by NP1 verbs and NP2 verbs is confounded with the effects of distance between pronoun and antecedent, of first mention, and of the antecedent's structural position. Because of the specific purpose of the study, I made no attempt to control for any of these potential confounds, and optimized the design on other dimensions. Follow-up work will have to examine why interactions with verb bias can come and go, and to what extent the abovementioned confounding factors play a role.

Figure 17. Mean reading times (in ms) for the consistent and inconsistent condition in Exp.6.



This pattern of results suggests that implicit causality information becomes available rapidly enough to have an impact on the interpretation of a pronoun occurring in mid-sentence. The immediate focusing account, where implicit causality information immediately makes the bias-consistent referent more accessible than the bias-inconsistent referent, just before the referring pronoun comes along, explicitly predicted such results. The clausal integration account, however, assumes that implicit causality is used *only* after the bulk of the subordinate clause has been read and the interpretations of the two clauses are integrated into a single interpretation for the sentence as a whole, an assumption that is difficult to reconcile with my findings.

Because the inconsistency effect did not reach significance on the critical pronoun itself, and, presumably due to spillover, emerged as a reliable effect on the two subsequent words only, my findings in fact provide a straightforward explanation for why Stewart *et al.* (2000) did not find any evidence for an early effect of implicit causality. Recall that Stewart *et al.* presented the sentences in two large fragments, with the split right after the critical pronoun. If, like the readers in my study, the readers in the Stewart *et al.* experiments only really slowed down right *after* the bias-inconsistent pronoun, this early effect would be visible in reading times to the second fragment only, and would as such mistakenly be taken as support for late clausal integration. Thus, the present word-by-word reading time results confirm the earlier hypothesis about Stewart *et al.*'s early null result. More generally, the results testify to the importance of tracking the use of a potentially relevant cue to sentence comprehension with sufficient temporal resolution.

Table 27. Mean self-paced reading times (in ms), Repeated Measures ANOVAs and minF' values for Exp. 6.

	Wordposition								
	-4	-3	-2	-1	0	1	2	3	4
con	*Linda*	*praised*	*David*	*because*	***he***	*had*	*been*	*able*	*to*
incon	*David*	*praised*	*Linda*	*because*	***he***	*had*	*been*	*able*	*to*
	Reading times								
total									
con	422	410	408	401	338	341	351	376	367
incon	418	404	417	404	349	363	375	391	376
NP1-bias									
con	420	403	409	403	347	350	340	388	373
incon	411	409	425	424	357	382	371	401	387
NP2-bias									
con	425	417	408	400	329	333	362	364	361
incon	424	399	410	384	340	343	379	380	364
F1 (Consistency, df = 1, 23)									
F	< 1	< 1	1.065	< 1	1.452	9.107	7.477	1.993	1.015
Mse	-	-	1755	-	1772	1241	1815	2561	1774
p	-	-	.313	-	.245	.006*	.012*	.171	.324
F2 (Consistency, df = 1, 38)									
F	< 1	< 1	1.362	< 1	1.733	9.379	9.643	1.966	1.386
Mse	-	-	1137	-	1096	955	1239	2625	894
p	-	-	.250	-	.196	.004*	.004*	.169	.246
minF' (Consistency)									
F	< 1	< 1	< 1	< 1	< 1	4.620	4.211	< 1	< 1
df	-	-	-	-	-	1, 57	1, 53	-	-
p	-	-	-	-	-	.036*	.045*	-	-
F1 (Consistency x Verb Bias, df = 1, 23)									
F	< 1	1.235	< 1	6.161	< 1	2.181	1.326	< 1	< 1
Mse	-	2854	-	1278	-	1289	985	-	-
p	-	.278	-	.021*	-	.153	.261	-	-
F2 (Consistency x Verb Bias, df = 1, 38)									
F	< 1	3.096	< 1	3.086	< 1	2.789	1.026	< 1	< 1
Mse	-	1099	-	2269	-	955	1239	-	-
p	-	.087	-	.087	-	.103	.317	-	-
minF' (Consistency x Verb Bias)									
F	< 1	< 1	< 1	2.056	< 1	1.223	< 1	< 1	< 1
df	-	-	-	1, 61	-	1, 53	-	-	-
p	-	-	-	.157	-	.274	-	-	-

Although my findings are in line with the immediate focusing account, I need to address two possible concerns with respect to the non-cumulative word-by-word self-paced reading method that was used. First, although a word-by-word reading paradigm has a higher temporal resolution than the clause-by-clause paradigm of Stewart *et al.*, the task is of course somewhat unnatural, as people normally do not press a button after reading each individual word (but see Mitchell, 2004, for a persuasive defence of the self-paced reading task). Furthermore, and perhaps more important in the present context, the use of a non-cumulative moving-window paradigm made it impossible for participants to regress to earlier parts of the sentence. It could be argued that readers will adapt to this situation by resorting to a more incremental processing strategy, in which they more immediately use the information afforded by each word – such as implicit causality – than they would do in unconstrained reading. To address these two potential concerns about my self-paced reading study, I repeated the experiment with the eye-tracking methodology.

5.3. Experiment 7: Eye tracking

5.3.1. Method

Participants. The participants were 24 members from the Utrecht University community (23 female, mean age 21, range 18-34 years) who received money for their participation.

Materials. The materials were the same as in Experiment 6, with two small exceptions. One is that in order to raise fixation probability, the two words following the critical pronoun *he* were, if necessary, changed so that they had a minimal length of five characters. Furthermore, because of the demands associated with the eye tracker and the variable length of words within the five-word spillover region, the one or two last words of this region (i.e. word 9 in the results table) were sometimes displayed on the next line. The same fillers, randomizations, and comprehension questions were used.

Procedure. The procedure was identical to the previous eye-tracking experiments (see Chapter 2, Paragraph 2.2.2). Each session ended with the administration of a Dutch reading span task, and was completed within 50 minutes.[5]

Analysis. All the participants scored above 85% correct (mean score 94%) on the comprehension questions. Prior to all analyses, 5.6% of the

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[5] Due to very low variability, the results of the reading span task did not allow for a sensible median split, and I therefore refrained from analyzing the results of Experiment 2 as a function of reading span group.

trials were removed because major tracker losses and eye blinks made it impossible to determine the course of fixations at or directly around the critical pronoun. Furthermore, if a fixation was shorter than 80 ms and within one character space of the previous or next fixation, it was assimilated to this fixation. All remaining fixations shorter than 80 ms, as well as fixations longer than 1200 ms or containing blinks, were excluded (8.4%). Because short words like pronouns receive very few fixations, I extended the region for the pronoun by six characters to the left, if the pronoun was skipped during first-pass reading. This *leftward-shifting* procedure is based on evidence that readers are able to obtain lexical information from words beginning six characters from a particular fixation, and on evidence that the perceptual span is asymmetric to the right of a fixation (see Rayner & Sereno, 1994, for more discussion). In the current experiment, the procedure increased the probability of fixating the critical pronoun from 42% to 86%. If after this procedure, the pronoun was still not fixated, the data point for the trial was treated as missing data (as was done for any other word that was not fixated during first-pass reading).

As in Experiment 6, I will report mean reading times and statistical analysis for the factor Consistency (and its interaction with Verb Bias) for four words in the pre-critical region, the critical pronoun, and four words in the spillover region. I will report mean reading times for three different eye-movement measures, namely first fixation, first gaze and regression path durations (see Chapter 1, paragraph 1.4.2.1 for a discussion of the different measures).

5.3.2. Results

Figures 18, 19 and 20 display the mean first fixation duration, first-gaze reading time, and regression path time as a function of Consistency and word position, collapsed across Verb Bias. Tables 28, 29 and 30 report the associated statistics, as well as additional data for the Consistency by Verb Bias interaction. In the pre-critical region, none of the three measures revealed a significant main effect of Consistency. However, relative to their bias-consistent counterparts, pronouns that were inconsistent with the implicit causality bias of the preceding verb reliably perturbed the reading process at or shortly after the pronoun. At the pronoun itself, the inconsistency effect emerged most clearly in the regression path duration. Furthermore, three words after the critical pronoun, significant inconsistency effects emerged both in first fixation and first gaze duration.

Table 28. Mean first fixation durations (in ms), Repeated Measures ANOVAs and minF' values for Exp. 7.

	Wordposition								
	-4	-3	-2	-1	0	1	2	3	4
con	*Linda*	*praised*	*David*	*because*	***he***	*had*	*been*	*able*	*to*
incon	*David*	*praised*	*Linda*	*because*	***he***	*had*	*been*	*able*	*to*
					First fixation duration				
total									
con	206	203	194	177	187	189	199	184	188
incon	209	200	204	171	191	193	200	205	187
NP1-bias									
con	203	201	187	178	193	189	203	174	188
incon	199	192	206	166	191	194	199	205	185
NP2-bias									
cons	209	204	200	175	180	189	194	194	188
incon	219	208	202	176	191	191	200	204	188
F1 (Consistency)									
F	< 1	< 1	1.931	< 1	1.754	< 1	< 1	14.268	< 1
df	-	-	1, 21	-	1, 23	-	-	1, 23	-
Mse	-	-	1291	-	222	-	-	684	-
p	-	-	.179	-	.198	-	-	.001*	-
F2 (Consistency)									
F	< 1	< 1	< 1	1.033	< 1	< 1	< 1	4.913	< 1
df	-	-	-	1, 38	-	-	-	1, 37	-
Mse	-	-	-	834	-	-	-	1909	-
p	-	-	-	.316	-	-	-	.033*	-
minF' (Consistency)									
F	< 1	< 1	< 1	< 1	< 1	< 1	< 1	3.654	< 1
df	-	-	-	-	-	-	-	1, 56	-
p	-	-	-	-	-	-	-	.061	-
F1 (Consistency x Verb Bias)									
F	1.411	< 1	< 1	1.207	3.651	< 1	1.098	2.663	< 1
df	1, 23	-	-	1, 20	1, 23	-	1, 23	1, 23	-
Mse	918	-	-	695	275	-	497	929	-
p	.247	-	-	.285	.069	-	.306	.116	-
F2 (Consistency x Verb Bias)									
F	< 1	< 1	< 1	2.895	1.527	< 1	< 1	< 1	< 1
df	-	-	-	1, 38	1, 38	-	-	-	-
Mse	-	-	-	834	573	-	-	-	-
p	-	-	-	.097	.224	-	-	-	-
minF' (Consistency x Verb Bias)									
F	< 1	< 1	< 1	< 1	1.076	< 1	< 1	< 1	< 1
df	-	-	-	-	1, 59	-	-	-	-
p	-	-	-	-	.304	-	-	-	-

Figure 18. Mean first fixation durations (in ms) for the consistent and inconsistent condition in Exp.7.

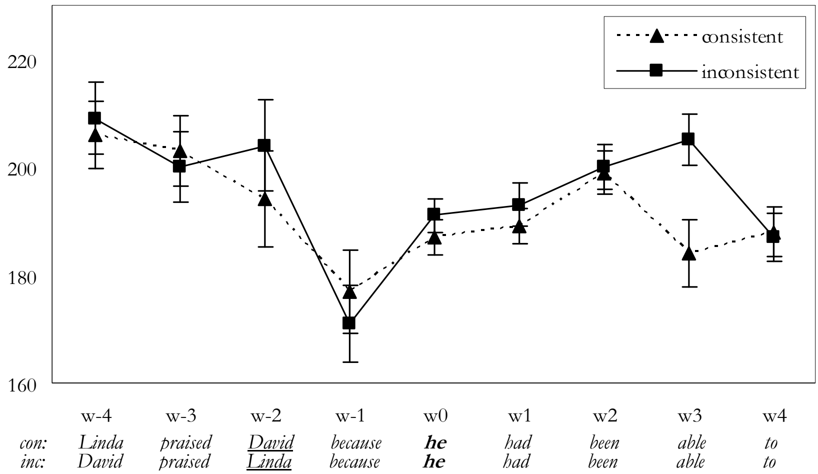
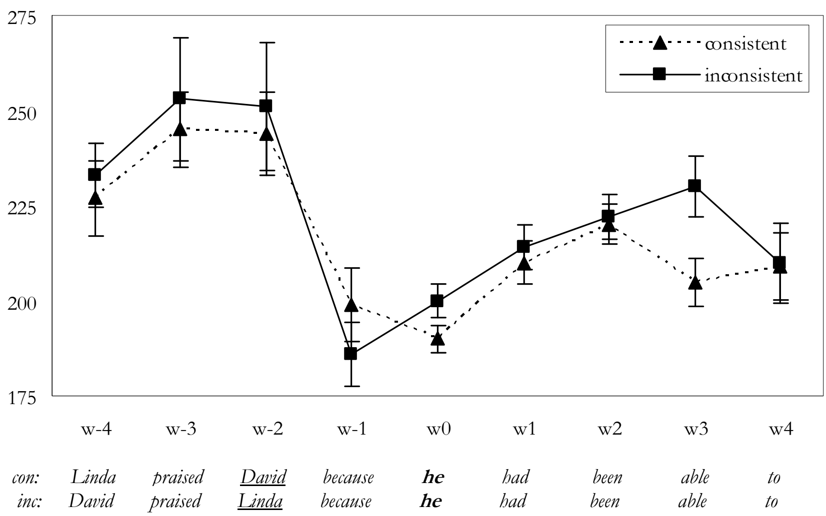


Figure 19. Mean first gaze durations (in ms) for the consistent and inconsistent condition in Exp.7.



As in Experiment 6, there were no reliable interactions between Consistency and Verb Bias at or directly following the critical pronoun. At the second word in the pre-critical region, I did however obtain a significant Consistency by Verb Bias interaction, in first-gaze and regression path durations. In both measures the reading times on this word in NP1 stories were longer in the consistent versions than in the inconsistent ones, whereas the opposite was observed for NP2 stories. I am inclined to interpret this as a chance effect, possibly related to the fact that, in contrast to the critical region, different words are involved across conditions.

Table 29. Mean first gaze durations (in ms), Repeated Measures ANOVAs and minF' values for Exp. 7.

	Wordposition								
	-4	-3	-2	-1	0	1	2	3	4
con	*Linda*	*praised*	*David*	*because*	***he***	*had*	*been*	*able*	*to*
incon	*David*	*praised*	*Linda*	*because*	***he***	*had*	*been*	*able*	*to*
					First gaze duration				
total									
con	227	245	244	199	190	210	220	205	209
incon	233	253	251	186	200	214	222	230	210
NP1-bias									
con	227	252	229	206	195	211	225	194	208
incon	224	230	232	187	202	209	225	224	201
NP2-bias									
con	227	237	259	192	185	208	215	216	209
incon	241	275	269	184	197	218	219	236	219
F1 (Consistency)									
F	< 1	< 1	< 1	1.968	5.705	< 1	< 1	12.814	< 1
df	-	-	-	1, 20	1, 23	-	-	1, 23	-
Mse	-	-	-	1924	351	-	-	1136	-
p	-	-	-	.176	.026*	-	-	.002*	-
F2 (Consistency)									
F	< 1	< 1	< 1	1.387	2.096	< 1	< 1	6.054	1.170
df	-	-	-	1, 38	1, 38	-	-	1, 37	1, 37
Mse	-	-	-	1455	1221	-	-	2601	2228
p	-	-	-	.246	.156	-	-	.019*	.286
minF' (Consistency)									
F	< 1	< 1	< 1	< 1	1.532	< 1	< 1	4.111	< 1
df	-	-	-	-	1, 58	-	-	1, 59	-
p	-	-	-	-	.221	-	-	.047*	-
F1 (Consistency x Verb Bias)									
F	2.074	7.244	< 1	< 1	< 1	1.122	< 1	< 1	< 1
df	1, 23	1, 23	-	-	-	1, 23	-	-	-
Mse	842	3000	-	-	-	730	-	-	-
p	.163	.013*	-	-	-	.300	-	-	-
F2 (Consistency x Verb Bias)									
F	< 1	4.064	2.261	< 1	< 1	1.007	< 1	< 1	< 1
df	-	1, 38	1, 36	-	-	1, 38	-	-	-
Mse	-	3663	1134	-	-	1014	-	-	-
p	-	.051	.141	-	-	.322	-	-	-
minF' (Consistency x Verb Bias)									
F	< 1	2.603	< 1	< 1	< 1	< 1	< 1	< 1	< 1
df	-	1, 61	-	-	-	-	-	-	-
p	-	.112	-	-	-	-	-	-	-

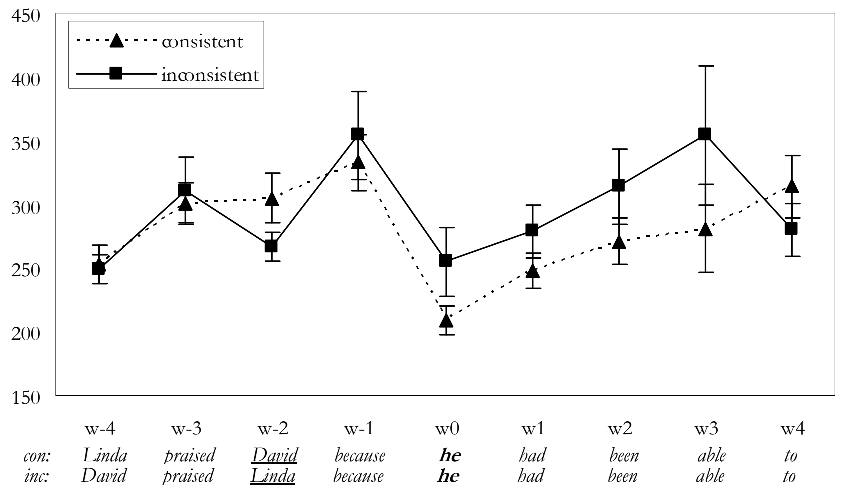
Table 30. Mean regression path durations (in ms), Repeated Measures ANOVAs and minF' values for Exp. 7.

	Wordposition								
	-4	-3	-2	-1	0	1	2	3	4
con	*Linda*	*praised*	*<u>David</u>*	*because*	***he***	*had*	*been*	*able*	*to*
incon	*David*	*praised*	*<u>Linda</u>*	*because*	***he***	*had*	*been*	*able*	*to*
	Regression path duration								
<u>total</u>									
con	253	301	305	333	209	248	271	281	314
incon	249	311	267	354	255	279	314	354	280
<u>NP1-bias</u>									
con	249	317	299	357	212	250	276	264	313
incon	240	266	248	329	282	289	311	290	275
<u>NP2-bias</u>									
con	256	284	310	308	205	245	265	297	314
incon	258	355	276	378	227	269	316	417	284
<u>F1 (Consistency)</u>									
F	< 1	< 1	8.438	< 1	6.144	3.604	3.531	2.858	2.375
df	-	-	1, 21	-	1, 23	1, 23	1, 23	1, 23	1, 23
Mse	-	-	4765	-	8215	6577	12735	44429	11820
p	-	-	.008*	-	.021*	.070	.073	.104	.137
<u>F2 (Consistency)</u>									
F	< 1	< 1	3.946	< 1	4.772	4.609	3.229	1.946	< 1
df	-	-	1, 36	-	1, 38	1, 38	1, 38	1, 37	-
Mse	-	-	3918	-	11862	3857	7750	33990	-
p	-	-	.055	-	.035*	.038*	.080	.171	-
<u>minF' (Consistency)</u>									
F	< 1	< 1	2.688	< 1	2.685	2.022	1.686	1.157	< 1
df	-	-	1, 56	-	1, 60	1, 53	1, 58	1, 60	-
p	-	-	.107	-	.107	.161	.199	.286	-
<u>F1 (Consistency x Verb Bias)</u>									
F	< 1	5.933	< 1	3.042	1.645	< 1	< 1	1.294	< 1
df	-	1, 23	-	1, 20	1, 23	-	-	1, 23	-
Mse	-	15134	-	16788	8472	-	-	41890	-
p	-	.023*	-	.096	.212	-	-	.267	-
<u>F2 (Consistency x Verb Bias)</u>									
F	< 1	5.628	< 1	< 1	1.082	< 1	< 1	2.482	< 1
df	-	1, 38	-	-	1, 38	-	-	1, 37	-
Mse	-	10685	-	-	11862	-	-	33990	-
p	-	.023*	-	-	.305	-	-	.124	-
<u>minF' (Consistency x Verb Bias)</u>									
F	< 1	2.888	< 1	< 1	< 1	< 1	< 1	< 1	< 1
df	-	1, 58	-	-	-	-	-	-	-
p	-	.095	-	-	-	-	-	-	-

As in Experiment 6, effects of implicit causality were obtained right after – and in this case even at – the critical pronoun, only two words into the subordinate clause. This shows that the early effects of implicit causality on sentence processing obtained in Experiment 6 cannot be attributed to particular strategies adopted in the self-paced reading task.

Moreover, these eye-tracking findings again show that implicit causality becomes available very early in the comprehension process, as predicted by the immediate focusing account. Regardless of whether readers make their way through a story in self-paced or unconstrained reading, the implicit causality information afforded by biased interpersonal verbs like *praise* or *apologize* is brought to bear on sentence comprehension rapidly enough to have an impact on the interpretation of a referring pronoun occurring in mid-sentence, only two words into the subordinate clause.

Figure 20. Mean regression path durations (in ms) for the consistent and inconsistent condition in Exp.7.



5.4. Interim Discussion

In two comprehension experiments, I examined the claim (e.g. Garnham, 2001; Stewart *et al.*, 2000) that verb-based implicit causality information is only used during sentence-final clausal integration. I did so by looking for mid-sentence reading delays caused by pronouns that are inconsistent with the bias of a preceding implicit causality verb (e.g. *David praised Linda because he*). In Experiment 6, I kept track of the impact of implicit causality by means of word-by-word self-paced reading. In Experiment 7, I used eye tracking, as participants freely read through the same materials.

In both experiments, I obtained evidence of such pronoun-induced delays. In self-paced reading (Experiment 6), pronouns that were inconsistent with the implicit causality bias of the verb reliably slowed down reading right after the pronoun. In unconstrained reading (Experiment 7) such pronouns also immediately perturbed the reading process, as indexed by significant delays, in various first-pass measures, at and shortly after the critical pronoun. The eye-tracking results confirm that the early use of implicit causality information in Experiment 6 is not a consequence of unnatural comprehension strategies induced by the word-by-word self-paced reading task. Furthermore, because identical critical words were used across bias-consistent and bias-inconsistent conditions, the results also unequivocally rule out the possibility (suggested by Oakhill *et al.*, 1998 and Garnham, 2001) that the implicit causality effects observed in language comprehension are artifacts of 'low-level' differences between bias-consistent and bias-inconsistent critical fragments. Hence, across experiments and methodologies, we have evidence that readers can very rapidly recruit verb-based implicit causality information in the service of comprehension, rapidly enough to impact on the interpretation of a pronoun early the subordinate clause.

In the immediate focusing account (Greene & McKoon, 1995; Long & De Ley, 2000; McKoon *et al.*, 1993), a sentence-initial fragment like *'David praised Linda because'* is assumed to bring Linda into focus immediately, at the expense of David. Because readers and listeners prefer to relate a personal pronoun to the most focused (i.e. most accessible) antecedent (see Arnold, 1998, for review), this account correctly predicted the early processing problem, a delay in reading at and immediately after the subsequent pronoun *he*. However, no such early effect was predicted by the clausal integration account (Garnham, 2001; Garnham *et al.*, 1996; Stewart *et al.*, 2000), at least not in its most common formulation, in which implicit causality becomes relevant in sentence-final 'retroactive' clausal integration only.

I stated in the beginning of this chapter that some controversy exists with respect to *when* and *how* implicit causality information influences sentence comprehension in general and pronoun resolution in particular. The results of my experiments unequivocally revealed that the answer to the *when*-question should be: very rapidly. As such, the results are consistent with the immediate focusing account and rule out clausal integration as the sole origin of the typical implicit causality effects observed in behavioral measures of language comprehension. However, although the former account correctly predicts the timing of the use of verb-based implicitly causality information, it does not provide a clear-cut answer on *how* this information is brought to bear. More specifically, a very important question that remains unanswered is whether or not the impact of implicit causality verbs critically depends on a subsequent *causal* connective, such as *because*.

The latter question received some attention in the literature (e.g. Arnold, 2001; Ehrlich, 1980; McKoon *et al.*, 1993; Stevenson *et al.*, 1994; Stevenson, Knott, Oberlander & McDonald, 2000). For instance, making use of the probe task McKoon *et al.* (1993) explicitly examined the contribution of the connective *because* to successful pronoun resolution following a verb exhibiting implicit causality. They presented bias-consistent and bias-inconsistent stories very similar to my stories, yet varied across experiments whether or not the connective *because* was present, i.e. in the experiments without the connective a critical sentence like '*David praised Linda because she had done well*' was changed into '*David praised Linda. She had done well*'. The results showed that in the experiments *with* the connective (Experiment 1-4), implicit causality information was brought to bear in pronoun resolution, yet indications of such an effect were absent in the experiments in which the connective was deleted (Experiment 5 and 6). They concluded therefore that the lexical structure of the verb and the information contained in the sentence continuations are not sufficient either alone or in combination to bring about successful pronoun resolution. In other words, an implicit causality verb does not seem to create a strong bias towards one of its arguments without an overt causal connective such as *because* being present.

In another study Ehrlich (1980) showed that the effects of the bias of an implicit causality verb are also attenuated if the connective *because* is replaced by *and,* and, very interestingly, even reversed if the connective is *but*. Thus, in the latter case readers prefer to connect a pronoun to the non-biased argument of the implicit causality verb. Ehrlich concluded that the claims made for implicit causality are supported for *because*, but do not generalize to other conjunctions.

After conducting a series of offline completion experiments Stevenson *et al.* (1994, 2000) arrived at a similar conclusion. In fact, they argued that in general the focus is not on the cause of an event, but rather on its consequence. This general tendency may, however, be modulated by the connective. For example, the default focus on the consequence is reinforced in the case of the connective *so*, but shifted to the cause when the connective *because* is used. Hence, in their account the implicit causality effect of interpersonal verbs solely hinge on the fact that *because* directs the attention of the reader to the cause of the event as described in the main clause.

Although the results of McKoon *et al.*, Ehrlich and Stevenson *et al.* directly bear on the question *how* implicit causality may affect pronoun resolution, the studies are unable to place these results in a specific time-frame. Obviously, the offline completion task of Stevenson *et al.* is not suitable for answering these types of questions. However, a similar objection can be made to the McKoon *et al.* study, in which the critical probe was presented at the end of a trial, i.e. after a participant had digested all the linguistic material including the implicit causality verb and the explicit cause. Furthermore, despite the fact that Ehrlich measured how quickly readers resolved the critical pronoun following the connectives *and*, *but* and *because,* she provided no detailed analysis of how these different connectives may alter the time-course of pronominal resolution. In all, the studies conducted so far clearly suggest that implicit causality effects are modulated by the type of connective, but they are however unable to inform us about when this modulating effect emerges during sentence or pronominal comprehension. To shed some light on the latter issue Experiment 8 was conducted, in which I presented similar materials as in the two previous experiments, but, like Ehrlich and Stevenson *et al.*, varied the type of connective to indicate the relationship between the two critical clauses.

5.5. Experiment 8: Three connectives[6]

Following Ehrlich, I used the connectives *because*, *but* and *and* to study the modulating effect of connectives on the use of implicit causality information in pronoun resolution. However, before examples of the stimuli are provided, some general remarks about the nature of the different connectives should be made, starting with *because* and *but.* Clearly these two connectives signal very different relationships. For example, Ehrlich argued – predominantly based on intuition – that *because* signals a reason for the event described in the first clause, whereas *but* denies this expectation and as such militates against any presuppositions of the event in the first clause. She illustrated this idea with the sentence *'John blamed Bill but he spilt the coffee'*, in which *but* indicates that the expectancy of *Bill* doing something wrong, and is

[6] Experiment 8 was conducted in close collaboration with Saskia de Leeuw. She wrote (or rewrote) most of the stimuli, and tested the participants. My special thanks go out to her.

therefore blamed, is *not* what actually happened, in fact, *John* is the one spilling the coffee.

Sanders, Spooren and Noordman (1992) put forward a similar idea in their comprehensive taxonomy of discourse coherence relationships. They use the terms 'positive' and 'negative polarity'[7] to distinguish between connectives of the *because* and the *but* type (see also Knott, 1996 and Knott & Mellish, 1996). Positive polarity is a property of a discourse relationship in which cause and consequence are aligned, like in the examples (8) and (9) below. Note that the main difference between *so* and *because* is the order in which cause and effect are mentioned: *so* is a forward causal connective (i.e. cause precedes consequence) and *because* a backward causal connective (i.e. consequence precedes cause, e.g. Pit, 2006).

(8) John's car was dirty, so he washed it.
(9) John washed his car, because it was dirty.

Negative polarity, on the other hand, reflects a discourse relationship in which cause and consequence are not aligned, like in the examples (10) and (11).

(10) John's car was dirty, but he didn't wash it.
(11) John washed his car, but it wasn't dirty.

In these examples the negative polarity connective *but* signals (or at least can signal) a violation of the type of relationship indicated by *so* and *because* (e.g. Sanders *et al.*, 1992; Knott & Mellish, 1996). In sentence (10), for example, *but* indicates a violation of the consequence. That is, 'normal' people tend to wash dirty objects, but John is apparently a lazybones and does not follow this general rule. In (11), on the other hand, *but* does not indicate a violation of the consequence, but rather of the cause. 'Normal' people do not wash clean things, but the John of sentence (11) seems to love his car so much that, unlike the rest of us, he has no problems with washing it, even if it is completely clean. Hence, these examples illustrate that *but* can be used to negate a causal relationship, either in a forward direction (i.e. a negation of the

[7] Not to be confused with positive and negative polarity in semantics.

consequence, ex. (10)) or backward direction (i.e. a negation of the cause, ex. (11)).

The relationship denoted by the conjunction *and*, however, doesn't specify whether a causal relationship is negated or not. In fact, it does not specify that there is an expected causal relationship to begin with, simply because *and* is used in many situations. For instance, *and* may indicate a causal (ex. (12)), additive (ex. (13)), or temporal relationship (ex. (14)) and as such is not a good predictor of how the subsequent clause relates to the previous clause.

(12) John's computer broke down and he fixed it.
(13) John called Mary and he called Lucie
(14) The soldier aimed and (then) he fired.

To sum up, the connectives *because*, *but* and *and* signal different discourse relationships. A conjunction with *because* indicates that the first clause is a consequence of the second clause. The connective *but*, on the other hand, signals that the cause-consequence relationship of two clauses is violated. Finally, *and* is used in many situations and as such does not specifically inform the reader or listener about the exact relationship between the two clauses.

5.5.1. Stimuli and predictions

In the present experiment I varied whether *because*, *but* or *and* connected the two clauses of the critical sentence and in effect added four conditions to the experimental design of the two previous experiments, i.e. in addition to a consistent and inconsistent condition with the connective *because* (ex. (15) and (16)), I also presented consistent and inconsistent conditions with the connective *but* (ex. (17) and (18)) and *and* (ex. (19) and (20)). Note that, as in the previous experiments, the critical pronoun *he* and five subsequent words were held constant across conditions. From this point onwards the sentences diverged in order to achieve overall coherence.

(15) <u>bias-consistent pronoun, *because*</u>
Linda praised <u>*David*</u> because *he* had been able to complete the difficult assignment with very little help.

(16) bias-inconsistent pronoun, *because*
David praised Linda because *he* had been able to complete the difficult assignment with her help only.

(17) bias-consistent pronoun, *but*
Linda praised *David* but *he* had been able to complete the difficult assignment with her help only.

(18) bias-inconsistent pronoun, *but*
David praised Linda but *he* had been able to complete the difficult assignment without her help.

(19) bias-consistent pronoun, *and*
Linda praised *David* and *he* had been able to complete the difficult assignment very rapidly as well.

(20) bias-inconsistent pronoun, *and*
David praised Linda and *he* had been able to complete the difficult assignment very rapidly as well.

On the basis of the characteristics of the connectives (and the results of the previous studies) a number of predictions were formulated. For the connective *because* I expected a replication of the typical inconsistency effect as observed in the self-paced reading and eye-tracking experiment. Thus, relative to a consistent pronoun in sentences like (15), a bias-inconsistent pronoun in sentences like (16) should cause a reading delay at or shortly after the aberrant pronoun.

I predicted a modulating effect for the connective *but*, which could, however, manifest itself in different ways. A first possibility is that the typical inconsistency effect is reversed as suggested by Ehrlich's findings. In that case the implicit causality information afforded by the verb is thought to focus the reader on the cause of the event *before* the reader encounters the connective. So, after digesting a clause like *Linda praised David* (cf. ex. (17)), the expected cause, *David*, is in focus. However, because *but* is used to deny expectations (e.g. Ehrlich, 1980) or at least to signal that the cause-consequence relationship is not aligned (cf. Sanders *et al.*), the reader's focus could shift to the other initially non-focused argument *Linda*. Consequently, when the reader encounters the pronominal *he*, its referent *David* is in fact the non-focused antecedent. The opposite happens in a fragment like *David praised Linda but* (cf. ex

(18)) in which the names have been swapped. The focus is initially on *Linda*, yet due to the connective *but* there is a shift of focus to *David* and as a result the later 'inconsistent' pronoun *he* in fact refers to the most accessible antecedent. Hence, this approach predicts that a bias-inconsistent pronoun is more easily resolved than a bias-consistent pronoun due to the modulating effect of the connective *but*, which tends to foreground the unexpected (cause).

However, this prediction crucially builds on two assumptions. First, in order to have a shift of focus in response to the connective *but*, a particular focus on one of the antecedents should be present before encountering the connective to begin with. In other words, a reversal of the typical inconsistency effect is only expected if we always – or at the very least in the case of an implicit causality verb – focus by default on the expected cause. Second, although *but* can certainly indicate a violation of the consequence-cause relationship between two clauses, in which the pronoun in the second clause refers to a non-focused antecedent (ex. (18)), this is just one of numerous violations signaled by *but*, many of which do not include a shift from the focused to the non-focused antecedent (ex. (21)-(23)).

(21) Linda praised *David* but *he* didn't do a good job.
(22) Linda praised *David* but *he* didn't care.
(23) Linda praised *David* but *he* couldn't hear her.

Thus, even if readers have a default focus on the cause of the event after reading the first clause, it seems unlikely that the connective *but* completely shifts the focus to the other antecedent, i.e. the antecedent that is not immediately associated with that cause. Perhaps a more plausible approach is therefore to assume that in the case of the connective *but*, all bets are off, apart from expecting the unexpected, which obviously includes a lot. Bearing this in mind I seriously considered another possible outcome of the experiment in which the modulating effect of *but* may eliminate the inconsistency effect as reported for the connective *because*, but doesn't result in a complete reversal of the effect.

I also distinguished two possible outcomes for the connective *and*. First, if a reader tends to focus on the cause of an event or state before encountering the connective, an inconsistent pronoun could, relative to a consistent pronoun, cause a reading delay. This prediction is based on the observation that *and* may signal many different discourse relationships, including causal, temporal and additive conjunctions. Consequently, its meaning is not specific enough to alter the default causal focus significantly. Alternatively, one could also argue that, because *and* does not signal a very specific relationship between two clauses, the initial default focus on the cause is severely attenuated, perhaps to the extent that the typical inconsistency effect as reported for the connective *because* may completely disappear.

In sum, for the connective *because* an inconsistency effect is expected at or shortly after the critical pronoun *he*. The predictions for the connectives *but* and *and* were however less straightforward. In the case of the connective *but* a modulating effect was expected, which could either emerge as an elimination or complete reversal of the inconsistency effect. Finally, for the connective *and*, I predicted an inconsistency effect, *if* the default focus on the cause remains essentially unaffected by its use. On the other hand, another plausible result would be that, since *and* may signal a lot of different relationships, the inconsistency effect is vastly reduced or in fact completely vanishes.

5.5.2. Method

Participants. Participants were 36 members from the Utrecht University community (33 female, mean age 22, range 18 - 38 years) who received money for their participation.

Materials. The materials were the same as in Experiment 6 and 7 with the following exceptions. First of all, instead of only using the causal connective *because,* I varied whether *because*, *but* or *and* connected the two clauses of the critical sentence. Besides the obvious semantic differences of these three connectives *because* differs fundamentally from *but* and *and* in an important syntactic aspect as well: whereas *because* subordinates the subsequent clause, both *but* and *and* join two main clauses. Likewise, in Dutch *omdat* 'because' (i.e. the connective used in the previous two experiments) heads a subordinate clause, yet, *maar* 'but' and *en* 'and' enter into a coordinating structure. This creates a potential problem because in Dutch the word order of subordinate clauses differs from the word order in main clauses. In the latter, Dutch shows a Subject-Verb-Object (SVO) order, yet, in a subordinate clause this order changes into SOV. As a result, it becomes very difficult or even impossible to keep the words directly following the critical pronoun constant across the different connective conditions. Therefore, another Dutch causal connective, namely *want*, was used instead of *omdat*. Both *want* and *omdat* are backward causal connectives (i.e. they signal that the cause follows the consequence) and both have a similar meaning as *because*. The main difference is that *want* leads to a coordinated structure of the two clauses in the critical sentence, whereas *omdat* subordinates the second clause.[8]

Since I used coordinating connectives in the present experiment, the ending of the critical sentence (i.e. the part following the pronoun) of the stimuli needed to be changed in order to obtain an SVO order. As in the previous two experiments, at least five words after the pronoun were held constant to ensure that any spillover effects of the critical manipulation would not be confounded with the effects of the different sentence continuations that were required to achieve overall coherence. Examples that involve an NP1 verb are given in (24), together with their approximate translation (see Appendix VI for all Dutch originals).

(24) <u>NP1-biased verb, introduction</u>
David en Linda reden allebei behoorlijk hard. Bij een druk kruispunt botsten zij met hun auto's stevig op elkaar.
(David and Linda were both driving pretty fast. At a busy intersection they crashed hard into each other.)

a. <u>Consistent pronoun, *want*</u>
<u>*David*</u> bood zijn excuses aan Linda aan want *hij* was volgens de getuigen van het ongeluk de veroorzaker van alle ellende.
(David apologized to Linda because he according to the witnesses was the one to blame.)

b. <u>Inconsistent pronoun, *want*</u>
<u>Linda</u> bood haar excuses aan *David* aan want *hij* was volgens de getuigen van het ongeluk niet de veroorzaker van alle ellende.
(Linda apologized to David because he according to the witnesses was not the one to blame.)

c. <u>Consistent pronoun, *maar*</u>
<u>*David*</u> bood zijn excuses aan Linda aan maar *hij* was volgens de getuigen van het ongeluk niet de veroorzaker van alle ellende.
(David apologized to Linda but he according to the witnesses was not the one to blame.)

[8] In addition, *want* and *omdat* differ in their contribution to the interpretation of the causal relationship in terms of subjectivity (see Pit, 2006, for extensive discussion). More specifically, whereas *want* is generally used to indicate that the speaker (or writer) of a particular discourse draws the conclusion that two clauses are causally related, *omdat* indicates a more objective causal relationship.

d. Inconsistent pronoun, *maar*
Linda bood haar excuses aan *David* aan maar *hij* was volgens de getuigen van het ongeluk de veroorzaker van alle ellende.
(Linda apologized to David but he according to the witnesses was the one to blame.)

e. Consistent pronoun, *en*
David bood zijn excuses aan Linda aan en *hij* was volgens de getuigen van het ongeluk erg in de war door de situatie.
(David apologized to Linda and he according to the witnesses was very confused due to the situation.)

f. Inconsistent pronoun, *en*
Linda bood haar excuses aan *David* aan en *hij* was volgens de getuigen van het ongeluk gelukkig in staat haar excuses te aanvaarden.
(Linda apologized to David and he according to the witnesses was fortunately able to except her apologies)

Furthermore, to increase the number of stimuli, 8 additional stories were constructed (4 contained verbs with a strong NP1-bias and 4 with a strong NP2-bias; Table 31 contains the relevant additional verbs, their bias and an approximate English translation) giving a total of 48 stories in 6 versions.

Table 31. Additional implicit causality verbs used in Exp. 8 with their bias.[9]

NP1-biased verbs		NP2-biased verbs	
Verb	*Mean Bias*	*Verb*	*Mean Bias*
zich verontschuldigen tegenover *(apologize)*	1.05	bang zijn voor *(fear)*	2.00
woedend maken (*infuriate)*	1.09	rouwen om (*mourn*)	1.95
besmetten *(infect)*	1.17	walgen van *(be disgusted by)*	1.91
bang maken *(frighten)*	1.22	medelijden hebben met *(feel sorry for)*	1.91

The stimuli were divided into six lists, with only one version of each story in a particular list. Another 24 stories were included as fillers. One pseudo-randomization was used for each list. The original randomization order was used for half of the participants, the reversed order for the other half. Half of the experimental and filler trials were followed by a

[9] Mean overall bias for NP1-verbs (i.e. including the other 20 verbs): 1.14, NP2: 1.94.

statement about the story to encourage discourse comprehension. Participants had to indicate whether the statement about the story was correct or false (half were correct and half were false). These statements never directly probed the interpretation of the pronoun.

Procedure. The procedure was identical to the previous eye-tracking experiments. Each session was completed within 35 minutes.

Analysis. For analysis purposes the sentences were divided into the following regions.[10]

1. David praised Linda *(pre-critical region)*
2. because/but/and he *(critical region)*
3. had been *(spillover region 1)*
4. able to *(spillover region 2)*

Thus, the first region consisted of the first clause, containing the implicit causality verb and two antecedents. The second region consisted of the connective and the critical pronoun. Spillover region 1 included the two words following the critical pronoun and spillover region 2 included the third and fourth word following the critical pronoun.

All the participants scored above 78% correct (mean score 91%) on the comprehension questions. I will report mean reading times for three different eye movement measures, namely first gaze, total first gaze and regression path durations (see Paragraph 1.4.2.1 in Chapter 1 for a discussion of the different measures). Prior to all the analyses, 1% of the trials was removed because major tracker losses and eye blinks made it impossible to determine the course of fixations at or directly around the critical pronoun. For all the different measures reading times more than two standard deviations from both the participant's mean and the item's mean in a region in a particular condition were treated as missing data (< 1 % for all measures).

For each connective separate pair-wise T-Tests were performed to compare the reading times for the consistent and inconsistent condition. In addition, because the strongest modulating effect on the use of implicit causality information was expected between the connectives *because* and *but*, Repeated Measures ANOVAs with the two-level factors *Bias* (i.e. *consistent pronoun* versus *inconsistent pronoun*) and *Connective* (i.e.

[10] Due to 'noisy' data I enlarged the regions of interest from one to two words, in order to increase fixation probabilities.

because versus *but*) were performed to locate the predicted modulating effect.

5.5.3. Results

Tables 32 to 34 report the different reading time measures as a function of Connective Type, Bias and sentence region. In addition, the tables include the associated Paired-Sample T-Tests and ANOVAs. For the connective *because*, none of the three reading time measures revealed a significant effect in the pre-critical and critical region. However, the region immediately following the critical pronoun showed a reliably inconsistency effect in the by-subjects analyses, both in first gaze and total first gaze durations (see Figure 21 and 22). Note that the by items analyses approached significance in both measures as well (first gaze, $p_2 = .06$; total first gaze, $p_2 = .053$). No significant differences emerged for the other two connectives in any of the measures. The ANOVAs returned reliable interactions between the connectives *because* and *but,* again in first gaze and total first gaze durations of the first spillover region. Inspection of the means and associated T-Tests showed that the inconsistency effect as found for the connective *because*, disappeared for the connective *but* (see Figure 21 and 22). In fact, in the total first gaze measure the numerical difference between the consistent and inconsistent condition of the connective *but* showed a reversed pattern, i.e. shorter reading times for a bias-inconsistent pronoun. This difference, however, did not reach the required level of significance.

Table 32. Mean first gaze durations (in ms), Repeated Measures ANOVAs and Paired-Sample T-Tests for Exp. 8.

	Region			
	1	2	3	4
e.g.:	*David praised Linda*	*because/ but/and **he***	*had been*	*able to*
		First gaze duration		
want				
consistent	673	262	256	292
inconsistent	698	237	285	306
maar				
consistent	690	265	273	303
inconsistent	653	262	269	291
en				
consistent	695	240	289	309
inconsistent	665	226	264	305
t1 (want, df = 35)				
t	< 1	1.519	2.665	< 1
Se	-	15.86	10.59	-
p	-	.138	.012*	-
t2 (want, df = 47)				
t	< 1	1,540	1.925	< 1
Se	-	13.75	16.61	-
p	-	.130	.060	-
t1 (maar, df = 35)				
t	1.122	< 1	< 1	< 1
Se	32.71	-	-	-
p	.269	-	-	-
t2 (maar, df = 47)				
t	1.102	< 1	< 1	< 1
Se	28.78	-	-	-
p	.276	-	-	-
t1 (en, df = 35)				
t	1.027	< 1	1.762	< 1
Se	29.90	-	14.06	-
p	.312	-	.087	-
t2 (en, df = 47)				
t	1.370	1.108	1.788	< 1
Se	34.51	13.02	11.37	-
p	.177	.273	.080	-
F1 (want x maar, df = 1, 35)				
F	1.618	< 1	5.155	1.693
Mse	21210	-	1797	3412
p	.212	-	.029*	.202
F2 (want x maar, df = 1, 47)				
F	1.979	1.360	4.604	< 1
Mse	17991	3175	4793	-
p	.166	.249	.037*	-

Table 33. Mean total first gaze durations (in ms), Repeated Measures ANOVAs and Paired-Sample T-Tests for Exp. 8.

		Region		
	1	2	3	4
e.g.:	*David praised Linda*	*because/ but/ and **he***	*had been*	*able to*
		Total first gaze duration		
want				
consistent	723	328	277	338
inconsistent	736	322	317	336
maar				
consistent	731	340	321	342
inconsistent	701	330	302	339
en				
consistent	744	286	341	357
inconsistent	724	290	324	349
t1 (want, df = 35)				
t	< 1	< 1	2.943	< 1
Se	-	-	13.77	-
p	-	-	.006*	-
t2 (want, df = 47)				
t	< 1	< 1	1.986	< 1
Se	-	-	18.32	-
p	-	-	.053	-
t1 (maar, df = 35)				
t	1.030	< 1	1.270	< 1
Se	29.39	-	14.69	-
p	.310	-	.213	-
t2 (maar, df = 47)				
t	< 1	< 1	1.801	< 1
Se	-	-	13.34	-
p	-	-	.078	-
t1 (en, df = 35)				
t	< 1	< 1	< 1	< 1
Se	-	-	-	-
p	-	-	-	-
t2 (en, df = 47)				
t	1.141	< 1	< 1	< 1
Se	33.78	-	-	-
p	.260	-	-	-
F1 (want x maar, df = 1, 35)				
F	1.278	< 1	10.641	< 1
Mse	13053	-	2962	-
p	.266	-	.002*	-
F2 (want x maar, df = 1, 47)				
F	< 1	< 1	7.972	< 1
Mse	-	-	5497	-
p	-	-	.007*	-

Table 34. Mean regression path durations (in ms), Repeated Measures ANOVAs and Paired-Sample T-Tests for Exp. 8.

	Region			
	1	2	3	4
e.g.:	*David praised Linda*	*because/ but/ and* ***he***	*had been*	*able to*
		Regression path duration		
want				
consistent	784	408	339	440
inconsistent	774	456	382	423
maar				
consistent	773	506	402	437
inconsistent	759	444	423	455
en				
consistent	785	390	432	436
inconsistent	802	408	451	493
t1 (want, df = 35)				
t	< 1	1.369	1.599	< 1
Se	-	35.28	26.85	-
p	-	.180	.119	-
t2 (want, df = 47)				
t	< 1	1.537	1.346	< 1
Se	-	27.79	26.52	-
p	-	.131	.185	-
t1 (maar, df = 35)				
t	< 1	1.319	< 1	< 1
Se	-	47.48	-	-
p	-	.196	-	-
t2 (maar, df = 47)				
t	< 1	1.213	< 1	< 1
Se	-	54.14	-	-
p	-	.231	-	-
t1 (en, df = 35)				
t	< 1	< 1	< 1	1.308
Se	-	-	-	43.46
p	-	-	-	.199
t2 (en, df = 47)				
t	< 1	< 1	< 1	1.725
Se	-	-	-	31.20
p	-	-	-	.091
F1 (want x maar, df = 1, 35)				
F	< 1	2.750	< 1	< 1
Mse	-	40274	-	-
p	-	.106	-	-
F2 (want x maar, df = 1, 47)				
F	< 1	2.805	< 1	< 1
Mse	-	50300	-	-
p	-	.101	-	-

Figure 21. Mean first gaze durations (in ms) for the first spillover region (region 3) of the *want* ('because') and *maar* ('but') conditions in Exp.8.

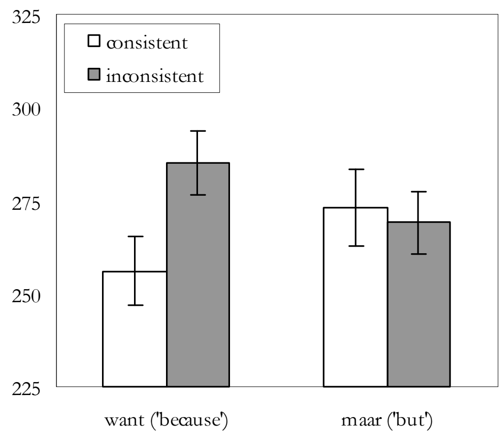
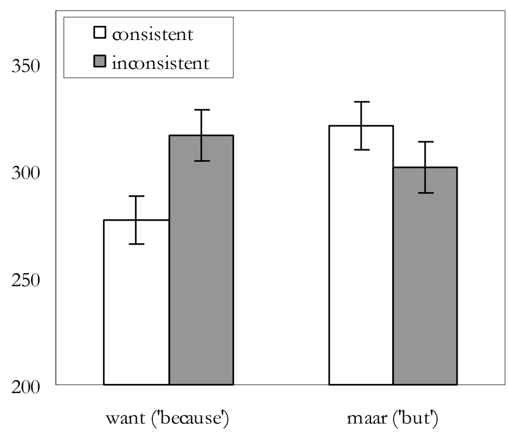


Figure 22. Mean total first gaze durations (in ms) for the first spillover region (region 3) of the *want* ('because') and *maar* ('but') conditions in Exp.8.



5.5.4. Discussion

As in Experiment 6 and 7, I obtained effects of implicit causality right after the critical pronoun, only two words into the second clause. Using a similar Dutch causal connective (i.e. *want* 'because') as in the previous two experiments (i.e. *omdat* 'because') the eye-tracking findings again showed that, relative to a bias-consistent pronoun, bias-inconsistent pronouns slowed down the reading process very early, as predicted by the immediate focusing account. The crucial finding of this experiment was, however, that the inconsistency effect totally depended on the type of connective that linked the two clauses of the critical sentence: the significant difference between inconsistent and consistent pronouns disappeared when the connective *want* 'because' was replaced with *maar* 'but' or *en* 'and'.

Previous offline studies suggested a modulating effect of connective type on the use of verb-based implicit causality information in pronoun resolution (e.g. Ehrlich, 1980; McKoon *et al.*, 1993; Stevenson *et al.*, 1994, 2000). These studies showed that the claims made for implicit causality hold if the connective *because* is present, but do not generalize to other connectives like *but* and *and* (Ehrlich), or to situations where no connective is present (McKoon *et al.*). My eye-tracking results indicate that this modulating effect of connective type also occurs during online tasks of language comprehension and more importantly, that the interaction between verb meaning and connective type on pronoun resolution presents itself very rapidly as indicated by the significant modulating effect between *because* and *but* only one or two words after the critical pronoun. These findings are consistent with a very dynamic view of focusing in which the focus constantly changes during the course of comprehension as a function of each new input (e.g. Arnold, 2001; Stevenson *et al.*, 2000).

Although my eye-tracking results are largely on a par with Ehrlich's findings, they diverge in one important aspect. Ehrlich reported that readers prefer to connect a pronoun to the non-biased argument of the implicit causality verb if *but* joins the two clauses instead of *because*, whereas in my experiment there were no clear signs of such a reversal. A possible explanation for the two different patterns is that, due to differences in the experimental set-up, readers knew what kind of violation is indicated through the connective *but* in Ehrlich's study, but remained initially unaware of the type of violation in my experiment. More specifically, because Ehrlich presented the critical sentences at once, and simply measured how quickly readers resolved the (ambiguous) pronoun, there is no way of telling how far readers had progressed into the second clause before they indicated that they had interpreted the pronoun – readers had to release a button that terminated a digital clock, when they had identified the proper referent. So, in a sentence like *'John blamed Bill but he spilt the coffee'* readers may have advanced to the verb *spilt* or even processed the complete sentence before giving their response. Consequently, in all likelihood they are aware of the fact that *but* signals a violation of cause, which may explain the reversed bias in comparison to the connective *because* (i.e. it explains why *he* is preferably connected to *John* instead of *Bill*). By contrast, in my experiment the reader did not really know what kind of violation was indicated through *but*, at least not while fixating the regions of interest (i.e. the critical pronoun and the spillover region) during first-pass reading. The connective *but* could signal a violation of cause, but it could just as easily indicate a violation of consequence, or even a violation of a completely different type. Hence, the lack of specificity of the connective *but* may have simply eliminated the focus on the antecedent associated with the cause, instead of shifting it to the other initially non-focused antecedent. This could explain why the eye-tracking data showed no clear signs of a reversed inconsistency effect, but simply no effect at all.

However, the absence of a reversed inconsistency effect for the connective *but* could also indicate that there is no particular focus prior to the connective to begin with. Consequently, *but* cannot shift the focus, simply because there is nothing to shift. This brings us to a very fundamental issue, namely, whether implicit causality verbs have the inherent ability to focus readers and listeners on the expected cause of an event without the further constraining properties of a connective like *because*. For present purposes I distinguish two possibilities. The first is that implicit causality verbs *do* carry some inherent feature which biases people to the cause. So, after reading a sentence fragment like *Linda praised David* the focus will be on *David*, the expected cause, and as a result *David* will be more accessible for subsequent reference than *Linda*. This inherent or default focus on the cause is, however, only sustained in the case of a backward causal connective like *because*, yet reduced or even completely eliminated in the case of less specific connectives like *but* or *and*. An alternative possibility is that implicit causality verbs *do not* induce a preset focus on the cause. So, after reading a sentence fragment like *Linda praised David*, there is no specific bias towards the cause of the event, and consequently neither *David* nor *Linda* will be focused on (putting other accessibility constraints like the first mention and subjecthood advantage aside for a moment). In the latter proposal the focus on the cause is induced solely through a backward connective like *because* and, hence, the typical inconsistency effects as observed in reading time and reaction time paradigms depend on the presence of a connective that highly constrains the continuation of a sentence or discourse.

In the remainder of this section I draw attention to a number of reasons that incline me to abandon the former hypothesis, i.e. that interpersonal verbs like *praise* and *apologize* inherently induce a focus on the cause. First of all, the eye-tracking results for the connective *but* and *and* did not reveal any reliable reading time differences between bias-consistent and bias–inconsistent pronouns. Even though these results speak neither in favor nor against the hypothesis, because the presence of *but* or *and* may simply swamp the initial focus on the cause, stronger evidence could have been obtained. For instance, for the connective *but* stronger evidence would be reflected by a reversal of the typical inconsistency effect as found for *because*. Recall that this prediction was based on the idea that *if* there is an initial focus on the antecedent associated with the cause, *but* may shift this bias to the other initially non-focused antecedent. As a result of this focus shift, verb-bias-inconsistent pronouns should be read more quickly than verb-bias-consistent pronouns, i.e. opposing the reading times for pronouns following the connective *because*. Although one eye-tracking measure (i.e. total first gaze) showed a numerical difference consistent with the latter prediction, this difference did not reach significance, and hence provided no explicit evidence in favor of an inherent bias to the cause. The hypothesis is further weakened by the observation that bias-consistent and bias-inconsistent pronouns following the connective *and* did not elicit reliable reading time differences. Again I emphasize that this finding does not necessarily invalidate the claim that implicit causality verbs induce a focus on the cause – because *and* may severely attenuate the default focus – yet, more convincing evidence would be reflected by a similar, perhaps reduced, inconsistency effect as for the connective *because*. So, while neither the absence of a (reduced) inconsistency effect for the connective *and*, nor the lack of a reversed effect for the connective *but* contradict an inherent causal bias, these results do, however, illustrate the need for independent evidence that suggests its reality.

Although human beings are in all probability sensitive to cause-consequence relationships, and perhaps even focused on these types of conjunctions, I strongly believe that there is no straightforward (a priori) reason to assume that such a focus would be on the cause rather than on the consequence. For instance, example (25) and (26) illustrate that a sentence containing an implicit causality verb can easily continue with the outcome of the event.

(25) Linda praised David, so he was happy.
(26) Linda praised David and she felt good about herself.

Researchers may be preoccupied with the causes of the phenomena they observe in the world, but this obviously does not mean that 'normal' people should behave in the same way. In fact, intuitively it may be even better to focus on the consequence or outcome of an event instead, in order to increase your chances for survival. You don't want to know why the lion in front of you is hungry, the scary possibility that you may end up in his or her empty stomach is all you can think about.

Not only intuition tells us that it is unlikely that implicit causality verbs have the inherent ability to bias people to the cause of an event: the experimental evidence is scarce or in fact, to the best of my knowledge, non-existent. As mentioned previously, McKoon *et al.* (1993) showed that implicit causality information is only used in pronoun resolution if the connective *because* joins the two clauses. Furthermore, Stevenson *et al.* (1994) argued explicitly against the claim that people generally focus on causes, and proposed a default focus on the outcome or consequence of an event instead. More recently, Arnold (2001) further examined the latter hypothesis in an offline continuation experiment in which participants provided a natural continuation of a three sentence story that ended with a fragment containing a source-goal or goal-source verb of transfer (see ex. (27) and (28)).

(27) Lisa *gave* the leftover pie to Brendan__ *(source-goal verb)*
(28) Marguerite *caught* a cold from Eduardo two days before Christmas__ *(goal-source verb)*

The results showed that participants were inclined to refer more to the goal (i.e. *Brendan*, *Marguerite*) than to source (i.e. *Lisa*, *Eduardo*). However, this bias was essentially unrelated to whether the continuations provided information about the consequence or the cause. Moreover, even though consequences appeared more often than causes (i.e. consistent with the hypothesis of Stevenson *et al.*) neither accounted for the majority of responses. Hence, these results suggest that a default focus (if present) should not be formulated in terms of causes and consequences but rather in terms of goals and sources.

In all, I currently see no reason to grant a special status to implicit causality verbs, namely, that they tend to focus people on the cause of an event and as such affect the accessibility levels of potential antecedents for subsequent reference. I do, however, deem it very plausible that the meaning of a verb like *praise* or *apologize* in combination with other bits of meaning in the sentence, including connectives, may have this effect. So, in a dynamic view of focusing the accessibility of potential antecedents in a sentence fragment like *Linda praised David because* may change rapidly in the following way. Initially the first-mentioned antecedent, *Linda*, may be in focus, due to the well-known first-mention and subjecthood advantage. Then, while processing an implicit causality verb and the second antecedent, this focus remains more or less the same. However, a little bit further downstream in the sentence the reader encounters the connective *because*, which in combination with the meaning of the verb *praise* rapidly shifts the focus to the second antecedent, *David*, because *David* is associated with the expected cause of the event. In this framework the meaning of a verb immediately interacts with other bits of meaning in the sentence, and the outcome of *this* dynamic process determines what will be focused on, not some encapsulated inherent causal bias of the verb itself.

5.6. General discussion

5.6.1. Overview and implications of the results

In one self-paced reading and two eye-tracking experiments I examined *when* and *how* verb-based implicit causality information affects sentence comprehension. In the first two experiments the focus was on the *when*-issue by comparing the reading times for pronouns that were either consistent with the bias of a preceding implicit causality verb (e.g. *Linda praised David because he*) or inconsistent (e.g. *David praised Linda because he*). Both experiments, revealed that the effect of implicit causality manifests itself very rapidly, namely at or immediately following the critical pronoun.

In Experiment 6, statistically reliable effects of implicit causality first emerged on the two words that followed the critical pronoun. As discussed before, this provides a straightforward explanation for why Stewart *et al.* may have failed to detect an early implicit causality effect in their two-fragment self-paced reading study. As such, the findings also testify to the importance of tracking the use of a potentially relevant cue to sentence comprehension with sufficient temporal resolution, so that immediate small effects, as well as their immediate spillover, can be accurately detected. Note that in the eye-tracking experiments (Experiment 7 and 8), bias-inconsistent pronouns had most of their impact on the reading times *after* the pronoun as well. This cognitive spillover phenomenon is entirely consistent with the fact that, in an

EEG experiment with (Dutch) spoken sentences like *Anna shot at Linda as he jumped over the fence*, the processing consequences of the referentially failing pronoun *he* can be seen to extend in the EEG for at least a second after pronoun onset (Van Berkum *et al.*, 2004; see also Osterhout & Mobley, 1995). Furthermore, because in the present study I had equated the pronoun as well as five words that followed the pronoun across consistent and inconsistent versions of each item, we can be confident that the spillover delays observed here were elicited by whether the pronoun confirmed or denied the implicit causality afforded by the verb.

These findings allow me to reject the hypothesis that verb-based implicit causality information is only used during late, clause-final integration. However, they also bear on two other suggested limitations of the use of implicit causality in comprehension. One is that people might only rapidly exploit this cue as part of some unnatural processing strategy, elicited by experiments in which implicit causality always provides reliable information (Garnham, 2001). Because an early effect of verb bias was obtained in experiments with as many bias-consistent as bias-inconsistent continuations, my results clearly do not support this suggestion. The findings also refute the hypothesis (Garnham *et al.*, 1996) that verb-based implicit causality might only be relevant to comprehension when the referent of a pronoun cannot be disambiguated by means of morphosyntactic (e.g. gender) cues. In my materials, pronoun gender unambiguously rules out one of the two candidate antecedents. However, in spite of the reliable presence of a strong gender cue, readers apparently cannot help but use the probabilistic implicit causality cue as well.

In the second eye-tracking experiment (Experiment 8) I focused on the *how*-issue by varying whether the connective *because*, *but* or *and* joined the two clauses of the critical sentence. The results for the connective *because* replicated the findings of Experiment 6 and 7, i.e. the effects of implicit causality emerged right after the critical pronoun, only two words into the second clause. Interestingly, however, the significant difference between inconsistent and consistent pronouns disappeared completely if the connective *because* was replaced with *but* or *and.* As such the results confirmed the claim made by a number of researchers that the use of implicit causality information in language comprehension crucially depends on a backward causal connective like *because* (e.g. Ehrlich, 1980; McKoon *et al.*, 1993; Stevenson *et al.*, 1994).

Possibly inspired by the various principled classification schemes that have been proposed for implicit causality verbs (see Rudolph &

Försterling, 1997, for review), psycholinguists are sometimes inclined to grant a special status to the causality-related features of verbs like *praise* and *apologize*. In terms of online processing, however, I currently see no reason to assume that the constraints provided by implicit causality verbs are brought to bear on interpretation in a 'special way'. More specifically, implicit causality does not appear to be an inherent feature of a verb, which by default determines that the focus of a reader or listener should be on the expected cause. Rather, the meaning of the verb in combination with other bits of meaning, especially those of constraining connectives like *because,* jointly determine the interpretation of an unfolding utterance and any predictions that can subsequently be made. Hence, you could envision focus and the associated accessibility levels of potential antecedents as being part of a highly dynamic discourse model in which the focus' direction and strength constantly changes during the course of language comprehension as a function of each new input of an unfolding sentence (see Stevenson *et al.*, 2000 and Arnold, 2001, for similar proposals).

5.6.2. Incremental integration, immediate focusing or prediction?

So far, I have discussed the results in the context of two extant theoretical options: immediate focusing and clausal integration. Although the findings clearly deny the clausal integration hypothesis as the sole origin of the effects of implicit causality in comprehension, this by itself should not compel us to adopt immediate focusing as the correct account. In this section, I will examine several possible underlying mechanisms, one of which actually involves a refined version of clausal integration.

The integration account that the findings allow us to dispense with is one in which implicit causality only becomes relevant during *late* 'retroactive' clausal integration, at or close to the end of the second clause. This theoretical option is most clearly adopted by Stewart *et al.* (2000), who were prepared to take implicit causality effects at the pronoun as evidence for immediate focussing and against clausal integration. In his review, Garnham (2001) appears to adopt a similar view. In addition, Long and De Ley (2000) have noted that sentence-final clausal integration of implicit causality information is explicitly predicted by a more general model of multi-clause sentence comprehension, the *Connective Integration Model* (Millis & Just, 1994).

According to this model, when readers encounter a connective like *because, but* or *and* they set the representation of the first clause aside in working memory until they have independently processed the complete second clause. Crucially, only upon having completed the latter would the information provided by the first clause be related to that provided by the second. The clause-medial implicit causality effects that were observed, reveal that such relationships are computed much earlier, and thereby show that this specific claim of the Connective Integration Model cannot be correct.

However, my findings are not necessarily inconsistent with an *incremental* clausal integration account, in which the information made available by the second clause is 'retroactively' related to the interpretation of the main clause *on a word-by-word basis*. One such account was proposed MacDonald and MacWhinney (1995), who in a probe verification task obtained very early implicit causality effects in comprehension, right after the pronoun. MacDonald and MacWhinney took their findings as evidence that the implicit causality information provided by the main clause verb can be used as soon as a referring pronoun in the second clause needs to be resolved. Along the same lines, Garnham *et al.* (1996) also proposed a restricted role for implicit causality information during pronoun-induced anaphoric processing. Note, however, that Garnham and colleagues assumed that implicit causality is only used to resolve a morphosyntactically ambiguous pronoun, as in *Betty punished Diane because she didn't do the dishes.* In gender-disambiguated cases such as *Betty punished Roger because he didn't do the dishes*, implicit causality was deemed to be irrelevant, this because "a coherent representation can be set up without considering which participant in an event of punishing is *usually* the cause" (p. 538). To explain the results within an incremental clausal integration framework, the latter assumption would need to be abandoned.

As discussed before, the findings were predicted by the immediate focusing account of how implicit causality affects sentence comprehension (Garnham *et al.*, 1996; Greene & McKoon, 1995; McKoon *et al.*, 1993), although I should add that, as shown in Experiment 8, the use of implicit causality information crucially depends on the presence of a backward causal connective like *because.* According to the immediate focusing model, the implicit causality afforded by *David praised Linda because* changes the availability of the two discourse entities involved, independent of any potentially upcoming pronouns. In fact, in most characterizations of immediate focusing (Garnham *et al.*, 1996;

McKoon *et al.*, 1993; but see Long & De Ley, 2000), the consequences for later pronoun resolution are deeply coincidental: implicit causality happens to highlight certain discourse entities at the expense of others as the system incrementally updates its model of the discourse, and later pronouns happen to be sensitive to the availability of candidate referents (see Gerrig & McKoon, 1998, for a similar view).

Immediate focusing has been characterized as 'proactive' (Garnham, 2001) because in this mechanism, and in contrast to late (as well as the incremental) clausal integration, implicit causality has an effect on the discourse model before the assumed moment of 'retroactive' integration. However, early effects of implicit causality are also compatible with a much more 'forward-looking' mechanism. In *David praised Linda because*, the meaning of *praise* in combination with *because* supplies information about whose behavior or state is the more likely immediate cause of the event at hand. As such, it can also support specific *expectations or predictions* about how the unfolding utterance and wider discourse might continue. In particular, comprehenders might anticipate that the *because*-clause is going to provide information about Linda, perhaps even actually refer to Linda. On the basis of research with goal- and source-oriented verbs of transfer (*to receive, to send*), Arnold (2001) proposed that readers and listeners continuously estimate the likelihood that a referent will be continued in the upcoming discourse. In addition, experiments with head-mounted eye tracking and ERPs suggest that people can use the meaning of verbs like *ate* or *told* to anticipate specific upcoming verb arguments, such as those that refer to edible things (Altmann & Kamide, 1999; Kamide *et al.*, 2003) or animate entities (Nieuwland & Van Berkum, 2006b). I see no deep reason why the semantics of *receive*, *ate* and *told* would support such anticipation, whereas the constraining meaning of a verb like *praise* in combination with *because* would not. In my study, predictions about who will soon be talked about and/or referred to would be contradicted by the bias-inconsistent pronoun, and might as such underlie the observed reading time delays.[11]

[11] Exploring the potential of anticipatory mechanisms somewhat further, I note that a fragment like *David praised Linda because* might in fact also lead people to predict specific upcoming *words*. Research with gender-inflected languages has recently shown that listeners and readers can use sentential as well as discourse context to rapidly make such lexical predictions, including, for nouns, their lexically stored gender (Otten & Van Berkum, 2004; Van Berkum, Brown, Zwitserlood, Kooijman & Hagoort, 2005; Wicha, Moreno & Kutas, 2004). In view of these findings, it is not inconceivable that a

The difference between implicit causality exerting its influence via immediate focusing or via the anticipation of what or whom will be talked about next is a subtle one, because focus and anticipation might be deeply related (see Long & De Ley, 2000, for exactly this position). However, whereas immediate focusing can *in principle* be viewed as a 'blind' incremental mechanism that simply modulates the availability of certain discourse entities without looking beyond the linguistic input processed so far, the anticipation of a specific upcoming topic or referent is *by definition* a predictive, forward-looking mechanism. It is for this reason that I distinguish these two types of explanations for the impact of implicit causality on language comprehension. At the same time, I sympathize with an account in which the highlighting of particular discourse entities is inextricably intertwined with – and perhaps in some sense even equivalent to – expectations about what or whom will be talked about next (e.g. Arnold 2001).

In a recent follow-up study of Experiment 6 and 7, Van Berkum, Koornneef, Otten and Nieuwland (2007) conducted a written-language ERP study to examine whether early implicit causality effects arise because of *incremental clausal integration*, *immediate focusing*, or truly 'proactive' *anticipation*. In addition to the 40 Dutch stories of Experiment 6 and 7, 40 more stories were constructed around the same verbs, using the same procedure and criteria as for the original set. Hence, note that the critical sentences were of the *Linda praised David because he*, or *David praised Linda because he* type, and did not include connectives other than *because*. As depicted in Figure 23, the results revealed that, relative to their bias-consistent controls, bias-inconsistent pronouns elicited a significant positive deflection at about 400-700 ms after pronoun onset with a maximum over centro-posterior scalp sites. Because of its polarity, timing, shape and scalp distribution Van Berkum *et al.* (2007) took this to be a P600 effect. This observation tells us a number of things. First of all, across three experimental paradigms with very different measures – ERPs, button-press self-paced reading times (Experiment 6), and eye-fixation patterns (Experiment 7 and 8) – the evidence unequivocally shows that implicit causality supplied by verbs as *praise* in combination with the backward connective *because*, can be brought to bear on

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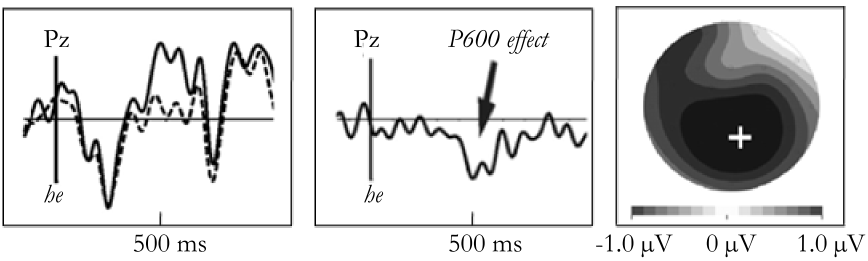
fragment like *David praised Linda because* allowed the readers to not only anticipate upcoming reference to Linda, but to actually also anticipate the specific pronoun *she*. To the extent that they do so, *he* would disconfirm the lexical prediction and cause readers to slow down.

comprehension very rapidly, and as such rule out clausal integration as the sole origin of the effects typically observed in implicit causality studies. Furthermore, it also sheds some light on the specifics of the underlying mechanism, i.e. it may help us to decide between the incremental integration, immediate focusing or 'proactive' anticipation account.

Figure 23. The ERP results of Van Berkum *et al.* (2007). *Left.* Grand average waveforms at the Pz electrode site (solid = consistent pronoun; dotted = inconsistent pronoun). Negative voltage is up, and onset of the pronoun is at 0 ms. *Middle.* Difference wave for inconsistent-consistent pronoun revealing a P600 effect. *Right.* Scalp distribution of the P600 effect in the 400-700 ms time window.



As mentioned previously, the P600 is most commonly associated with syntactic problems of language comprehension (e.g. Hagoort *et al.* 1999). So, going beyond the behavioral results of Experiment 6 and 7, the P600 effect in the ERP study suggests that readers perceive the bias-inconsistent pronoun as a "syntactic dead end" (Van Berkum *et al.*, 2007, p. 162) and are apparently "prepared to put the blame on syntax" (p. 167). This indicates that implicit causality information, emerging as a function of verb meaning and the connective *because*, may not be a subtle cue at all, but in fact relatively strong, at least strong enough to outweigh a clear morphosyntactic gender cue. In my opinion the most natural explanation for this strong commitment is that readers use implicit causality in a sentence fragment like *David praised Linda because* to anticipate that the remainder of the sentence will provide some information about *Linda*. Consequently, if a gender-marked pronoun such as *he* fails to refer to the preferred antecedent *Linda*, readers initially interpret the pronoun as having the 'wrong' morphosyntactic gender which results in a P600 effect. Hence, in this view the ERP results are most easily explained by assuming a 'proactive' anticipation mechanism. However, as discussed previously, the difference between immediate focusing and anticipation is a subtle one and in fact *focus on* may be identical to *anticipation* at some abstract level. For this reason, I see no obvious motivation to choose between either account and simply restate that I sympathize with both.

Does the above imply that incremental integration should be ruled out as a plausible account of online implicit causality effects? With respect to this question, it should be noted that the line of reasoning as presented above crucially depends on the assumption that the P600 effect specifically reflects a syntactic problem. In that case the most obvious explanation is to assume a 'proactive' focus or anticipation mechanism. However, although most researchers agree that the P600 contains a syntactic component, some studies have shown that the P600 may not exclusively be connected to syntactic operations alone, but could also be indicative of general integration and revision processes and, furthermore, can possibly be seperated into various subcomponents (cf. Friederici, 1999, 2002). Moreover, P600-like effects have also been observed in instances where an N400 effect would have been more obvious (e.g. Kim & Osterhout, 2005; Kolk, Chwilla, Van Herten & Oor, 2003; Kuperberg, Sitnikova, Caplan & Holcomb, 2003; Nieuwland & Van Berkum, 2005; Van Herten, Kolk & Chwilla, 2005).[12] In the context of our present discussion this would imply that, even though the observed P600 effect is consistent with 'proactive' accounts of processing, it does not completely rule out incremental integration, because the P600 elicited by bias-inconsistent pronouns could potentially reflect integration problems as well.

In all, although we have certainly come closer to an understanding of *when* and *how* implicit causality information influences sentence comprehension in general and pronoun resolution in particular, some issues are left open for future research, especially whether or not readers focus on the biased antecedent before the critical pronoun comes along. With respect to the latter, the *visual world paradigm* seems to be a very promising way of tracking focus change over time. In a typical visual world experiment participants listen to sentences or a short discourse while looking at a semi-realistic scene on a computer screen and, crucially, their eye movements are monitored simultaneously (cf. Altmann & Kamide, 1999; Arnold *et al.*, 2000; Cooper, 1974; Tanenhaus,

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[12] Note that the results could easily have been different. For instance, the inconsistent pronoun *he* in a sentence fragment like *David praised Linda because he* could have elicited an N400 (cf. Bentin, McCarthy & Wood, 1985; Holcomb & Neville, 1990; Kutas & Hillyard, 1980, 1983; Kutas & Van Petten, 1994; Osterhout & Holcomb, 1995), because it negates the *meaning-based* bias towards Linda.

Spivey-Knowlton, Eberhard & Sedivy, 1996). The method has been shown to be sensitive to ongoing language processes, in particular to pronoun resolution processes (e.g. Arnold *et al.*, 2000), and has the advantage that it provides some clues about what happens *prior* to a critical word or sentence region. In other words, adopting this paradigm may shed some light on the anticipatory mechanisms which are potentially at work in the rapid use of implicit causality information in language comprehension.

Recently, researchers have in fact begun to exploit the visual world paradigm to study the above issue (e.g. Cozijn, Commandeur, Vonk & Noordman, in preparation; Pyykkönen & Järvikivi, submitted for publication), which may ultimately allow us to embrace proactive focusing or anticipation as the most plausible explanation and rule out incremental integration (or vice versa). However, pending relevant data, I reemphasize the puzzle posed by any incremental clausal integration account (cf. Garnham *et al.*, 1996): why use a cue about who *might* be talked about (i.e. implicit causality cue) when a definitive cue about who *is* talked about is available (i.e. gender cue)? Garnham and colleagues resolved the puzzle by assuming that implicit causality would only impact on the resolution of a morphosyntactically ambiguous pronoun, an assumption that my findings now allow us to reject. If incremental clausal integration is modeled in terms of simultaneous constraint satisfaction (e.g. MacDonald *et al.*, 1994; Tanenhaus & Trueswell, 1995; Trueswell & Tanenhaus, 1994), the puzzle could be solved by assuming that the latter cue, although formally overruled, is strong enough to delay the system in converging onto a stable representation of the sentence up to that point. Another way out might be to assume that when a pronoun is encountered, implicit causality is actually used to look for its referent *before* the system considers the gender of the pronoun. Note, however, that whereas within an incremental clausal integration account, some additional assumptions are needed to make sense of implicit causality effects on gender-disambiguated pronouns, the puzzle is solved for free if anticipatory or immediate focusing mechanisms are at work. The reason is that in both mechanisms, implicit causality information is used *before* the pronoun comes along, i.e. before more definitive evidence on causality has become available.

5.6.3. Implicit causality, accessibility and the POB model

Recall that the goal of this chapter was twofold. First, an attempt was made to contribute to a hotly debated issue in the psycholinguistic literature, namely *when* and *how* implicit causality affects language comprehension, specifically pronoun resolution. Based on my behavioral results and the ERP findings of Van Berkum *et al.* (2007), I argued that the most plausible and parsimonious approach is to assume that verb-based implicit causality in combination with further constraining information, most notably the semantics of connectives, influences pronoun resolution in a 'proactive' way. That is, implicit causality information immediately highlights a particular discourse entity at the expense of others, or in fact, encourages readers and listeners to anticipate a specific upcoming referent. Either way, both approaches can be reconciled with the idea that implicit causality somehow alters the accessibility level of the discourse characters involved and as such affects the ease of subsequent pronoun induced referential processes.

Furthermore and by abstracting away from the particulars of implicit causality, the results are also highly interesting in the light of the POB model. I stated in the beginning of this chapter that the algorithms of the syntactic and semantic phase, namely A-Chain formation and variable binding respectively, are well-defined via structure-based concepts such as coargumenthood and c-command. On the other hand, the coreference algorithm of the discourse phase remained rather underdetermined and a second goal of this chapter was therefore to provide insight into the time-course and architecture of this phase. With respect to the latter the findings discussed in the present chapter tell us a number of things. First, the very rapid effects of implicit causality information on pronoun resolution imply that discourse cues are used quickly while establishing anaphoric dependencies. In fact, the ERP findings of Van Berkum *et al.* (2007) allow me to (tentatively) present a more detailed picture of the time-course of anaphora resolution processes. That is, based on the assumption that pragmatic information only affects the discourse phase of the POB model, the P600 in the ERP study suggests that this phase takes place at the utmost some 600 ms after a reader or listener encounters a pronominal and, hence, a complete processing cycle of the POB model, consisting of a syntactic, semantic and discourse step, does not require more than a few hundreds of milliseconds. Furthermore, since discourse-based pronoun resolution (i.e. coreference) seems to be closely tied to concepts such as *rapid focus shift* and *anticipation*, the architecture of the discourse module appears to be highly dynamic. That is, numerous pragmatic constraints like first mention, distance (between the pronoun and antecedent), and implicit causality jointly determine people's referential focus and expectations, and more importantly, this focus (and the predictions made from there) can change rapidly and radically with every new input of an unfolding sentence.

In addition, the results of the present chapter are also interesting with respect to Friederici's neurocognitive model on general language comprehension (2002). Recall from the previous chapter that, building on the findings of a range of neuro-imaging studies (i.e. ERP, MEG, PET and fMRI studies), this model addresses the time course of language comprehension by assuming three core phases, i.e. very similar to the POB model. Although the three phases of the two models are not completely identical some important parallels can be drawn, most notably for the first phase, which in both accounts is tightly knotted to syntactic structure building. Furthermore, both models propose that semantically-based computations take place in the second phase, but for now my interest lies in the third phase. According to Friederici the third and final phase is concerned with the integration of information established in prior phases. If the information in the first and second phase is consistent, interpretation has been accomplished, but, if there is a (syntactic) mismatch between the information in the two earlier phases, processes of repair and re-analysis are initiated. Interestingly, Friederici assumes that the latter is indexed by a P600 and as such strengthens the idea of Van Berkum *et al.* (2007) that the ERP signature in their implicit causality study suggests that readers initially perceive an implicit causality bias-inconsistent pronoun as having the 'wrong' morphosyntactic gender and consequently engage in processes of re-analysis to repair the initial interpretation. Furthermore, based on the assumptions that (i) the discourse phase of the POB model and the final phase of the neurocognitive model closely resemble each other – in the sense that higher level (less automatic) language processes take place – and (ii) that the final phase is initiated some 500 ms after stimulus onset (e.g. Friederici, 2002; Friederici & Kotz, 2003) another interesting conclusion follows. Namely, regardless of whether the P600 is indicative of a syntactic mismatch, integration problem, or processes of re-analysis and repair, the observation that implicit causality information does not elicit an ERP signature until some 600 ms after pronoun onset supports the hypothesis that implicit causality information influences anaphora resolution in the discourse phase only. So, even though implicit causality – as well as other pragmatic cues such as first mention and antecedent distance – plausibly affects pronominal resolution by proactive means, the actual effect of focusing or anticipation only becomes visible in the third and final phase of the POB model, the phase in which discourse information is added to the previously gathered structural information.

Obviously, the latter conclusion remains rather speculative, mainly due to the non-specific interpretation of the P600 effect, but it does however raise a very interesting question. Namely, can we maintain a serial order of processing as proposed in the POB model and Friederici's neurocognitive model, and at the same time assume that highly dynamic and even predictive (discourse) mechanisms are at work as well? This topic goes beyond the scope of this dissertation, but I will briefly return to the issue in the final chapter (see Paragraph 6.4.2). For the moment I state, without argumentation, that while some may feel that the notion of sequentiality cannot be reconciled with dynamic anticipatory mechanisms, the outcome of my thoughts on the matter in the final chapter suggests that the two are not necessarily incompatible.

CHAPTER 6

Overview, general conclusion and beyond

6.1. Overview of the dissertation

The thread throughout this dissertation has been to characterize the interplay between structure and pragmatics (i.e. discourse information) in the course of real time anaphora comprehension. In the first part (Chapter 2, 3 & 4) the focus was on the effects of structure by thoroughly examining the predictions of a specific linguistic account – the *Primitives of Binding* (POB) model – on how structural constraints determine the use of different anaphoric expressions and, furthermore, the processing resources the human parser has to allocate in order to connect them to their antecedents. In the second part (Chapter 5) I concentrated on the influence of pragmatics by dissecting when and how a hotly debated verb-based implicit causality constraint affects pronominal resolution.

6.1.1. Part 1: Evaluating the POB model

6.1.1.1. Theoretical background

In linguistics the restrictions of sentential structure on the use of different anaphoric expressions has traditionally been described through Principles A, B and C of binding theory (Chomsky, 1981). As discussed more thoroughly in Chapter 1, one of the crucial implications of Principles A and B is that reflexives and pronouns should appear in a complementary distribution. We have seen that, even though the latter holds in many canonical sentential structures (see ex. (1)), there are some notable exceptions as exemplified in (2)-(4) in which both a reflexive and pronominal yield a grammatically acceptable structure.

(1) *Peter$_i$* hurt *himself$_i$*/ **him$_i$*.

(2) *Peter*$_i$ saw a gun near *himself*$_i$/*him*$_i$.
(3) *Peter*$_i$ said that the queen invited Mary and *himself*$_i$/*him*$_i$ to tea.
(4) *John*$_i$ said that there was a picture of *himself*$_i$/*him*$_i$ in the post office.

The many violations of the complementarity principle in natural language pose a real problem for binding theory in its classical form and have led other researchers to re-examine Chomsky's claims. As observed by Reinhart and Reuland (1991, 1993; Pollard & Sag, 1992, 1994), for example, reflexives and pronominals are only interchangeable if the anaphoric element and antecedent are not coarguments of the same predicate. They proposed that 'true' *coargument reflexives* can be interpreted on syntactic grounds alone, yet the proper antecedent for *logophoric reflexives* such as in (2)-(4) require the application of extra-syntactic (i.e. discourse-like) processing mechanisms.

Building partly on the proposal of Reinhart and Reuland, and partly on concepts of the *minimalist program* (Chomsky, 1995), Reuland (2001) presented the outline for the POB framework. The architecture of the POB model includes three different modules: a syntactic, semantic and discourse module. The syntactic module establishes dependencies between coargument reflexives and their antecedents by means of A-Chain formation. For the interpretation of pronominals and logophoric reflexives on the other hand, two algorithms are available. They are either bound in the semantic module or co-valued in the discourse module.

6.1.1.2. The economy principle and its predictions

The essence of the POB model can be described in terms of modularity, sequentiality and economy. Modularity refers to the hypothesis that the syntactic, semantic and discourse route should be regarded as autonomous mechanisms, i.e. they are *domain specific* and functionally *encapsulated* (cf. Fodor, 1983). Furthermore, the POB model also assumes an inherent sequentiality: syntactic operations precede semantic operations, which themselves are initiated before discourse computations. However, in this dissertation I initially focused on the third core feature, economy. Within the POB framework economy reflects the idea that the processing resources needed to establish syntactic, semantic and discourse anaphoric dependencies, increase as a function of how many cross-modular steps have to be made, resulting in a hierarchy in which syntactic dependencies are more economic than semantic dependencies and the latter in turn require less resources than discourse dependencies. The economy principle makes some clear predictions with respect to behavioral measures of real time anaphora resolution processes. In Chapter 2 and 3 I examined the following three predictions in four eye-tracking experiments in order to establish whether the POB model is not only a comprehensive linguistic framework, but has psychological validity as well.

1. The construction of syntactic anaphoric dependencies requires less effort than the construction of semantic and discourse anaphoric dependencies.
2. The construction of semantic anaphoric dependencies requires less effort than the construction of discourse anaphoric dependencies.
3. If a pronominal is ambiguous between a semantic or discourse interpretation, the former is (initially) preferred, since it reflects the most economical option.

6.1.1.3. Summary of Chapter 2

In Chapter 2, I examined whether coargument reflexives require fewer resources to resolve than logophors and hence tested the first prediction of the economy principle. Previous online studies on the matter reported results that were consistent with this prediction (Burkhardt, 2005; Piñango *et al.*, 2001). However, since these studies made use of a cross modal interference design in which participants performed two tasks simultaneously, I raised the concern that this may not be the most ecologically valid way of measuring language processes online. In order to overcome this potential problem the Dutch reflexive *zich* 'himself/herself' was presented in two different sentential structures, but this time by using the less obtrusive eye-tracking methodology as a behavioral measure of processing load. In one condition *zich* was a coargument reflexive and could only be resolved at the syntactic level through A-Chain formation, whereas in the other condition *zich* was a logophor and could only be interpreted extra-syntactically (either through variable binding or coreference). The results showed that, relative to a coargument reflexive, readers clearly spent more time processing a logophor. Hence, across methodologies (and languages) the online evidence supports the first prediction of the economy hierarchy, i.e. syntactic anaphoric dependencies impose fewer processing costs on the comprehension system than extra-syntactic anaphoric dependencies.

6.1.1.4. Summary of Chapter 3

In Chapter 3 we shifted our attention from reflexives to pronominals. A crucial assumption in the POB model is that a pronoun can be connected to its antecedent either through binding in the semantic module or through a process of coreference in the discourse module. The former mechanism is thought to be more economic since less cross-modular processing is involved and consequently a bound pronominal should elicit shorter reading times than a coreferential pronominal. This second prediction of the economy principle was tested in two eye-tracking experiments (Experiment 4 and 5), which, in fact, yielded mixed results. In Experiment 5 the prediction was borne out as indicated by a processing advantage for pronouns with c-commanding antecedents, whereas Experiment 4 showed the opposite: longer reading times for bound pronouns than for coreferential pronouns.

In Experiment 5, I also explored a possible explanation for the unexpected finding of Experiment 4, namely Burkhardt's (2005) complexity hierarchy for antecedents. In this approach it is assumed that pronouns that depend on 'light quantifiers' like *everyone* require less processing resources than pronouns referring to referential antecedents like *the soldier*. Furthermore, the latter type of pronouns require less processing resources than pronouns that refer to a 'referential quantifier' like *every soldier*. In Experiment 4, the binding antecedents were referential quantifiers (e.g. *every worker*) and the coreferential antecedents plain proper names (e.g. *Paul*). Hence, if Burkhardt's complexity hierarchy is correct, this could explain why in Experiment 4 bound-variable dependencies elicited a higher processing load than coreferential dependencies. However, no complexity hierarchy for antecedents was observed in Experiment 5: light quantifiers, referential quantifiers and plain referential antecedents elicited similar processing costs for the dependent pronoun.

To account for these somewhat puzzling results, I adopted a more liberal version of Burkhardt's complexity hierarchy. Namely, instead of assuming a fixed ranking based on quantification, I merely proposed that the intrinsic costs (i.e. the processing costs that emerge *within* a module) of binding depend on the complexity of the semantic representation, and similarly, the intrinsic costs of coreference on the complexity of the wider discourse. Consequently, in some specific circumstances the binding process as a whole may induce a higher processing load than coreference, because the summation of intrinsic and cross-modular costs comes out higher.

On the other hand, the results for the third prediction, stating that if a pronoun is ambiguous between a bound and coreferential interpretation the former should initially be preferred, revealed a very consistent pattern. In two eye-tracking experiments (Experiment 3 and 4) examining very different ambiguous structures, readers exhibited a clear preference for bound dependencies, irrespective of the specific sentential structure. In Experiment 3 this general tendency reliably emerged in the course of comprehending ellipsis sentences such as *Lisa thinks that her pimped room has a touch of class, but Anouk does not.* When the context prior to the critical ellipsis was biased towards the non-preferred coreferential (i.e. strict) reading, meaning that 'Anouk is thinking about Lisa's room and not that 'Anouk is thinking about her own room' (the sloppy or bound interpretation), participants slowed down in the ellipsis region of the second conjunct and in addition spent more time re-analysing the biasing context of the preceding sentence. Moreover, the latter results were replicated for *only*-structures such as *Only Lisa thinks that her pimped room has a touch of class.* This type of sentence displays a similar sloppy-strict ambiguity as observed for ellipses, since the sentence can either denote that 'people other than Lisa think that their own room does not have a touch of class' (sloppy interpretation) or alternatively that 'they think that Lisa's room does not have a touch of class' (strict interpretation). Again the results revealed signs of re-analysis when the context prior to the *only*-structure was biased towards the strict interpretation, suggesting that the claim made by Frazier and Clifton (2000) that the binding preference does not generalize to structures other than ellipses, cannot be correct.

In fact, Experiment 4 offered additional evidence in favour of a general binding preference, because in quantificational contexts – very different from ellipses and *only*-structures – readers initially preferred to bind an ambiguous pronoun as well. Furthermore, the results of Experiment 4 suggested we should also dispense with another limitation of the binding preference, again proposed by Frazier and Clifton (2000). They argued that the preference crucially depends on the 'anaphoric vehicle', that is, it holds for possessive pronouns like *his* but not for phrasal pronouns like *he.* Since phrasal pronouns were used in Experiment 4 and a significant binding preference was still observed, this assumption needs to be abandoned as well.

6.1.1.5. Summary of Chapter 4

Based on the results of Chapter 2 and 3, I concluded that in general the economy predictions of the POB model were borne out. We were, on the other hand, left with the puzzle of why binding dependencies are clearly preferred in case of ambiguity (prediction 3), yet not necessarily more economic than coreferential dependencies in unambiguous situations (prediction 2). In order to resolve the puzzle I distinguished three versions of the POB model that differed in how strictly they incorporated the notion economy underlying the syntax-semantics-discourse processing hierarchy. In the strongest hypothetical version of the POB model the processing advantage for bound dependencies emerges for three reasons, namely (i) because binding is intrinsically more economic than coreference, (ii) because binding requires fewer cross-modular processing steps and (iii) because bound dependencies are initiated before coreferential dependencies, due to the sequential architecture of the language system. It seemed that this rather strong version of the POB model could not be correct, since the results did not permit the conclusion that the overall processing costs of coreferential dependencies are always higher than the overall processing costs of bound dependencies. My results were, however, compatible with a slightly weakened version in which I dispensed with the first assumption – the assumption that binding is always intrinsically more economic than coreference – yet maintained the idea that the economy hierarchy can be defined in terms of cross-modular processing costs. More specifically, by accentuating the distinction between the processing costs emerging from computations *between* modules and *within* modules, I proposed that it is not inconceivable that under specific circumstances the intrinsic costs of binding are higher than the intrinsic costs of coreference, thereby masking the definite cross-modular advantage of bound pronominals.

Regardless of whether the above line of reasoning turns out to be correct, I reemphasize that the results of all the experiments reported in this dissertation were completely compatible with the weakest real time version of the POB model, namely, one in which the syntax-semantics-discourse hierarchy emerges as a result of an inherent serial order of processing. To substantiate this claim further, the scope of the evaluation was expanded in the remainder of Chapter 4. I provided an overview of studies that complemented the sequentiality hypothesis. For instance, dual task experiments (Nicol & Swinney, 1989) and eye-tracking experiments (Sturt, 2003a) provided strong evidence in favor of a syntax-first approach like the POB model. In another study, Badecker and Straub (2002) argued explicitly against such an account. However, a closer examination of the study revealed that the results were mixed at least. Moreover, it was argued that because Badecker and Straub adopted the self-paced reading methodology, which seems inferior to eye-tracking with regard to its temporal resolution, we should be hesitant to take their results as strong evidence against syntax-first proposals on language comprehension.

Subsequently, the hypothesis on modularity, the third core feature of the POB model, was addressed. I discussed three ERP studies that showed that coargument reflexives and logophors are resolved by qualitatively different mechanisms, most likely a syntactic mechanism in the case of the former and a discourse or semantic mechanism in the case of the latter (Burkhardt, 2005; Harris *et al.*, 2000; Osterhout & Mobley, 1995). These results were consistent with Reuland's (2003) correspondence hypothesis in which "differences between major modules of the grammatical system correspond with differences in processes at the neural level and vice versa" (p.4; cf. Jackendoff, 1997). In other words, the functional dissociation between syntactic and extra-syntactic anaphoric resolution mechanisms is also reflected at the neurocognitive level, the human brain designates different cortical networks to deal with these different types of dependencies.

In all, my results as well as those of others suggested that the three core features of the POB model (i.e. economy, sequentiality and modularity) are reflected in behavioral (and neuro-cognitive) measures of language comprehension. These observations led me to propose that the POB model is not only a comprehensive linguistic account of how sentential structure constrains the legitimate use of specific anaphoric elements, but in addition elucidates issues in online language comprehension. I further illustrated the latter by comparing the online version of the POB model to a number of other proposals on anaphora resolution, most notably the *defeasible filter* (Sturt, 2003a) and *syntactic prominence* model (Gordon & Hendrick, 1998), and showed that the POB model combines the most important features of these influential accounts in a very natural way and, more importantly, dispenses with some crucial weaknesses.

6.1.2. Part 2: Exploring the discourse phase

Whereas the objective of the first part of the dissertation was to elucidate how (syntactic) structure affects the course of real time anaphora resolution, the second part (Chapter 5) focused on the influence of pragmatic constraints. I assumed that pragmatic information enters the comprehension process in the discourse phase of the POB model, yet noted that, relative to the well-defined A-Chain and variable binding algorithms, the discourse algorithm (i.e. coreference) remained rather underdetermined. Since the ultimate goal is to present a model with the ability to illuminate every facet of anaphora resolution, my aim was to collect more information about the nature of the discourse phase by keeping track of the use of verb-based implicit causality information in the course of pronoun resolution.

6.1.2.1. Summary of Chapter 5

Implicit causality is a property of some interpersonal verbs in which one or the other of the verb's arguments is implicated as the underlying cause of the action or attitude (Au, 1986; Brown & Fish, 1983; Garvey & Caramazza, 1974; Garvey *et al.*, 1975; Greene & McKoon, 1995; Long & De Ley, 2000; Stewart *et al.*, 2000). For example, people normally ascribe the underlying cause of the *praising*-event in a sentence fragment such as *David praised Linda because* to the object NP and are consequently inclined to continue the sentence by providing some information about *Linda* (e.g. *she had been able to complete the difficult assignment with very little help*). In Chapter 5, I examined *when* and *how* this pragmatic implicit causality cue is brought to bear in the course of anaphora resolution. In the first two experiments (one self-paced reading and one eye-tracking experiment) I concentrated on the *when*-issue by comparing the reading times for pronouns that were either consistent with the bias of a preceding implicit causality verb (e.g. *Linda praised David because he*) or inconsistent (e.g. *David praised Linda because he*). Both experiments revealed that the effect of implicit causality manifests itself very rapidly, namely at or immediately following the critical pronoun. In a second eye-tracking experiment (Experiment 8) the focus was shifted to the *how*-issue by varying whether the connective *because*, *but* or *and* joined the two clauses of the critical sentence. The results for the connective *because* replicated the findings of the previous two experiments, however, the significant difference between inconsistent and consistent pronouns disappeared completely if the connective *because* was replaced with *but* or *and*.

These results were discussed in the light of the two classical approaches that have emerged in the psycholinguistic literature, the *immediate focusing* and *clausal integration* account. The clausal integration account (e.g. Garnham *et al.*, 1996; Stewart *et al.*, 2000), predicts that verb-based implicit causality information is used relatively late in the course of comprehension, namely at or towards the end of the second clause. Proponents of the immediate focusing account (e.g. Greene & McKoon, 1995; Long & De Ley, 2000; McKoon *et al.*, 1993), on the other hand, have suggested that implicit causality information can be brought to bear on comprehension much more rapidly. In this account, implicit causality is assumed to bring one of the persons mentioned in the first clause into focus, meaning that the relevant discourse entity becomes more *accessible* for subsequent reference at the expense of the other potential antecedent. The results were consistent with the immediate focusing account and ruled out clausal integration as the sole origin of the typical implicit causality effects in sentence comprehension. However, based on the findings of Experiment 8, in which I varied the connective type, as well as on the findings of other researchers (e.g. Ehrlich, 1980; McKoon *et al.*, 1993; Stevenson *et al.*, 1994), I concluded that the meaning of an implicit causality verb does not of itself make people focus on the cause of an event, but rather that an interaction between the meaning of the verb and connective has this effect.

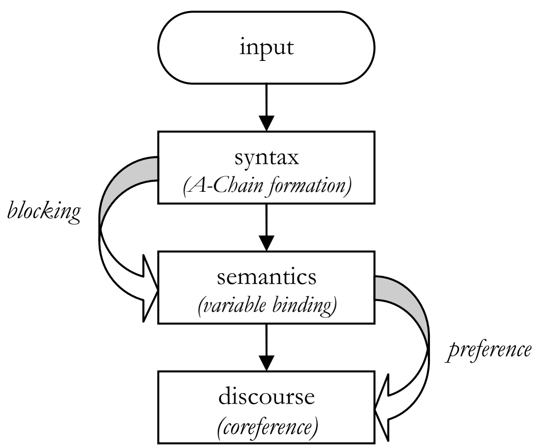
The findings of Chapter 5 were thus consistent with a dynamic view of focusing in which the focus changes constantly during the course of comprehension as a function of each new input (cf. Arnold, 2001; Stevenson *et al.*, 2000). In fact, immediate focusing has been characterized as 'proactive' (Garnham, 2001) because it affects the accessibility of the antecedents essentially *before* a pronoun comes along. However, it was further noted that the early effects of implicit causality and especially the results of a recent ERP follow-up study (Van Berkum *et al.*, 2007) are also compatible with a much more 'forward-looking' mechanism. That is, the meaning of an implicit causality verb in combination with a connective such as *because* could also support specific expectations or predictions about how the unfolding utterance and wider discourse might continue. In conclusion, the discourse module of the POB model could be characterized as a fast-acting and highly dynamic anticipatory mechanism in which numerous 'bits of meaning' co-determine the outcome of the coreference process.

6.2. General conclusion

Most researchers agree that successfully linking an anaphoric element to its antecedent critically depends on the rapid integration of both structural and pragmatic information. In this dissertation, I have tried to decipher the nature of these different sources and, furthermore, made an attempt to illuminate the time course of their use. The effects of syntactic structure on anaphora resolution were addressed by means of evaluating the psychological validity of the POB model. The influence of pragmatic or discourse factors was examined by tracking when and how verb-based implicit causality information is brought to bear in the course of pronominal resolution.

On the basis of my self-paced reading and eye-tracking results, as well as the data of other studies – ranging from behavioral measures of the healthy, developing and damaged brain (e.g. Burkhardt, 2005; Burkhardt *et al.*, 2008; Fiengo & May, 1994; Foley *et al.*, 1997; Frazier & Clifton, 2000; Guo *et al.*, 1996; Nicol & Swinney, 1989; Piñango *et al.*, 2001; Sturt, 2003a; Vasić, 2006) to neuro-imaging measures (e.g. Burkhardt, 2005; Harris *et al.*, 2000) – I presented the outline of a serial architecture, consisting of three distinct processing phases (see Figure 24).

Figure 24. The POB model



In the syntactic phase the parser computes local dependencies in terms of A-Chain formation. This means, for instance, that reflexives like English *himself* and Dutch *zich* and *zichzelf* are linked to their antecedent, *if* the two constitute coarguments of one and the same predicate. If not, the reflexive may still be interpretable, but these so-called logophoric reflexives behave more or less like pronominals and depend instead on variable binding or coreference for their value. The latter two algorithms are executed in the semantic and discourse phase respectively. More specifically, in the second phase of a POB processing cycle the semantic module may bind pronominals (or logophors), as long as the anaphoric element is in a c-command configuration with its antecedent. If this structural relation is absent the human parser will be forced to rely on coreference in order to establish an anaphoric dependency. It should be noted, however, that even though the semantic phase precedes the discourse phase, the eventual choice between binding or coreference is intrinsically free, as indicated by the fact that people can obtain both a sloppy (i.e. bound) and strict (i.e. coreferential) reading for VP-ellipses, for instance.

The POB model describes first and foremost how linguistic structure affects the way in which anaphoric elements are used and processed in natural language. In addition, it also specifies *when* structural and discourse information is brought to bear on anaphora comprehension: structural information is used in the first two phases which implies that the computations enabling the detection of coargumenthood and c-command are performed before discourse information affects the comprehension process. However, the latter should by no means be taken to suggest that pragmatic cues are used very late in the comprehension process, or that the discourse phase is slow in any other sense. On the contrary, my studies on the use of verb-based implicit causality information clearly showed that such a subtle pragmatic cue is used within only half a second (600ms at the utmost) of encountering a pronominal. Or framed in more general terms, the language system appears to constantly update the information within the discourse module as soon as each new input of an unfolding sentence is processed, which suggests an underlying architecture which is both highly incremental and dynamic.

Throughout this dissertation I have used terms like *accessibility* and *focus* to denote the ever-changing status of story characters within the mental representation of an unfolding discourse. Over the last decades the notion of accessibility has become a well-known concept among both linguists (e.g. Ariel, 2001, 2004) and psycholinguists (e.g. Arnold *et al.*, 2000; Sanders & Gernsbacher, 2004 and many others), perhaps because it can be framed in terms of mental activation and as such easily appeals to one's imagination. That is, intuitively it makes sense that the activation level of discourse entities increases or decreases on the basis of every new piece of information entering the language comprehension system. Furthermore, accessibility lumps together a miscellaneous set of discourse constraints – including for instance first mention, distance (between the antecedent and pronominal) and implicit causality – which are known to affect the outcome of the pronoun resolution process. However, this generalizing property of the accessibility approach also exposes an inherent weakness. Often the term accessibility seems to function essentially as a 'straw man': it merely redefines the debate on how discourse factors may influence anaphora resolution in terms of activation and discourse prominence, but has no genuine explanatory power. Nevertheless, accessibility and focus remain useful tools in the debate on real time anaphora resolution processes, primarily because they allow for proactive processing. The implicit causality studies of Chapter 5 and especially a more recent ERP follow-up study (Van Berkum *et al.*, 2007) suggested that implicit causality may have its effect on pronominal resolution essentially before a pronoun comes along. I reemphasize that this seemingly paradoxical conclusion is easily explained in an accessibility-based framework in which implicit causality (in combination with other discourse cues) immediately highlights one particular discourse character, i.e. irrespective of whether the remainder of the discourse contains a pronominal.

6.3. Future research

Throughout this dissertation we have seen that the POB model accounts for a broad range of linguistic and experimental observations. Nevertheless, a number of important questions relating to all three core features of the model are left open for future research. Within the domain of economy, for example, future studies should seek additional evidence in support of the hypothesis that bound dependencies require less (cross-modular) processing than coreferential dependencies, since the results were somewhat mixed with respect to this issue. Furthermore, to the best of my knowledge the difference between binding and coreference has been studied solely by obtaining behavioral measures of language comprehension, which in the long run may not be specific enough to answer all the questions pertaining to anaphora resolution. In particular, answering questions on modularity and sequentiality requires supplementary measures, indicative of both the *timing* and *identity* of the different subcomponents of the language processing system (but see

Boland, 2004, for some interesting thoughts on how the eye-tracking methodology can be of use here as well).

Almost thirty years of ERP research in psycholinguistics have shown that measuring neural activation at the human scalp while the brain is involved in specific language comprehension tasks may satisfy these two needs (and allows for additional inferences, see Van Berkum, 2004, for a review). In the previous chapters, I discussed some studies suggesting that syntactic anaphoric dependencies (i.e. coargument reflexives) are resolved by a qualitatively different mechanism than extra-syntactic anaphoric dependencies (i.e. logophoric reflexives) (Burkhardt, 2005; Harris *et al.*, 2000). However, it should be noted that these studies did not permit the conclusion that the former are automatically constructed before the latter. Nevertheless, future ERP studies may further inform us about this aspect of anaphora resolution and, in addition, could establish whether a similar qualitative difference exists for bound and coreferential dependencies.

A related, yet slightly different issue that needs to be addressed with respect to the identity of bound and coreferential dependencies is whether in (VP) ellipses – and other structures that allow both a sloppy and strict reading – all representations are activated at the point of reconstruction (cf. Shapiro & Hestvik, 1995; Shapiro *et al.*, 2003; Vasić, 2006). In addition to behavioural measures such as cross-modal priming data (suggested by Vasić), ERPs may provide some crucial insight into the matter, in particular in light of some striking developments of the research program of Van Berkum and colleagues.

This program partly builds on the observation that the ERP paradigm is sensitive enough to pick up subtle referential ambiguities. In a study – originally aimed at studying context effects in syntactic parsing – Van Berkum *et al.* (1999a) presented short discourses that were either about two girls (ex. (5)) or only one (ex. (6)).

(5) Ambiguous
David had asked *the two girls* to clean up their room before lunchtime. But one of the girls had stayed in bed all morning, and the other had been on the phone all the time. David told *the girl* that had been on the phone to hang up.

(6) Unambiguous

David had asked the boy and *the girl* to clean up their room before lunchtime. But the boy had stayed in bed all morning, and the girl had been on the phone all the time. David told *the girl* that had been on the phone to hang up.

As a result of this simple manipulation they observed that, relative to its unambiguous control, the ambiguous noun *girl* in the final sentence of mini-stories such as (5) elicited a sustained frontal negative shift – i.e. not unlike the LAN effect – that they subsequently labeled the *Nref* effect (see Van Berkum *et al.*, 2007). The emergence of the Nref suggests that the comprehension system somehow 'knows' that *the girl* is (temporally) ambiguous and, moreover, since the ERP signature was qualitatively different from the P600 and N400 effect, referentially-induced ambiguities seem to require different (or at least additional) neural circuitry than processes of semantic and syntactic integration (e.g. Van Berkum *et al.*, 2007).

Further research on the matter demonstrated that (i) the Nref effect does not depend on whether the stimuli are presented in written or spoken form (Van Berkum, Brown, Hagoort & Zwitserlood, 2003a), (ii) emerges not only for ambiguous nouns but for ambiguous pronouns as well (Van Berkum *et al.*, 2004; Nieuwland & Van Berkum, 2006a), and (iii) is indicative of a deep 'situation-model' ambiguity (Nieuwland, Otten & Van Berkum, 2007). Bearing these additional findings in mind, I deem it highly interesting to compare ambiguous ellipsis sentences such as *Lisa thinks that her pimped room has a touch of class, but Anouk does not* to unambiguous ellipsis sentences such as *Lisa thinks that the pimped room has a touch of class, but Anouk does not,* to witness whether an Nref effect is elicited in the ambiguous ellipsis. If so, this could then be taken to suggest that the sloppy and strict reading are somehow activated simultaneously and, moreover, the timing of the Nref effect may enlighten us about when both readings are available.

Stretching the potential explanatory power of the Nref even further, I note that it is not inconceivable that an Nref-like effect also emerges in sentences that are not ambiguous in their interpretation, but that nevertheless allow two (mental) representations. The pronoun *he* in the sentence *The clown thinks that he is funny*, for example, may either be interpreted through variable binding in the semantic module or through coreference in the discourse module. Alternatively, for a sentence such as *Every clown thinks that he is funny*, only the semantic route is available. If a comparison between these two types of sentences results in a Nref, it could indicate that the linguistic difference between binding and coreference is represented at the neural level as well, that is, we may then tentatively conclude that the human brain 'knows' that there are two routes available to connect a pronominal to its antecedent.

Continuing these exploratory thoughts, if the duality between binding and coreference indeed elicits an Nref, it would present a very straightforward explanation for the results of Burkhardt's ERP study (2005). Recall from the discussion in Chapter 4 (Paragraph 4.2.3) that she compared logophoric reflexives with coargument reflexives and reported a pronounced negativity with an anterior maximum for the logophor condition – i.e. not unlike the Nref effect. Burkhardt explained these results by suggesting that the ERP signature suggested additional discourse processing, consistent with the claim that logophors are resolved extra-syntactically. However, alternatively we could also state that logophoric reflexives elicited this *Nref-like* effect, because there are two routes available to resolve the logophor (i.e. the semantic and discourse route), yet only one to resolve the coargument reflexive (i.e. the syntactic route). Obviously, this line of reasoning is at present entirely speculative, especially since Van Berkum and colleagues attribute the Nref to more discourse-based ambiguities (e.g. Van Berkum *et al.*, 2007)[1] and it remains to be seen whether the effect will generalize to structurally induced referential ambiguities. Nevertheless, the above does show that we potentially have some powerful tools at our disposal to extend the evaluation of the POB model, or more generally, to decipher the characteristics of anaphora resolution even further.

6.4. Beyond anaphora

In the first chapter, I formulated the hypothesis that anaphora may function as a window into the architecture of the language system and, hence, studying them offers the opportunity to contribute to fundamental language comprehension issues such as the autonomy-

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[1]Note that this makes the Nref effect very suited for examining issues related to antecedent accessibility, or more generally, to exploring the dynamics of the discourse phase. For instance, Nieuwland, Otten and Van Berkum (2007) mentioned that "…if the frontal negative shift reported by Van Berkum *et al.* (1999a, 2003b) reflects situation model referential ambiguity, it should also prove to be sensitive to this waxing and waning of referential accessibility." (p. 229).

interaction and serial-parallel debate. On the assumption that this hypothesis is correct the question then becomes: what have we seen?

Allowing ourselves to adopt the basic architecture of the POB model as a blueprint of the language comprehension system, we can 'see' a number of things. First of all, the behavioral data presented throughout this dissertation suggested that syntactic, semantic and discourse computations differ in terms of economy. Not only with respect to anaphora resolution, but at a more general level of conception this makes sense, because structure-based computations differ from discourse-based computations in terms of the size of their working space. That is, the syntactic module operates locally and the degrees of freedom can thus be kept to a minimum, which explains why syntactic computations are often viewed as being highly automatic and consequently intrinsically cheap (e.g. Reuland, 2001). More or less the same point can be made for semantic representations, which are in all likelihood somewhat richer (i.e. contain more meaning) than syntactic representations, but nevertheless for the most part determined by purely structural principles (e.g. by c-command configurations). In this sense syntactic/semantic computations differ substantially from discourse computations, which take numerous sources of information into account often including information of multiple sentences back. Consequently, the processing load for discourse representations is plausibly considerably higher than for structural representations (but see the discussion in Chapter 3, Paragraph 3.7.4.1).

Additional implications of assuming a POB-like architecture for the human language system are that the linguistic input is processed in different autonomous subcomponents and, furthermore, in a fixed serial order. In the next sections I will make an attempt to place this sequential and modular architecture into a broader perspective.

6.4.1. Converging approaches: The POB and Friederici's neurocognitive model

In more general terms the POB model is a syntax-first model of language comprehension. In the opening chapter we briefly touched upon this issue by distinguishing between serial and parallel approaches to language comprehension. By way of illustration I mentioned the *Garden Path model* (e.g. Frazier, 1978, 1987; Frazier & Rayner, 1982) as one of the best-known examples of how the ideas of Fodor (1983) on domain specificity and encapsulation can be integrated into an actual human parsing system. Furthermore, this autonomous syntax-first model was contrasted with *constrained-based models*. These latter types of models typically assume some degree of parallelism and, furthermore, do not in general distinguish between a first stage of structure-building and later stages in which semantic and discourse information is integrated, but rather state that all these different sources of information immediately and constantly influence each other (e.g. Bates & MacWhinney, 1989; MacDonald *et al.*, 1994; Marslen-Wilson, 1973; Tanenhaus & Trueswell, 1995; Taraban & McClelland, 1988; see Versteeg, in prep., for an excellent overview of syntax-first, weak interactive and strong interactive accounts of language comprehension). In that sense the POB model is more intimately related to the garden path model than to the interactive approaches.

From this observation, however, one should not deduce that parsing strategies like *minimal attachment* (i.e. always initially construct that structure of the sentence that creates the least number of nodes) and *late closure* (i.e. if possible, attach new items within the clause or phrase currently being processed), which constitute the core of the garden path model, are executed in the syntactic phase of a POB-like architecture. The latter remark is by no means trivial, because it signifies the importance of making a clear distinction between syntactic parsing *strategies* and syntactic parsing *operations* in order to arrive at a correct interpretation of studies aimed at choosing between syntax-first or interactive approaches. According to Hagoort (2003a), for example, the lack thereof has led to some confusion because "some of the discrepancies between the different views on this topic are due to the fact that no clear distinction is made between cases in which the syntactic constraints are, at least temporarily, indeterminate with respect to the structural assignment (syntactic ambiguity) and cases in which these constraints are sufficient to determine the syntactic analysis." (p. S19). He further claims that in the former case a substantial body of evidence suggests an immediate influence of (non-syntactic) context (cf. Tanenhaus & Trueswell, 1995; Van Berkum *et al.*, 1999b; Versteeg, in prep.), yet for the latter case the available evidence supports a certain level of syntactic autonomy (Hagoort, 2003b; O'Seaghdha, 1997). In other words, in the case of syntactic ambiguity discourse context can immediately override – and thus interacts with – parsing strategies such as minimal attachment and late closure, but that should not be taken to suggest that a similar interaction occurs while applying syntactic rules.

In terms of the POB model the syntactic phase is thus associated with algorithms that capture syntactic rules and, hence, remains blind to whether these rules introduce syntactic ambiguity or not. As such this initial syntactic phase is on a par with the first phase of a more recent neurocognitive version of the autonomous syntax-first view, proposed by Friederici and colleagues (Friederici, 2002; Friederici & Kotz, 2003; Grodzinsky & Friederici, 2006). As discussed in Chapter 4 and 5, they present the outline of a parsing system consisting of three functionally and temporally separable phases of processing. In the first phase the parser builds a rudimentary hierarchical tree-structure based on purely (lexical) syntactic information, most notably word category information (i.e. noun, verb, determiner etc.). During the second phase thematic role assignment takes place, and a processing cycle ends with a third phase in which the system is engaged in higher level processes such as (syntactic) revision and final integration.

One of the major strengths of Friederici's model is that it is based on the results of a range of different experimental methodologies including fMRI, ERP, MEG and patient studies and, furthermore, makes an attempt to connect the three processing phases to specific ERP signatures and separate temporofrontal circuits in (the left hemisphere of) the human brain (for reviews see Friederici, 2002; Friederici & Kotz, 2003; Grodzinsky & Friederici, 2006). More specifically, in her approach the ELAN (Early Left Anterior Negativity) ERP is indicative of processing (problems) in the first phase, the LAN and N400 emerge in the second phase and the P600 is the main ERP component of the third phase.

Recall that one of the claims of syntax-first approaches to language comprehension – including the POB approach I advocate – is that semantic information cannot be used before the parser has built an initial syntactic structure "because structural information is necessary as input for thematic role assignment" (Hagoort, 2003a, p. S22). To illustrate how Friederici and colleagues addressed this key issue, I would like to discuss an ERP study which provides a strong test of the assumed asymmetrical relationship between syntax and semantics. In this particular study, Friederici, Gunter Hahne and Mauth (2004) auditorily presented German sentences like (7) and (8) to healthy adults.

(7) Das Buch wurde trotz *<u>verpflanzt</u> von einem Verleger, den wenige empfahlen.
*(The book was despite *<u>replanted</u> by a publisher who(m) few recommended.)*

(8) Der Strauch wurde trotz <u>Verpflanzung</u> vernachlässigt von einem Gärtner, den wenige empfahlen.
(The bush was despite <u>replanting</u> neglected by a gardener who(m) few recommended.)

First of all, note that the critical (underlined) word is syntactically and semantically anomalous in sentence (7), because the parser expects a noun (not a verb) and, furthermore, the word *book* is normally not associated with *replant*. In control sentence (8), on the other hand, the critical word is syntactically and semantically correct. The crucial manipulation in this experiment is that the syntactic word category information is not available up to the suffix position, yet semantic information is already available in the word stem, i.e. *before* the suffix. Interestingly however, the results showed that – relative to the control condition – the double-violation condition elicited an ELAN and P600, yet no N400. Apparently the human parser notices the syntactic anomaly as indicated by the ELAN, but remains essentially unaware of the semantic irregularity because there was no indication of a N400. According to Friederici *et al.* this suggests a "functional independence of structure-building processes from semantic information" and "a functional priority of local phrase-structure-building processes as expected on the basis of syntax-first models" (in Friederici & Kotz, 2003, p. S12; but see Van Den Brink & Hagoort, 2004, for different results). Thus, also outside the domain of anaphora resolution, there are some clear signs that a serial multiple-phase approach to language comprehension is warranted (but see, for example, Hagoort, 2003a and Hagoort & Van Berkum, 2007, for an alternative view in which syntactic, semantic and discourse information is processed in parallel and feeds into a single 'unification space').

Furthermore, given that the POB and the neurocognitive model show a remarkable resemblance to one another, the intriguing opportunity of connecting the functional POB model to the human brain present itself. However, I should note that I am not alone in my attempt to connect (formal) linguistic operations to Friederici's model. A similar but independently motivated view has recently been put forward by

Grodzinsky and Friederici (2006). Partly based on concepts of the minimalist program (Chomsky, 1995), they distinguish a number of very basic operations to establish relationships among words and phrases in a sentence: LEX, MERGE, MOVE and BIND. LEX stands for the word information stored in the lexicon that is syntactically relevant such as the argument structure of a verb (i.e. the type and number of arguments that natural language predicates require) and the operation MERGE reflects a class of highly constrained structure-building devices. Based on the syntactic information provided by LEX, MERGE can for example connect the determiner *the* to the noun *girl* resulting in the NP *the girl*. The MERGE operation will crash, however, if it violates the constraints dictated by LEX. For instance, a determiner can only be connected to a noun, not to verb, and consequently MERGE will not occur between elements such as *the* and *see* (V). Furthermore, because linguistic elements are not always found in their canonical position another basic operation is MOVE. MOVE links an audible phrase (or verb) to one or more silent, yet active syntactic positions. Thus, MOVE includes for example the more informally formulated copy-and-paste operation, which is executed in the VP-ellipsis comprehension process. Last but certainly not least, the framework also contains the basic algorithm BIND, which is responsible for linking reflexives and pronominals to their (c-commanding) antecedent.

Even though Grodzinsky and Friederici do not always *explicitly* attach these elementary linguistic operations to the three processing phases and associated brain areas of the neurocognitive model, they do seem to sketch the following picture. First of all, they suggest that Phase I is most closely associated with MERGE, which enables the build-up of local phrase structures. During this first syntactic phase the frontal operculum and anterior superior temporal gyrus (STG) are thought to play a vital role – and in addition the inferior tip of Brodmann's area (BA) 44 may be involved (Friederici, 2002). Subsequently, in Phase II BIND and MOVE are executed to establish (anaphoric) dependencies to figure out 'who is doing what to whom'. During this phase Broca's area (BA 44 and 45) appears to be most important. Finally, in Phase III the posterior STG and posterior superior temporal sulcus (STS) are concerned with higher level integration processes, meaning the previously gathered syntactic and semantic information may now interact.

Although their framework resembles the POB model in some important aspects, most notably in the idea that pronominals are bound in the second phase, their view differs as to when coargument reflexives are resolved. That is, whereas they use the same basic operation BIND to connect both reflexives and pronominals to their antecedents in the second phase of a processing cycle, the POB framework assumes that coargument reflexives are resolved in the first phase through A-Chain formation (which is essentially a MERGE operation). Furthermore, their model does not address how and when coreferential dependencies are resolved and therefore cannot account for the diversity of anaphoric dependencies as found in natural languages.[2] Nevertheless, bearing these differences in mind the parallels between their approach and the POB model are evident, which reinforces my idea that we have the opportunity to formulate some specific hypotheses in relation to where inside the brain the three POB algorithms reside. For instance, since in A-Chain formation is essentially a MERGE operation, a plausible hypothesis is that areas such as the frontal operculum, anterior STG and the inferior part of BA 44 are involved in its execution. Variable binding, on the other hand, more likely requires the involvement of Broca's area, the most important area of Phase II.[3] For coreference computations matters are less clear-cut, simply because this algorithm makes use of information originating from a lot of different sources (e.g. knowledge about the wider discourse, world knowledge) and consequently it may activate a more diffuse network. In other words, I am hesitant to map coreference only onto the posterior STG and STS – the areas associated with Phase III of the neurocognitive model – particularly because a recent fMRI study has shown that referentially (ambiguous) pronouns recruit medial prefrontal regions as well (Nieuwland, Petersson & Van Berkum, 2007).[4]

To conclude, above I have illustrated how a real time version of the linguistic POB model may meet other models that are currently emerging in psycholinguistics and neurolinguistics. In fact, this attempt to unify the POB and Friederici's neurocognitive model exposes a relatively unexplored part of the language comprehension territory. Recall from

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[2] This should not be taken as criticism, because it was never the intention of Grodzinsky and Friederici to present a full account of anaphora resolution.

[3] However, note that Grodzinsky and Friederici suggest that BIND modulates the middle frontal gyrus of the right hemisphere, the middle temporal gyrus of the left hemisphere and the left orbital gyrus.

[4] In fact, Nieuwland, Petersson and Van Berkum (2007) claim that "referential analysis during sentence comprehension draws upon brain regions beyond the 'traditional' temporal–frontal language network" (p. 1002).

the opening chapter that the slightly different goals of linguists and psycholinguists led to a split somewhere in the '70s. The discussion above revealed, however, that we now may have both the tools and the theoretical framework to re-unite the two and as such harmonize the advances made in both. Obviously I do not wish to claim that the alliance of the linguistic and psycholinguistic world will be unproblematic hereafter. All I am saying here is that the developments in both fields are at times strikingly analogous and in that sense only strengthen the idea that linguists should work in close cooperation with psycholinguists (and vice versa).

6.4.2. Anticipation and prediction

I ended Chapter 5 with the following question: Can we maintain a serial order of processing as proposed in the POB model and Friederici's neurocognitive model, and at the same time assume that predictive discourse mechanisms are at work as well? Although it is well beyond the scope of this dissertation to present the full picture of how anticipatory mechanisms may affect language comprehension, I do want to illustrate the fact that (linguistic) predictions may have a high degree of specificity and, furthermore, say a few words on how prediction may fit into a syntax-first model of language comprehension.

Until recently the thought that people may predict how a sentence or wider discourse will continue has not been very popular among (psycho)linguists. To an objective reader this may come as a big surprise as, for example, we all know that some among us have the (annoying) habit of rapidly and *accurately* finishing other people's sentences (cf. Pickering & Garrod, 2004; Van Berkum, Brown, Zwitserlood, Kooijman & Hagoort, 2005). However, as pointed out by Van Berkum *et al.* (2005), the unpopularity of prediction makes sense in the light of the assumption that human language encompasses an infinite number of expressions (cf. Chomsky, 1957). Or as Fodor (1983) puts it: "There are, in general, so many syntactically different ways of saying the same thing that even if context allowed you to estimate the content of what is about to be said, that information wouldn't much increase your ability to predict its form" (p. 78). So, although Fodor does not completely dismiss the idea that people have some abstract idea about how a sentence may unfold, these ideas will most likely not lead to specific predictions. On the basis of the experimental studies on the use of implicit causality in sentence comprehension (see Chapter 5) and an ERP follow-up study (Van

Berkum *et al.*, 2007), I, on the other hand, deemed the latter not at all inconceivable.

In fact, the remarkable results of another ERP (and self-paced reading) study unmistakably suggest that people use their knowledge of the wider discourse to predict specific upcoming words. Van Berkum *et al.* (2005) presented short, yet highly constraining Dutch mini-stories that either ended with a highly predictable word like for instance *schilderij* 'painting' in (9) or a less predictable word like *boekenkast* 'bookcase' in (10).

(9) De inbreker had geen enkele moeite de geheime familiekluis te vinden. Deze bevond zich natuurlijk achter een groot$_{\text{neu}}$ maar onopvallend schilderij$_{\text{neu}}$.
(The burglar had no trouble locating the secret family safe. Of course, it was situated behind a big$_{neu}$ but unobtrusive painting$_{neu}$.)

(10) De inbreker had geen enkele moeite de geheime familiekluis te vinden. Deze bevond zich natuurlijk achter een grote$_{\text{com}}$ maar onopvallende boekenkast$_{\text{com}}$.
(The burglar had no trouble locating the secret family safe. Of course, it was situated behind a big$_{com}$ but unobtrusive bookcase$_{com}$.)

In Dutch (as in German and French) every noun has a fixed syntactic gender feature, (e.g. Van Berkum, 1996) and building on this aspect of the Dutch language, Van Berkum *et al.* (2005) varied the gender feature of the noun across conditions, e.g. in the examples above the predictable noun has a *neuter* gender feature (ex. (9)) and the less predictable noun a *common* gender feature (ex. (10)). Crucially, this manipulation affects the suffix of the adjective *groot* 'big' that appears prior to the noun: in case of neuter gender the adjective remains the same (zero suffix), yet for common gender nouns an *–e* must be added to the stem, resulting in *grote*. Very interestingly, the EEG recordings showed that – relative to their consistent counterparts – adjectives that were inconsistent with the gender of the predicted noun (*grote* in the examples above) elicited a reliable (non-specific) positive deflection in the ERP waveforms *before* the noun was actually heard. In addition, in a self-paced reading variant of the ERP study Van Berkum *et al.* (2005) showed that readers also slow down in the inconsistent condition before the noun was shown. These findings only seem to make sense if people somehow predict a specific upcoming word like *painting* and, more importantly, use "the syntactic features of an anticipated ghost noun" (p. 460) in the syntactic analysis. Otherwise, there is no straightforward reason for why neuter-inflected or common-inflected adjectives would result in a disparity in the EEG signal and reading time data, because both are fully grammatical at the moment they are encountered.

Hence, Van Berkum *et al.* (2005) very elegantly showed that not only do people make predictions, these predictions also affect the ongoing comprehension process of an unfolding sentence. Some may argue that these findings fit better with a single-step model, since this approach predicts that all different sources of information, including discourse-driven predictions, are used immediately. However, the idea that predictions affect the parse of a sentence is in fact not incompatible with a serial syntax-first approach to language comprehension. That is, in my view it all boils down to the question of whether the predictive power of discourse directly affects the syntactic merging operations or that it alternatively only affects the input of the syntactic phase. It probably does not come as a big surprise to the reader that I favor the latter explanation. So, whereas Van Berkum *et al.* (2005) did not wish to claim that the prediction of a very specific noun like *painting* "is accompanied by hallucinations about an actual noun being presented in the input" (p. 461), but prefer to assume that their early ERP is indicative of a system that "continually adjusts its predictions in the face of new evidence" (p. 464)[5], I, on the other hand, deem the former explanation not that far-fetched at all. Namely, from a syntactic module's point of view the predicted noun *painting* could just as well have been in the input, simply because it is a blind autonomous system and does not know or care whether its input originates internally (i.e. predictions) or externally (i.e. actual auditory or visual input). Hence, accepting this view we can indeed maintain the core assumptions of a syntax-first model, and at the same time account for the fact that predictive discourse mechanisms are at work.

Of course, I have merely sketched a very general picture of prediction and anticipation in language comprehension. A lot of details need to be worked out. Nevertheless, my brief discussion does illustrate two important things. First, prediction is a genuine characteristic of online

[5] In example (10) new evidence that signals a re-evaluation of the predictions made so far would be inferred from the fact that the syntactic information in the suffix of the adjective *grote* 'big' goes against the prophecy that the noun *schilderij* 'painting' will follow soon.

language comprehension processes and, hence, needs to be addressed. Second, at present I see no deep reason why prediction could not be incorporated in a sequential processing architecture such as the POB framework and Friederici's (2002) neurocognitive model.

6.4.3. Language *is* a virus

Let's wind up with one final (really far-fetched!) associative thought. Recall that Reuland's POB framework, and Grodzinsky and Friederici's approach (2006) are – at least partly – based on the concepts of the minimalist program (Chomsky, 1995). If language is really as 'minimal' as proposed in Chomsky's program, our pessimistic friend William S. Burroughs was, in fact, not that far off when he sighed that "language is a virus from outer space" (see Chapter 1, Paragraph 1.1.1). Namely, a minimalist language device is not that different from a virus: both are extremely simple, yet highly effective systems that only apply a number of very basic operations, such as MERGE (with your host) and COPY (yourself). Moreover, neither mechanisms can function properly, or even exist, without parasitizing their host, the host being either another organism or the human cognitive system – including subcomponents such as (working) memory, perception etc. Having said that, even to me the 'from outer space' element of Burrough's hypothesis seems a little bit too exotic, so perhaps we should rub out the latter, leaving: 'language is a virus'.[6]

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[6] Or perhaps the thought is not that far-fetched after all, see Piattelli-Palmarini and Uriagereka (2004).

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Appendix I

Stimuli Experiment 1 (Chapter 2)

(a = logophor; b = coargument reflexive; \ = line break)

1a. De bioloog plantte dagelijks een bloem met echt\ prachtige kleuren voor zich terwijl de vogels een\ vrolijk liedje floten.
1b. De bioloog, die dagelijks een bloem met prachtige\ kleuren plantte, schoor zich terwijl de vogels een\ vrolijk liedje floten.

2a. De getuige legde na het bekijken\ van de uitnodiging het stukje\ papier haastig naast zich omdat er al binnen\ een uur getrouwd zou moeten worden.
2b. De getuige, die na het bekijken\ van de uitnodiging het stukje papier haastig\ neer legde, verzorgde zich omdat er al binnen\ een uur getrouwd zou moeten worden.

3a. De crimineel verplaatste snel de enorme buit\ achter zich omdat de politie natuurlijk al lange\ tijd door had dat er iets niet helemaal pluis was.
3b. De crimineel, die de enorme buit verplaatste,\ verraadde zich omdat de politie natuurlijk al lange\ tijd door had dat er iets niet helemaal pluis was.

4a. De kunstenaar projecteerde snel de aparte dia op\ de muur achter zich omdat de officiële opening\ van het museum al was begonnen.
4b. De kunstenaar, die een aparte dia projecteerde op\ de muur, verkleedde zich omdat de officiële opening\ van het museum al was begonnen.

5a. De schilder verplaatste alle spullen naast zich omdat\ het werk eindelijk klaar was.
5b. De schilder, die alle spullen verplaatste, waste zich omdat\ het werk eindelijk klaar was.

6a. De presentator pakte stiekem een afkijkbriefje\ voor zich omdat de show blijkbaar te ingewikkeld\ was om uit het hoofd te leren.
6b. De presentator, die een afkijkbriefje pakte,\ vernederde zich omdat de show blijkbaar te ingewikkeld\ was om uit het hoofd te leren.

7a. De brandweerman gooide zijn zware brandwerende\ kleding naast zich omdat onze held ten koste van\ alles de arme zielen in het brandende huis wilde redden.
7b. De brandweerman, die zijn zware brandwerende kleding neer\ gooide, verwondde zich omdat onze held ten koste van\ alles de arme zielen in het brandende huis wilde redden.

8a. De paparazzi-fotograaf zette zijn moderne camera neer in de\ bosjes naast zich zodat de beroemde voorbijgangers geen\ idee hadden van zijn snode plannen.
8b. De paparazzi-fotograaf, die zijn camera neer zette in de\ bosjes, verborg zich zodat de beroemde voorbijgangers geen\ idee hadden van zijn snode plannen.

9a. De topvoetballer zette tijdens de training steeds een\ nepmuurtje neer voor zich omdat dit een prima manier\ is om in alle rust de vrije trap te oefenen.
9b. De topvoetballer, die tijdens de training een nepmuurtje\ neer zette, verbeterde zich omdat dit een prima manier\ is om in alle rust de vrije trap te oefenen.

10a. De zwerver trok toch een veel te zwaar beladen\ winkelwagentje achter zich in de gloeiend hete zon\ terwijl iedereen waarschuwde voor de gevaren van de\ ultraviolette straling.

10b. De zwerver, die toch een veel te zwaar beladen\ winkelwagentje trok, brandde zich in de gloeiend hete zon\ terwijl iedereen waarschuwde voor de gevaren van de\ ultraviolette straling.

11a. De boer zaaide de zaadjes voor de oogst van volgend jaar\ voornamelijk achter zich omdat er een enorme koe in de weg\ stond.
11b. De boer, die de zaadjes voor de oogst van volgend jaar\ zaaide, bezeerde zich omdat er een enorme koe in de weg\ stond.

12a. De clown legde verdrietig zijn normale\ kloffie naast zich terwijl het waardeloze\ optreden van de acrobaten gelukkig op zijn\ einde liep.
12b. De clown, die verdrietig zijn normale kloffie neer\ legde, vermomde zich terwijl het waardeloze\ optreden van de acrobaten gelukkig op zijn\ einde liep.

13a. De aannemer bouwde een piepklein schuurtje in\ de tuin achter zich toen een of andere vent van\ de gemeente kwam zeuren over een vergunning.
13b. De aannemer, die een piepklein schuurtje bouwde in\ de tuin, beheerste zich toen een of andere vent van\ de gemeente kwam zeuren over een vergunning.

14a. De atleet legde de nieuwe gouden schoenen\ teleurgesteld naast zich nadat de waanzinnig slecht\ verlopen wedstrijd ervoor gezorgd had dat enkele\ sponsors geen geld meer gaven.
14b. De atleet, die de gouden schoenen teleurgesteld neer\ legde, verachtte zich nadat de waanzinnig slecht\ verlopen wedstrijd ervoor gezorgd had dat enkele\ sponsors geen geld meer gaven.

15a. De graffitikunstenaar spoot een mooie tekening op een lege\ muur ver voor zich omdat de verfdampen enorm veel jeuk\ aan zijn neus veroorzaakten.
15b. De graffitikunstenaar, die een mooie tekening op een lege\ muur spoot, krabde zich omdat de verfdampen enorm veel jeuk\ aan zijn neus veroorzaakten.

16a. De vieze man lokte een klein spelend\ hondje bij zich toen de eigenaar plotseling\ opdook en het beestje riep.
16b. De vieze man, die een klein spelend hondje\ lokte, verstopte zich toen de eigenaar plotseling\ opdook en het beestje riep.

17a. De behulpzame man tekende een nieuwe duidelijke\ plattegrond voor zich zodat een groep Japanse\ toeristen deze kon bestuderen.
17b. De behulpzame man, die een duidelijke plattegrond\ tekende, verplaatste zich zodat een groep Japanse\ toeristen deze kon bestuderen.

18a. De goochelaar toverde ineens een zwart\ konijn achter zich tijdens het enigszins\ rommelige optreden waarbij niemand in het\ publiek echt oplette.
18b. De goochelaar, die een zwart konijn\ toverde, verwonderde zich tijdens het enigszins\ rommelige optreden waarbij niemand in het\ publiek echt oplette.

19a. De astronaut plantte op Mars een grote Amerikaanse\ vlag naast zich toen plotseling een marsmannetje\ met een nieuwsgierige blik in zijn ogen kwam aanlopen.
19b. De astronaut, die op Mars een Amerikaanse vlag\ plantte, verbaasde zich toen plotseling een marsmannetje\ met een nieuwsgierige blik in zijn ogen kwam aanlopen.

20a. De advocaat verstopte laatst belangrijk bewijsmateriaal\ tegen een bedrijf achter zich omdat het openbaar\ ministerie precies hetzelfde had gedaan met bewijs dat\ zijn cliënt zou vrijspreken.
20b. De advocaat, die belangrijk bewijsmateriaal tegen\ een bedrijf verstopte, verdedigde zich omdat het openbaar\ ministerie precies hetzelfde had gedaan met bewijs dat\ zijn cliënt zou vrijspreken.

21a. De schrijver legde met veel theater het\ boek voor zich toen de Boekenweek feestelijk\ werd geopend door een bekende uitgever.
21b. De schrijver, die met veel theater het boek neer\ legde, presenteerde zich toen de Boekenweek feestelijk\ werd geopend door een bekende uitgever.

22a. De kwajongen strooide een zak\ confetti naast zich toen de conrector\ plotseling het klaslokaal binnenkwam.

22b. De kwajongen, die een zak confetti\ strooide, verstopte zich toen de conrector\ plotseling het klaslokaal binnenkwam.

23a. De vuilnisman deponeerde juichend de laatste\ vuilniszak achter zich omdat de zomervakantie\ nu officieel begonnen was.
23b. De vuilnisman, die de laatste vuilniszak\ deponeerde, feliciteerde zich omdat de zomervakantie\ nu officieel begonnen was.

24a. De inbreker verschoof te luid een\ schilderij voor zich zodat de man des\ huizes op tijd de bewaking kon waarschuwen.
24b. De inbreker, die te luid een schilderij\ verschoof, verraadde zich zodat de man des\ huizes op tijd de bewaking kon waarschuwen.

Appendix II

Stimuli Experiment 2 & 3 (Chapter 3)

(a = strict-bias, only-operator; b = sloppy-bias, only-operator; c = strict-bias, ellipsis; d = sloppy-bias, ellipsis; \ = line break; stories 1-24 were used in the eye-tracking experiment)

1a. Fleur en Amber proberen een vriendje te vinden\ door afspraakjes te maken via het internet.\ Fleur heeft sinds kort een verhouding met zo'n\ internetdate en ziet alles zeer rooskleurig in.\ Alleen Fleur ziet helaas toekomst in haar relatie.\ Liefde blijft natuurlijk altijd een gok.
1b. Fleur en Amber proberen een vriendje te vinden\ Door afspraakjes te maken via het internet.\ Zij hebben allebei sinds kort een verhouding met zo'n\ internetdate, maar zien het niet even rooskleurig in.\ Alleen Fleur ziet helaas toekomst in haar relatie.\ Liefde blijft natuurlijk altijd een gok.
1c. Fleur en Amber proberen een vriendje te vinden\ door afspraakjes te maken via het internet.\ Fleur heeft sinds kort een verhouding met zo'n\ internetdate en ziet alles zeer rooskleurig in.\ Fleur ziet toekomst in haar relatie,\ maar Amber helaas niet. Liefde blijf\ natuurlijk altijd een gok.
1d. Fleur en Amber proberen een vriendje te vinden\ door afspraakjes te maken via het internet.\ Zij hebben allebei sinds kort een verhouding met zo'n\ internetdate, maar zien het niet even rooskleurig in.\ Fleur ziet toekomst in haar relatie,\ maar Amber helaas niet. Liefde blijft\ natuurlijk altijd een gok.

2a. Laura en Judith houden wel van een house-feestje.\ Laura neemt op de grote feesten altijd een\ XTC-pilletje. Laura is de enige van de twee gabbertjes \ die vindt dat haar gedrag dan bijna niet verandert.\ Sommigen hebben het blijkbaar allemaal niet zo door.
2b. Laura en Judith houden wel van een house-feestje.\ Zij nemen op de grote feesten altijd een\ XTC-pilletje. Laura is de enige van de twee gabbertjes\ die vindt dat haar gedrag dan bijna niet verandert.\ Sommigen hebben het blijkbaar allemaal niet zo door.
2c. Laura en Judith houden wel van een house-feestje. Laura\ neemt op de grote feesten altijd een XTC-pilletje. Van de\ twee gabbertjes vindt Laura dat haar gedrag dan bijna niet\ verandert, maar Judith wel. Sommigen hebben het blijkbaar\ allemaal niet zo door.
2d. Laura en Judith houden wel van een house-feestje. Zij\ nemen op de grote feesten altijd een XTC-pilletje. Van de \ twee gabbertjes vindt Laura dat haar gedrag dan bijna niet\ verandert, maar Judith wel. Sommigen hebben het blijkbaar\ allemaal niet zo door.

3a. Frank en Mark zijn op een ontzettend saaie verjaardag in\ Lunteren. Frank kent niemand en probeert het ijs te\ breken door grapjes te maken, hetgeen hij met veel\ zelfvertrouwen doet. Van de twee heeft alleen Frank\ het idee dat zijn humor ook daadwerkelijk gewaardeerd\ wordt. Het valt te hopen dat het niet zal eindigen in\ een avond vol schaamte en ergernissen.
3b. Frank en Mark zijn op een ontzettend saaie verjaardag in\ Lunteren. Zij kennen niemand en proberen allebei het ijs te\ breken door grapjes te maken, hetgeen zij niet met evenveel\ zelfvertrouwen doen. Van de twee heeft alleen Frank\ het idee dat zijn humor ook daadwerkelijk gewaardeerd\ wordt. Het valt te hopen dat het niet zal eindigen in\ een avond vol schaamte en ergernissen.
3c. Frank en Mark zijn op een ontzettend saaie verjaardag\ in Lunteren. Frank kent niemand en probeert het\ ijs te breken door grapjes te maken, hetgeen hij met\ veel zelfvertrouwen doet. Van de twee heeft Frank het\ idee dat zijn humor ook daadwerkelijk gewaardeerd wordt,\ maar Mark niet. Het valt te hopen dat het niet zal eindigen\ in een avond vol schaamte en ergernissen.
3d Frank en Mark zijn op een ontzettend saaie verjaardag\ in Lunteren. Zij kennen niemand en proberen allebei het\ ijs te breken door grapjes te maken, hetgeen zij niet met\ evenveel zelfvertrouwen doen. Van de twee heeft Frank het\ idee dat zijn humor ook daadwerkelijk gewaardeerd wordt,\ maar Mark niet. Het valt te hopen dat het niet zal eindigen\ in een avond vol schaamte en ergernissen.

4a. Sinds lange tijd gaan Karin en Saskia elke week wel een\ keer naar de sauna. Karin heeft in de loop der jaren\ een enorm dikke buik gekregen. Karin is de enige van de\ twee die geen problemen heeft met haar buik. Ik dacht\ begrepen te hebben dat je ontzettend afviel in de sauna,\ niet altijd blijkbaar...
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5a. Johnny Depp en Christopher Walken zijn gezegend met een berg\ acteertalent. Johnny wordt daarom vaak gecast voor aparte\ rollen, al verschilt hij daarover van mening. Johnny is\ namelijk de enige die zijn rollen altijd normaal vindt.\ 'Normaal' valt nu eenmaal niet te definieren.
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6a. Lucas en Bram zijn lekker aan het borrelen.\ Lucas kletst een beetje over zijn werk als\ accountant en hij vindt het blijkbaar superleuk.\ Het probleem is dat alleen Lucas zijn beroep interessant\ vindt. Ze besluiten maar snel ergens anders over te gaan\ praten.
6b. Lucas en Bram zijn lekker aan het borrelen.\ Zij kletsen een beetje over hun werk als\ accountant, maar zij vinden het blijkbaar niet even leuk.\ Het probleem is dat alleen Lucas zijn beroep interessant\ vindt. Ze besluiten maar snel ergens anders over te gaan\ praten.
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7a. Lisa en Anouk zijn dol op de zender MTV. Lisa kon\ haar geluk niet op toen zij mee mocht doen aan het\ programma 'Pimp My Room', waarin haar kamer werd\ 'opgeknapt'. Maar helaas, van de twee vriendinnen\ vindt alleen Lisa dat haar 'gepimpte' kamer klasse\ heeft. Smaken verschillen nu eenmaal.
7b. Lisa en Anouk zijn dol op de zender MTV. Zij konden\ hun geluk niet op toen zij mee mochten doen aan het\ programma 'Pimp My Room', waarin hun twee kamers werden\ 'opgeknapt'. Maar helaas, van de twee vriendinnen\ vindt alleen Lisa dat haar 'gepimpte' kamer klasse\ heeft. Smaken verschillen nu eenmaal.
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8a. De studenten Stijn en Luuk zijn sinds kort kamergenootjes. Stijn is echt een TV-junkie en brengt hele dagen op de bank door. Van de twee denkt alleen Stijn dat het zijn creativiteit stimuleert. TV kijken kan blijkbaar echt een verslaving worden.
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9a. John de Mol en Joop van den Ende zijn al lang\ collega's en goede vrienden. Zoals iedereen weet,\ heeft John wel eens een nieuwe zender opgericht.\ Alleen John wist zeker dat zijn nieuwe zender een\ Succes zou worden. Wat een zelfvertrouwen hebben\ sommigen mensen toch.
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10a. Sven en Daniël komen elkaar tegen in het park.\ Sven heeft zoals altijd een enorme hond aan de lijn.\ Alleen Sven kan zijn hond onder controle houden.\ Honden luisteren nu eenmaal niet naar iedereen.
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11a. Rob Oudkerk en Wouter Bos keren steeds weer terug in\ mijn verhaaltjes. Wouter heeft altijd zijn mond vol over\ 'de arbeider' en 'de natuur'. Eigenlijk heeft alleen Wouter\ de overtuiging dat zijn ideeën echt socialistisch zijn.\ Het is tegenwoordig de vraag of het echte socialisme nog\ wel bestaat.
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12a. Sem en Milan volgen de cursus 'Koken voor dommerdjes'.\ Vandaag moest Sem een appeltaart bakken en zijn\ projectje kan men het best omschrijven als 'interessant'.\ Sem is de enige die zijn creatie zelfs niet durft te\ proeven. Tot nu toe zijn er nog geen doden gevallen\ tijdens de cursus, maar je weet maar nooit.
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13a. Yvonne en Mariska gaan elk jaar snowboarden\ in Aspen en zijn er dol op. Yvonne maakte op de\ laatste skivakantie een sprong over een minuscuul\ schansje. Alleen Yvonne vond haar sprong stoer.\ Echt hoog springen, dat kunnen de locals die het\ hele jaar niets anders doen.
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14a. Ruben en Nick kennen elkaars ouders vrij goed.\ Ruben heeft een beetje een gekke vader en\ daar denken ze zeer verschillend over. Ruben is\ de enige die zijn vreemde vader niet kan waarderen.\ Waarschijnlijk is het gewoon een vorm van schaamte.
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15a. Sanne en Isa hebben sinds kort het chatten op het\ Internet ontdekt. Sanne slaapt sindsdien nog maar\ maximaal twee uur per dag en maakt zich daar een\ beetje zorgen over. Sanne is gek genoeg de enige van\ de twee die denkt dat haar chat-gedrag niet normaal is.\ Het valt te hopen dat ze het allebei een beetje binnen\ de perken kunnen houden.
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16a. Liesbeth en Esther zijn allebei ontzettend dol op koffie.\ Liesbeth maakte afgelopen zondag voor het eerst een koffie\ verkeerd, naar haar mening met veel succes. Van het\ tweetal vond alleen Liesbeth haar probeerseltje lekker.\ Misschien kun je in sommige gevallen echt spreken van\ een koffie verkeerd
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18a. Sofie en Marit spelen samen in een punkbandje. Sofie\ bespeelt een normale gitaar en Marit de basgitaar.\ Sofie ging laatst helemaal los tijdens haar solo.\ Van beide 'gitaarvirtuozen' was alleen Sofie niet\ tevreden over haar timing en algemene performance\ tijdens de solo. De ene dag gaat het nu eenmaal\ voor je gevoel wat beter dan de andere.
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19a. Maarten en Bart zitten samen op de filmacademie.\ Maarten heeft vandaag de laatste hand gelegd aan\ zijn nieuwste korte film. Maarten is de enige van de\ twee jonge cineasten die zijn film goed gelukt vindt.\ Uiteindelijk gaat het er natuurlijk wel om wat het\ publiek ervan vindt.
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20a. Kevin en Robin kwamen toevallig tegelijk terug\ van een lange reis. Kevin gaf bij terugkomst\ een feestje voor zijn vrienden, maar was niet\ echt tevreden met de avond. Van hen beiden\ vond alleen Kevin zijn feestje niet geslaagd.\ Soms verheug je je gewoon teveel op iets.
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21a. Toen ze samen aan het reizen waren door Australië,\ hebben Agnes en Edith leren surfen. Agnes wankelde\ voortdurend op het surfboard. Agnes was de enige\ die dacht dat haar surfstijl professioneel aandeed.\ 'Hang loose' en 'no worries' zijn veelgehoorde kreten\ op de Australische stranden, maar niet altijd van\ toepassing op onhandige West-Europese meisjes.
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22a. Daan en Thomas zijn net jarig geweest.\ Daan heeft een fiets gekregen en is er erg blij mee.\ Helaas is Daan de enige die zijn nieuwe fiets mooi vindt.\ Toch hebben ze afgesproken morgen een leuk tochtje te\ maken.
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23a. Lieke en Femke waren allebei op zoek naar een\ nieuwe computer. Lieke heeft zich laten verleiden\ door een aanbieding bij de Mediamarkt en heeft\ een laptop aangeschaft. Lieke is de enige van\ de twee die haar laptop handig vindt. Soms is\ het beter een wat duurder product te kopen.
23b. Lieke en Femke waren allebei op zoek naar een\ nieuwe computer. Zij hebben zich laten verleiden\ door een aanbieding bij de Mediamarkt en hebben\ een laptop aangeschaft. Lieke is de enige van\ de twee die haar laptop handig vindt. Soms is\ het beter een wat duurder product te kopen.
23c. Lieke en Femke waren allebei op zoek naar een\ nieuwe computer. Lieke heeft zich laten verleiden\ door een aanbieding bij de Mediamarkt en heeft\ een laptop aangeschaft. Lieke vindt haar laptop\ handig, maar Femke absoluut niet. Soms is\ het beter een wat duurder product te kopen.
23d. Lieke en Femke waren allebei op zoek naar een\ nieuwe computer. Zij hebben zich laten verleiden\ door een aanbieding bij de Mediamarkt en hebben\ een laptop aangeschaft. Lieke vindt haar laptop\ handig, maar Femke absoluut niet. Soms is\ het beter een wat duurder product te kopen.

24a. Roger Federer en Marat Safin hebben allebei een grand-slam\ toernooi gewonnen in 2005. Roger presteert momenteel volgens\ iedereen in het circuit op het toppen van zijn kunnen,\ maar hij heeft daar duidelijk een andere mening over.\ Als enige denkt Roger toch dat zijn spel nog verbeterd kan\ worden. Zonder zelfvertrouwen blijf je immers niet nummer\ één.
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25a. Jasper en Tom zijn allebei zeer slordige personen. Jasper laat bijvoorbeeld zijn sleutels op de vreemdste plekken liggen. Jasper is dan de enige die zijn sleutels nog binnen afzienbare tijd kan vinden. Vaak liggen ze in de koelkast, maar soms hangen ze zelfs aan het daarvoor bedoelde haakje.
25b. Jasper en Tom zijn allebei zeer slordige personen. Zij laten bijvoorbeeld hun sleutels op de vreemdste plekken liggen. Jasper is dan de enige die zijn sleutels nog binnen afzienbare tijd kan vinden. Vaak liggen ze in de koelkast, maar soms hangen ze zelfs aan het daarvoor bedoelde haakje.

25c. Jasper en Tom zijn allebei zeer slordige personen. Jasper laat bijvoorbeeld zijn sleutels op de vreemdste plekken liggen. Jasper kan zijn sleutels dan nog binnen afzienbare tijd vinden, maar Tom niet. Vaak liggen ze in de koelkast, maar soms hangen ze zelfs aan het daarvoor bedoelde haakje.
25d. Jasper en Tom zijn allebei zeer slordige personen. Zij laten bijvoorbeeld hun sleutels op de vreemdste plekken liggen. Jasper kan zijn sleutels dan nog binnen afzienbare tijd vinden, maar Tom niet. Vaak liggen ze in de koelkast, maar soms hangen ze zelfs aan het daarvoor bedoelde haakje.

26a. Emma en Iris zitten in hun laatste studiejaar. Emma heeft net met veel pijn en moeite haar scriptie afgerond en zij is gelukkig met het resultaat. Spijtig genoeg is alleen Emma tevreden over haar scriptie. Het is blijkbaar toch wel erg moeilijk om een goed verhaal op papier te krijgen.
26b. Emma en Iris zitten in hun laatste studiejaar. Zij hebben net met veel pijn en moeite hun scriptie afgerond, maar ze zijn niet even gelukkig met het resultaat. Spijtig genoeg is alleen Emma tevreden over haar scriptie. Het is blijkbaar toch wel erg moeilijk om een goed verhaal op papier te krijgen.
26c. Emma en Iris zitten in hun laatste studiejaar. Emma heeft net met veel pijn en moeite haar scriptie afgerond en zij is gelukkig met het resultaat. Emma is tevreden over haar scriptie, maar Iris spijtig genoeg niet. Het is blijkbaar toch wel erg moeilijk om een goed verhaal op papier te krijgen.
26d. Emma en Iris zitten in hun laatste studiejaar. Zij hebben net met veel pijn en moeite hun scriptie afgerond, maar ze zijn niet even gelukkig met het resultaat. Emma is tevreden over haar scriptie, maar Iris spijtig genoeg niet. Het is blijkbaar toch wel erg moeilijk om een goed verhaal op papier te krijgen.

27a. Anna en Lotte coachen de twee hockeyteams die momenteel op het veld staan. Plotseling ontstaat er een grote vechtpartij tussen de twee teams en Anna grijpt direct in. Anna is helaas de enige die haar speelsters tot de orde roept. Het wordt echt een drama!
27b. Anna en Lotte coachen de twee hockeyteams die momenteel op het veld staan. Plotseling ontstaat er een grote vechtpartij tussen de twee teams, maar ze grijpen niet allebei direct in. Anna is helaas de enige die haar speelsters tot de orde roept. Het wordt echt een drama! 27c. Anna en Lotte coachen de twee hockeyteams die momenteel op het veld staan. Plotseling ontstaat er een grote vechtpartij tussen de twee teams en Anna grijpt direct in. Anna roept haar speelsters tot de orde, maar Lotte helaas niet. Het wordt echt een drama!
27d. Anna en Lotte coachen de twee hockeyteams die momenteel op het veld staan. Plotseling ontstaat er een grote vechtpartij tussen de twee teams, maar ze grijpen niet allebei direct in. Anna roept haar speelsters tot de orde, maar Lotte helaas niet. Het wordt echt een drama!

28a. Eva en Maud bereiden zich voor op de Olympische Spelen van Athene. Eva zit in een behoorlijk dipje, of zeg maar gerust een dip! Eva is de enige van de twee topsportsters die verwacht dat haar topvorm nog op tijd gaat komen om een kans te maken op een medaille. Je moet nu eenmaal in supervorm zijn wil je op het podium belanden.
28b. Eva en Maud bereiden zich voor op de Olympische Spelen van Athene. Zij zitten allebei in een behoorlijk dipje, of zeg maar gerust een dip! Eva is de enige van de twee topsportsters die verwacht dat haar topvorm nog op tijd gaat komen om een kans te maken op een medaille. Je moet nu eenmaal in supervorm zijn wil je op het podium belanden.
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28d. Eva en Maud bereiden zich voor op de Olympische Spelen van Athene. Zij zitten allebei in een behoorlijk dipje, of zeg maar gerust een dip! Van de twee topsportsters verwacht Eva dat haar topvorm nog op tijd gaat komen om een kans te maken op een medaille, maar Maud niet. Je moet nu eenmaal in supervorm zijn wil je op het podium belanden.

29a. Jos Verstappen en zeker zijn manager Sjakie zijn ontzettend blij dat Jos weer mag gaan racen. Voor het nieuwe team rijdt Jos in een felle oranje F1-auto. Helaas vindt alleen Jos zijn nieuwe wagen mooi. Maar eigenlijk is het het belangrijkste dat er eindelijk weer wat geld verdiend wordt om al die verkeersbonnen een keer te betalen.
29b. Jos Verstappen en zeker zijn manager Sjakie zijn ontzettend blij dat Jos weer mag gaan racen. Voor het nieuwe team rijdt Jos in een felle oranje F1-auto en Sjakie in een oranje cabrio. Helaas vindt alleen Jos zijn nieuwe wagen mooi. Maar eigenlijk is het het belangrijkste dat er eindelijk weer wat geld verdiend wordt om al die verkeersbonnen een keer te betalen.
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30a. Arnold en Peter waren blij toen de Tweede Wereld Oorlog was afgelopen. Toch moest Arnold waarschijnlijk een beetje uitkijken, want hij was het neefje van Hitler. Arnold dacht als enige dat zijn achternaam niet voor problemen zou zorgen. Wat heb je toch een naïeve mensen op deze wereld. 30b. Arnold en Peter waren blij toen de Tweede Wereld Oorlog was afgelopen. Toch moesten zij waarschijnlijk een beetje uitkijken, want zij waren de neefjes van respectievelijk Hitler en Himmler. Arnold dacht als enige dat zijn achternaam niet voor problemen zou zorgen. Wat heb je toch een naïeve mensen op deze wereld.
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31a. Dave en Wouter zijn inmiddels 27 jaar. Dave rommelt maar wat aan met zijn werk, maar maakt zich daar niet druk om. Van de twee vrienden vindt alleen Dave dat zijn toekomst er toch rooskleurig uitziet. Nou ja, er is eigenlijk ook niets mis met een beetje optimisme.
31b. Dave en Wouter zijn inmiddels 27 jaar. Zij rommelen maar wat aan met hun werk, maar maken zich daar niet even druk om. Van de twee vrienden vindt alleen Dave dat zijn toekomst er toch rooskleurig uitziet. Nou ja, er is eigenlijk ook niets mis met een beetje optimisme.
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32a. De rappers Eminem en P-Diddy brengen tegelijkertijd hun nieuwst elpee uit. Eminem lijkt vol vertrouwen, zoals altijd. Maar van de twee popsterren denkt eigenlijk alleen Eminem dat zijn nieuwe album het goed gaat doen. Eerlijk gezegd valt het gewoon niet te voorspellen.
32b. De rappers Eminem en P-Diddy brengen tegelijkertijd hun nieuwst elpee uit. Zij lijken allebei vol vertrouwen, zoals altijd. Maar van de twee popsterren denkt eigenlijk alleen Eminem dat zijn nieuwe album het goed gaat doen. Eerlijk gezegd valt het gewoon niet te voorspellen.
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33a. Jennifer Lopez en Madonna treden samen op in een nieuwe show. J-Lo gedraagt zich soms alsof zij de wereld bezit en is daar zelfs trots op. Als enige schaamt J-Lo zich nooit voor haar diva-gedrag. Roem kan blijkbaar vreemde dingen met je doen.
33b. Jennifer Lopez en Madonna treden samen op in een nieuwe show. Zij gedragen zich soms alsof zij de wereld bezitten, maar zijn daar niet allebei even trots op. Als enige schaamt J-Lo zich nooit voor haar diva-gedrag. Roem kan blijkbaar vreemde dingen met je doen.
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34a. De favoriete bezigheid van Kim en Tessa is toch wel knippen en plakken. Vooral Kim maakt vaak een creatief doch plakkerig kunststuk. Kim denkt als enige dat haar werk ooit in het Stedelijk Museum zal hangen. Het zal allemaal sowieso nog wel een tijdje duren, aangezien ze pas vier jaar oud zijn.
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35a. Het is zover, Maaike en Wendy gaan nu echt samen fietsen in Tibet. De plannen die Maaike maakt, worden per week wilder en wilder. Maaike denkt als enige dat haar conditie goed genoeg is om het basiskamp op de Mount Everest te bereiken. Ze zullen daar raar opkijken als iemand op een fietsje aan komt rijden.
35b. Het is zover, Maaike en Wendy gaan nu echt samen fietsen in Tibet. De plannen die ze maken, worden per week wilder en wilder. Maaike denkt als enige dat haar conditie goed genoeg is om het basiskamp op de Mount Everest te bereiken. Ze zullen daar raar opkijken als iemand op een fietsje aan komt rijden.
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36a. Zwemmen op de Zuidpool is het coolste wat Pien en Jolijn in hun leven hebben gedaan. Een beetje hachelijk was toch wel het moment dat Pien met een orka aan het spelen was. Pien had als enige niet door dat haar leven in gevaar was. In het Engels heten orka's heten niet voor niets "killer whales".
36b. Zwemmen op de Zuidpool is het coolste wat Pien en Jolijn in hun leven hebben gedaan. Een beetje hachelijk was toch wel het moment dat zij met een orka aan het spelen waren. Pien had als enige niet door dat haar leven in gevaar was. In het Engels heten orka's heten niet voor niets "killer whales".
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Appendix III

Stimuli Experiment 4 (Chapter 3)

(a = VB-bias; b = CR-bias; c =VB-only; d = CR-only; e = VB/CR-all; f = VB/CR-proper-name; \ = line break; stories 1-24 were used in the analysis of the VB-bias and CR-bias condition)

1a. Voor een bruisend studentenleven moet\ je in Groningen zijn. Veel studenten,\ waaronder Gijs, besteden dan ook veel te veel\ tijd aan feesten en lezen niets. Iedere student\ die net zoals Gijs eigenlijk geen boek aanraakt,\ weet vrijwel zeker dat hij langer dan vier jaar over\ zijn studie zal doen. Dat wordt dus lenen!
1b. Voor een bruisend studentenleven moet je in Groningen\ zijn. De student Gijs besteedt dan ook veel te veel\ tijd aan feesten en leest niets. Iedere student\ die ziet dat Gijs eigenlijk geen boek aanraakt,\ weet vrijwel zeker dat hij langer dan vier jaar over\ zijn studie zal doen. Dat wordt dus lenen!
1c. Voor een bruisend studentenleven moet je in\ Groningen zijn. Veel studenten besteden dan\ ook veel te veel tijd aan feesten en lezen niets.\ Iedere student die eigenlijk geen boek aanraakt,\ weet vrijwel zeker dat hij langer dan vier jaar over\ zijn studie zal doen. Dat wordt dus lenen!
1d. Voor een bruisend studentenleven moet je\ in Groningen zijn. De student Gijs besteedt\ dan ook veel te veel tijd aan feesten en leest\ niets. Gijs raakt eigenlijk geen boek aan. Het\ is vrijwel zeker dat hij langer dan vier jaar over\ zijn studie zal doen. Dat wordt dus lenen!
1e. Voor een bruisend studentenleven moet je in\ Groningen zijn. Veel studenten besteden dan\ ook veel te veel tijd aan feesten en lezen niets.\ Alle studenten die eigenlijk geen boek aanraken,\ weten vrijwel zeker dat zij langer dan vier jaar over\ hun studie zullen doen. Dat wordt dus lenen!
1f. Voor een bruisend studentenleven moet\ je in Groningen zijn. De student Gijs\ besteedt dan ook veel te veel tijd aan feesten en\ leest niets. Gijs, die eigenlijk geen boek aanraakt,\ weet vrijwel zeker dat hij langer dan vier jaar over\ zijn studie zal doen. Dat wordt dus lenen!

2a. Er woedde een hevige brand in een oude loods.\ Toen de loods plotseling instortte, raakten\ enkele brandweermannen, waaronder Paul, helaas\ gewond. Elke brandweerman die samen met Paul\ snel werd afgevoerd naar het ziekenhuis, vond\ het erg jammer dat hij nu niet meer mee kon helpen.\ Je wilt als brandweerman natuurlijk niet verslagen\ worden door een brand.
2b. Er woedde een hevige brand in een oude loods. Toen\ de loods plotseling instortte, raakte brandweerman\ Paul helaas gewond. Elke brandweerman die zag hoe\ Paul snel werd afgevoerd naar het ziekenhuis, vond\ het erg jammer dat hij nu niet meer mee kon helpen.\ Je wilt als brandweerman natuurlijk niet verslagen\ worden door een brand.
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3a. De politiek is maar een apart wereldje.\ Zo wringen veel politici, waaronder Balkenende,\ zich in allerlei bochten om vooral maar\ niets te zeggen. Iedere politicus die net als\ Balkenende de gewoonte heeft vragen te ontwijken,\ geeft als reden dat hij bang is om afgerekend te\ worden op onbedoelde beloftes. Vandaar dat vage en\ onduidelijke antwoorden de boventoon voeren.
3b. De politiek is maar een apart wereldje.\ Zo wringt Balkenende zich in allerlei bochten\ om vooral maar niets te zeggen. Iedere politicus\ die de gewoontes van Balkenende een beetje kent,\ geeft als reden dat hij bang is om afgerekend te\ worden op onbedoelde beloftes. Vandaar dat vage en\ onduidelijke antwoorden de boventoon voeren.
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4a. Wimbledon is het belangrijkste tennistoernooi\ van het jaar. Voor proftennissers, waaronder Sjeng\ Schalken, is het winnen van dit toernooi dan ook\ het hoogst haalbare. Elke profspeler die zich ieder\ jaar weer net zo perfect voorbereidt als Sjeng, acht\ het mogelijk dat hij dankzij deze volledige inzet ooit\ eens zal triomferen. Een tenniscarrière kan daarna\ niet meer mislukken.
4b. Wimbledon is het belangrijkste tennistoernooi\ van het jaar. Voor proftennisser Sjeng Schalken\ is het winnen van dit toernooi dan ook het\ hoogst haalbare. Elke profspeler die ieder jaar\ weer de perfecte voorbereiding van Sjeng ziet, acht\ het mogelijk dat hij dankzij deze volledige inzet ooit\ eens zal triomferen. Een tenniscarrière kan daarna\ niet meer mislukken.
4c.Wimbledon is het belangrijkste tennistoernooi van\ het jaar. Voor proftennissers is het winnen van dit\ toernooi dan ook het hoogst haalbare. Elke profspeler\ die zich ieder jaar weer perfect voorbereidt, acht\ het mogelijk dat hij dankzij deze volledige inzet ooit\ eens zal triomferen. Een tenniscarrière kan daarna\ niet meer mislukken.
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5a. Het grote dorpsfeest is weer in aantocht.\ Veel boeren uit de omgeving, waaronder Piet,\ laten de koe dan even de koe. Elke boer die zich\ net als Piet tegoed zal doen aan bier en worst, weet\ eigenlijk nu al dat hij uiteindelijk ladderzat met de\ tractor naar huis gaat. Gelukkig gaat een beetje\ tractor niet veel harder dan dertig kilometer per uur.
5b. Het grote dorpsfeest is weer in aantocht. Boer\ Piet komt altijd en laat de koe dan even de koe.\ Elke boer die de drinkgewoontes van Piet kent, weet\ eigenlijk nu al dat hij uiteindelijk ladderzat met de\ tractor naar huis gaat. Gelukkig gaat een beetje\ tractor niet veel harder dan dertig kilometer per uur.
5c. Het grote dorpsfeest is weer in aantocht. Veel boeren\ uit de omgeving laten de koe dan even de koe. Elke\ boer die zich tegoed zal doen aan bier en worst, weet\ eigenlijk nu al dat hij uiteindelijk ladderzat met de\ tractor naar huis gaat. Gelukkig gaat een beetje\ tractor niet veel harder dan dertig kilometer per uur.

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6a. De belangrijke finale ging weer eens\ tussen Ajax en PSV. Helaas raakten de spelers\ van Ajax, waaronder de aanvoerder Johan, geen\ één bal goed. Iedere Ajax-speler die samen\ met Johan toch voortdurend zijn best deed, wenste\ natuurlijk wel dat hij snel beloond zou worden voor\ deze inzet. Anders zou er zeker een kleedkamertje\ sneuvelen.
6b. De belangrijke finale ging weer eens tussen Ajax en\ PSV. Helaas raakte Johan, de aanvoerder van Ajax,\ geen één bal goed. Iedere Ajax-speler die zag hoe\ Johan toch voortdurend zijn best deed, wenste\ natuurlijk wel dat hij snel beloond zou worden voor\ deze inzet. Anders zou er zeker een kleedkamertje\ sneuvelen.
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7a. Een werkweek bestaat eigenlijk voornamelijk\ uit het uitzien naar zaterdag. Veel werknemers,\ zoals Guido, zullen dat zeker beamen. Iedere\ werknemer die net als Guido al op maandag\ over het weekend droomt, weet natuurlijk maar\ al te goed dat hij dan lekker lang in bed blijft\ liggen. Maar wat duurt een week toch lang!!
7b. Een werkweek bestaat eigenlijk voornamelijk\ uit het uitzien naar zaterdag. Guido zal dat\ zeker beamen. Iedere werknemer die de gewoontes\ van Guido een beetje kent, weet natuurlijk maar\ al te goed dat hij dan lekker lang in bed blijft\ liggen. Maar wat duurt een week toch lang!!
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8a. In Almelo was even sprake van een kleine politieke\ crisis. Enkele wethouders en tevens burgemeester de\ Vries waren het namelijk pas na vele uren debatteren\ eens met een voorstel. Iedere wethouder die net als\ burgemeester de Vries lang had getwijfeld, was\ ervan overtuigd dat hij uiteindelijk de juiste\ beslissing had genomen. Al moest de toekomst dat\ natuurlijk uitwijzen.
8b. In Almelo was even sprake van een kleine\ politieke crisis. Burgemeester de Vries was het\ namelijk pas na vele uren debatteren eens met\ een voorstel. Iedere wethouder die meer van het\ onderwerp wist dan burgemeester de Vries, was\ ervan overtuigd dat hij uiteindelijk de juiste\ beslissing had genomen. Al moest de toekomst dat\ natuurlijk uitwijzen.

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9a. Gedurende een schaakwedstrijd worden de\ stukken soms achteloos verschoven. Vooral\ grootmeesters, waaronder Kasparov, lijken dan\ heel snel alle mogelijkheden te berekenen. Iedere\ grootmeester die net als Kasparov computerachtige\ trekjes lijkt te vertonen, geeft daarentegen\ de verklaring dat hij gewoon bepaalde stellingen\ herkent. Als je een stelling herkent, weet je\ natuurlijk veel sneller wat je moet doen.
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10a. Onze samenleving is duidelijk aan het veranderen.\ Eerst vonden bijna alle Nederlanders,\ zoals Victor, geld het belangrijkste\ in hun leven. Iedereen die net als Victor\ vooral een dikke vette bankrekening wilde, ziet\ nu gelukkig in dat hij uiteindelijk kapot zal gaan\ aan dat streven. Geld is een middel, geen doel op\ zich.
10b. Onze samenleving is duidelijk aan het veranderen.\ Eerst vond Victor, een echte Nederlander, geld\ het belangrijkste in zijn leven. Iedereen die in\ het begin Victor aanmoedigde rijk te worden, ziet\ nu gelukkig in dat hij uiteindelijk kapot zal gaan\ aan dat streven. Geld is een middel, geen doel op\ zich.
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11a. Door de feestdagen en de bijbehorende kadootjes\ is december een vrij stressvolle maand voor\ kinderen. Vooral veel jongens, zoals Niels,\ balen dan erg van hun gedrag. Elke jongen die\ net als Niels het hele jaar stout is, weet\ eigenlijk zeker dat hij de mooie kado's wel kan\ vergeten. Waarschijnlijk geeft de kerstman dit jaar\ weer een sjaal, of nog erger, een appel.
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12a. Zoals elk jaar werd in december 2003 de Gouden\ Loeki uitgereikt voor het beste reclamespotje.\ Bijna alle genomineerden, waaronder Vincent,\ waren aanwezig tijdens de grootse uitreiking.\ Iedere genomineerde die net als Vincent tot\ de echte kanshebbers behoorde, was er eigenlijk\ zeker van dat hij die avond de bokaal mee naar\ huis zou nemen. Die zou vast en zeker mooi staan\ op de schoorsteenmantel.
12b. Zoals elk jaar werd in december 2003 de Gouden Loeki\ uitgereikt voor het beste reclamespotje. Vincent\ was genomineerd en aanwezig tijdens de grootse\ uitreiking. Iedere genomineerde die het perfecte\ werk van Vincent had gezien, was er eigenlijk\ zeker van dat hij die avond de bokaal mee naar\ huis zou nemen. Die zou vast en zeker mooi staan\ op de schoorsteenmantel.
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13a. Carré is één van de belangrijkste podia in Nederland.\ Veel toneelspelers, waaronder Hans, zien in dat een\ optreden in Carré hun carrière een behoorlijk duwtje\ in de rug kan geven. Iedere toneelspeler die net\ als Hans keihard werkt om beroemd te worden, hoopt\ dan ook echt dat hij ooit eens mag aantreden in\ Carré. Zo'n eerste optreden zal natuurlijk wel\ zenuwslopend zijn.
13b. Carré is één van de belangrijkste podia in\ Nederland. De toneelspeler Hans ziet in dat een\ optreden in Carré zijn carrière een behoorlijk\ duwtje in de rug kan geven. Iedere toneelspeler die\ veel respect heeft voor het werk van Hans, hoopt\ dan ook echt dat hij ooit eens mag aantreden in\ Carré. Zo'n eerste optreden zal natuurlijk wel\ zenuwslopend zijn.
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14a. Het is tegenwoordig maar moeilijk\ overleven op een middelbare school. Zo moeten\ docenten, zoals bijvoorbeeld Huib, erg hun best\ doen om populair te zijn. Iedere docent die net\ als Huib probeert cool over te komen, is wel\ een beetje bang dat hij daardoor minder autoriteit\ uitstraalt. Maar wat moet je anders, als streng zijn\ geen enkel effect heeft?
14b. Het is tegenwoordig maar moeilijk overleven op een\ middelbare school. Zo moet Huib als docent erg zijn\ best doen om populair te zijn. Iedere docent die\ ziet dat Huib probeert cool over te komen, is wel\ een beetje bang dat hij daardoor minder autoriteit\ uitstraalt. Maar wat moet je anders, als streng zijn\ geen enkel effect heeft?
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15a. Verliefd zijn heeft dezelfde werking als een sterke\ drug. Veel verliefde mannen, zoals Tim, zullen\ dat zeker beamen. Iedere man die momenteel net\ als Tim in een droomwereld leeft, weet echter maar\ al te goed dat hij ooit weer met beide benen op de\ grond zal staan. Dat is maar goed ook, want anders\ zou er van werken weinig terechtkomen.
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16a. Het heeft ook nadelen om ontzettend beroemd\ te zijn. Zo hebben veel muzikanten, waaronder\ Robbie Williams, de grootste moeite hun leven\ op de rails te houden. Iedere muzikant die\ net als Robbie niet goed tegen de druk kan, is\ ontzettend bang dat hij continu verslaafd raakt aan\ het één of ander. De verleidingen van drugs en drank\ zijn nu eenmaal groot.
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18a. Vreemdgaan is al zo oud als de mensheid. Veel mannen\ en ook Max kunnen daarover meepraten. Iedere man\ die net als Max vaak in de verleiding komt, hoopt\ over het algemeen dat hij sterk en dus trouw zal\ zijn als de volgende kans zich aandient. Monogamie\ staat in onze samenleving immers nog steeds hoog in\ het vaandel.
18b. Vreemdgaan is al zo oud als de mensheid.\ Max kan daarover meepraten. Iedere man\ die weet dat Max graag wil veranderen, hoopt\ over het algemeen dat hij sterk en dus trouw zal\ zijn als de volgende kans zich aandient. Monogamie\ staat in onze samenleving immers nog steeds hoog in\ het vaandel.
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19a. De mensheid wordt al sinds haar ontstaan\ gefascineerd door vliegen. Piloten, zoals Marcel,\ zijn daar natuurlijk een goed voorbeeld van.\ Iedere piloot die net als Marcel kort geleden\ zijn vliegbrevet heeft gehaald, voorspelt met\ veel zekerheid dat hij nooit de dag van zijn\ eerste vlucht zal vergeten. Het valt namelijk te\ vergelijken met een engel die zijn vleugels krijgt.
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20a. In feite is de wetenschap een nieuwe religie die enige\ zin geeft aan het leven. Wetenschappers als Albert\ zijn in zo'n vergelijking trouwe volgelingen van een\ godsdienst. Elke wetenschapper die net zoals Albert\ dag en nacht bezig is met dit nieuwste geloof, is\ ervan overtuigd dat hij daarmee bijdraagt aan de\ vooruitgang van de mens. Het blijft natuurlijk wel\ de vraag wat vooruitgang nu precies is.
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21a. De derde etappe van de Tour de France stond\ vandaag op het programma. De toeschouwers,\ waaronder Erik, zagen aan de donkere lucht dat\ het snel ging regenen. Elke toeschouwer die\ daar net als Erik niet op gerekend had, vond het\ natuurlijk dom dat hij geen paraplu had meegenomen.\ Als je een hele dag van huis bent, moet je op regen\ voorbereid zijn.
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22a. De politie is vaak sneller op de plaats\ van een medisch spoedgeval dan de ambulance.\ Daarom leren veel politieagenten, zoals Rogier,\ momenteel belangrijke eerste-hulp technieken.\ Iedere agent die net als Rogier hard moet\ leren voor het ingewikkelde examen, vertelt met\ veel overtuiging dat hij graag tijd vrijmaakt om deze\ vaardigheden onder de knie te krijgen. Levens redden\ is immers een nobele bezigheid.
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23b. Het is een bekend gegeven dat bij het maken van\ een film nooit al het materiaal gebruikt wordt. Toch\ was de acteur Brad erg teleurgesteld bij de première\ van zijn film 'Anarchie'. Iedere acteur die samen\ met Brad naar het uiteindelijke resultaat keek, had\ namelijk door dat hij minstens uit tien scènes was\ geknipt. Dat was een beetje teveel van het goede.
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24a. Morgen begint het jaarlijkse padvindersfestijn.\ Veel nieuwe padvinders, waaronder Simon,\ zullen hutten bouwen en oude vrouwtjes helpen\ oversteken. Iedere padvinder die net als Simon\ van de spanning haast niet kan slapen, verwacht\ zonder enige twijfel dat hij een ontzettend leuke tijd\ tegemoet gaat en na afloop een lintje krijgt. Een\ padvinder zonder lintje is namelijk zoiets als een\ piraat zonder ooglapje.
24b. Morgen begint het jaarlijkse\ padvindersfestijn. Simon zal dan als nieuwe\ padvinder hutten bouwen en oude vrouwtjes helpen\ oversteken. Iedere padvinder die weet dat Simon\ van de spanning haast niet kan slapen, verwacht\ zonder enige twijfel dat hij een ontzettend leuke tijd\ tegemoet gaat en na afloop een lintje krijgt. Een\ padvinder zonder lintje is namelijk zoiets als een\ piraat zonder ooglapje.
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25a. Kansspelletjes lijken eigenlijk heel\ onschuldig. Waarom kunnen veel gokverslaafden,\ zoals Ron, dan niet stoppen met gokken? Iedere\ gokverslaafde die net als Ron soms tienduizenden\ euro's verbrast, legt uit dat er een fysieke\ pijn ontstaat, als hij niet regelmatig gokt. Er is\ dus echt sprake van een lichamelijke afhankelijkheid.
25b. Kansspelletjes lijken eigenlijk heel\ onschuldig. Waarom kan gokverslaafde Ron dan\ niet stoppen met gokken? Iedere gokverslaafde\ die wel begrijpt dat Ron soms tienduizenden\ euro's verbrast, legt uit dat er een fysieke\ pijn ontstaat, als hij niet regelmatig gokt. Er is\ dus echt sprake van een lichamelijke afhankelijkheid.
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26a. Het is soms niet echt prettig om in de keuken van\ een goed restaurant te werken. Bijna alle chefkoks,\ waaronder Charles, dulden namelijk geen enkele\ tegenspraak. Elke chefkok die net als Charles\ autoriteit hoog in het vaandel heeft staan, stelt\ zelfs overduidelijk dat hij de keuken beschouwt als\ zijn koninkrijk. Daar moet geluisterd worden naar\ 'de koning'.

26b. Het is soms niet echt prettig om in de keuken\ van een goed restaurant te werken. Charles, de\ chefkok van het Hilton, duldt namelijk geen enkele\ tegenspraak. Elke chefkok die weet dat Charles\ autoriteit hoog in het vaandel heeft staan, stelt\ zelfs overduidelijk dat hij de keuken beschouwt als\ zijn koninkrijk. Daar moet geluisterd worden naar\ 'de koning'.
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27a. Na een botsing tussen een bruine Porsche en een\ gele Lada, arriveerde de politie. De betrokkenen\ bij het ongeluk, waaronder Bas, werden pittig\ ondervraagd. Iedere betrokkene die net zoals Bas\ helemaal niets fout had gedaan, vertelde dit aan\ de politie, voordat hij misschien gearresteerd zou\ worden. Dat zou namelijk onterecht zijn.
27b. Na een botsing tussen een bruine Porsche\ en een gele Lada, arriveerde de politie.\ Bas was betrokken bij het ongeluk en werd pittig\ ondervraagd. Iedere betrokkene die had gezien dat Bas\ helemaal niets fout had gedaan, vertelde dit aan\ de politie, voordat hij misschien gearresteerd zou\ worden. Dat zou namelijk onterecht zijn.
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28a. In de hoogovens aan het Noordzeekanaal wordt altijd\ hard gewerkt. Vandaag hadden veel arbeiders, waaronder\ de oude Nico, het echt te zwaar. Iedere arbeider\ die net zoals Nico op instorten stond, vond het\ heel erg fijn dat hij eerder naar huis mocht van de\ baas. Een verkwikkende douche zou de pijn hopelijk\ verzachten.
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30a. Houthakken is echt een mannenberoep. Veel houthakkers,\ zoals Lars, dragen dan ook altijd stoere geblokte\ overhemden. Iedere houthakker die net als Lars\ zo'n hemd als een driedelige pak beschouwt, heeft\ zelfs het idee dat hij zonder geblokt overhemd niet\ goed werkt. Het voelt waarschijnlijk gewoon niet\ lekker.
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32a. Het was een schitterende zomerse dag en druk\ op het strand. Een grote groep strandgangers,\ waaronder Frans, lag lekker te bakken op het\ warme zand, maar sommigen waren te lui om zich\ in te smeren. Elke strandganger die net als\ Frans niet de moeite nam zich te beschermen, zag\ al vrij snel dat hij helemaal rood werd. Dat is dus\ typisch een voorbeeld van: eigen schuld, dikke bult!
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33a. Het was op oudejaarsavond erg druk in het\ VU-ziekenhuis. Vrijwel alle dokters, waaronder\ dokter Evert, werden onverwacht opgeroepen\ om de vele gewonden van de vreselijke brand\ in Volendam te behandelen. Iedere arts die\ net als Evert eigenlijk geen dienst had, wist\ natuurlijk wel dat hij een beetje teveel had\ gedronken. Maar in zo'n situatie moet je roeien\ met de riemen die je hebt.
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Pinkeltje\ officieel in staking was gegaan, verklaarde tijdens\ een persconferentie dat hij zelfs over lijken zou\ gaan. Zo zou Sneeuwwitje wel eens 'een ongelukje'\ kunnen krijgen, als er niet snel iets gebeurde.
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36a. Thailand staat bekend om zijn tempels en zwoele\ zomeravonden. Veel mensen, waaronder Rick, hebben dan\ ook Thailand bezocht om cultuur te snuiven en lekker\ te luieren. Iedereen die net als Rick ruim een half\ jaar in dit land heeft rondgezworven, merkt zonder\ enige twijfel dat hij gedurende zijn verblijf\ duidelijk een andere kijk op het leven heeft\ gekregen. De mysterieuze Thaise glimlach zorgt\ daar wel voor.
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Appendix IV

Stimuli Experiment 5 (Chapter 3)

(a = LQ; b = RQ; c =RCC; d = RnoCC; \ = line break)

1a. De meeste barmannen zitten al decennia helemaal\ vastgeroest in een ordinaire kroeg. Iedereen\ droomde natuurlijk nog wel gedurende de eerste\ paar jaar dat hij zou groeien binnen het bedrijf en\ uiteindelijk misschien zijn eigen bar zou openen,\ maar dromen vervliegen.

1b. De meeste barmannen zitten al decennia helemaal\ vastgeroest in een ordinaire kroeg. Iedere barman\ droomde natuurlijk nog wel gedurende de eerste\ paar jaar dat hij zou groeien binnen het bedrijf en\ uiteindelijk misschien zijn eigen bar zou openen,\ maar dromen vervliegen.

1c. Een barman zit al decennia helemaal\ vastgeroest in een ordinaire kroeg. De barman\ droomde natuurlijk nog wel gedurende de eerste\ paar jaar dat hij zou groeien binnen het bedrijf en\ uiteindelijk misschien zijn eigen bar zou openen,\ maar dromen vervliegen.

1d. Een barman zit al decennia helemaal\ vastgeroest in een ordinaire kroeg. De barman\ droomde natuurlijk nog wel gedurende de eerste\ paar jaar. Hij zou groeien binnen het bedrijf en\ uiteindelijk misschien zijn eigen bar openen,\ maar dromen vervliegen.

2a. Een aantal bergbeklimmers is gisteren doodsbenauwd\ aan de beklimming van de gevaarlijkste berg\ in het Himalaya-gebergte begonnen.\ Iedereen is bij elke stap van de onzinnige\ onderneming bang dat hij zal eindigen als een smakelijk\ Yeti-ijsje en dus roemloos ten onder gaat.

2b. Een aantal bergbeklimmers is gisteren doodsbenauwd\ aan de beklimming van de gevaarlijkste berg\ in het Himalaya-gebergte begonnen.\ Iedere bergbeklimmer is bij elke stap van de onzinnige\ onderneming bang dat hij zal eindigen als een smakelijk\ Yeti-ijsje en dus roemloos ten onder gaat.

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3a. De generale repetitie van het toneelstuk\ was een complete ramp. Iedereen moest\ toegeven dat hij had gestunteld, vooral in\ het tweede bedrijf.

3b. De generale repetitie van het toneelstuk\ was een complete ramp. Iedere hoofdrolspeler moest\ toegeven dat hij had gestunteld, vooral in\ het tweede bedrijf.

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4a. Laatst werd aan een groep journalisten van het Parool\ gevraagd of het wel een ethisch beroep is waarin altijd\ de waarheid wordt beschreven. Iedereen gaf na een\ moment van innerlijke strijd toe dat hij moest beamen\ niet altijd zeker te weten of een artikel volledig in\ overeenstemming was met de feiten.

4b. Laatst werd aan een groep journalisten van het Parool\ gevraagd of het wel een ethisch beroep is waarin altijd\ de waarheid wordt beschreven. Iedere journalist gaf na een\ moment van innerlijke strijd toe dat hij moest beamen\ niet altijd zeker te weten of een artikel volledig in\ overeenstemming was met de feiten.

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5a. De beroemdste, knapste en rijkste acteurs van de\ wereld kwamen weer eens naar een dertien-in-een-dozijn\ cocktailparty om mee te doen aan een wedstrijdje\ wie-versiert-het-mooiste-meisje. En natuurlijk was\ iedereen weer vol vertrouwen dat hij had gewonnen en\ toch echt het lekkerste meisje van de zaal had gescoord.
5b. De beroemdste, knapste en rijkste acteurs van de\ wereld kwamen weer eens naar een dertien-in-een-dozijn\ cocktailparty om mee te doen aan een wedstrijdje\ wie-versiert-het-mooiste-meisje. En natuurlijk was\ iedere acteur weer vol vertrouwen dat hij had gewonnen en\ toch echt het lekkerste meisje van de zaal had gescoord.
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6a. De gelovigen uit Urk leken een rotsvast vertrouwen in een\ leven na de dood te hebben. Iedereen bracht echter\ kort geleden het schokkende nieuws dat hij is veranderd en\ vreest na het sterven erachter te komen dat de hemel niet\ bestaat, hoe paradoxaal dat ook mag klinken.
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7a. Het is niet goed als een land te lang bestuurd\ wordt door dezelfde president. Iedereen\ gaat namelijk na een aantal jaren van regeren\ denken dat alleen hij kan voorkomen dat het land\ verandert in een chaos en daarmee onmisbaar is.
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8a. Een groep beginnende advocaten uit Den Helder had\ het idealistische wereldbeeld dat rechtspraak om de\ waarheid draait. Iedereen leerde echter met vallen \ en opstaan dat hij had gedroomd en in de praktijk de\ waarheid een beetje moest masseren om ooit een zaak\ te kunnen winnen.
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9a. Matrozen die vaak maandenlang van huis gaan,\ hebben hulp van boven nodig. Tijdens de lange\ reizen probeert iedereen God en Neptunes\ gunstig te stemmen zodat hij zal overleven en\ dus in staat zal zijn op te scheppen over\ zeemeerminnen en reusachtige zeeslangen.
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10a. Dat schrijvers vaak maar wat in de breedte lullen,\ werd wel duidelijk na een mini-onderzoekje van\ de Volkskrant onder deze zeer gerespecteerde\ bevolkingsgroep. Iedereen gaf namelijk\ volmondig toe dat hij schrijft en dicht om\ handtekeningen uit te delen en mooie meisjes\ te krijgen.
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11a. Het was echt grappig hoe bekende en rijke Nederlanders\ reageerden op de vraag of ons sociale stelsel veranderd\ moest worden. Iedereen declameerde zonder\ enige vorm van schaamte dat hij ging verhuizen om zijn zuur\ verdiende centjes te behouden.
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12a. Nederland kent al jaren geen echte winter meer en dat is\ een probleem voor de Friezen. Iedereen moet toch onder\ ogen zien dat hij moet rekenen op een toekomst zonder\ Elfstedentocht.
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14a. De Amsterdamse huisbazen staan bekend om hun gierigheid,\ wat ten koste gaat van de kwaliteit van de woningen. \ Bij navraag geeft iedereen zelfs zonder blikken of\ blozen toe dat hij wil verdienen en dat gaat nu eenmaal\ het beste als je zo weinig mogelijk uitgeeft aan onderhoud.

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15a. De zakenmannetjes in de saaie standaard\ Hollywood-film jaagden natuurlijk de eeuwige\ 'American Dream' na. Zo droomde iedereen\ elke minuut van de dag dat hij zou slagen in\ het leven en in de toekomst een groot en machtig\ bedrijf zou runnen.
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16a. De studentjes wilden ook wel eens een keer\ zelf een eye-tracking experiment ontwerpen\ en uitvoeren. Iedereen begon enorm op\ te scheppen dat hij zou gaan publiceren binnen\ een maandje, maar dat bleek natuurlijk niet het\ geval.
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17a. Dichters hebben een enorm ego en voelen\ zich door goed bedoelde kritiek altijd\ diep geraakt. Blijkbaar vergeet iedereen \ tijdens het schrijven dat hij moet accepteren dat\ hij gewoon hele goede sinterklaasrijmpjes maakt.
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18a. Het was oorlog in Soedan en de soldaten aan de\ frontlinie waren constant met de dood bezig.\ Iedereen was ontzettend bang dat hij zou sterven\ op het bloedige slagveld.
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19a. Universiteit Utrecht komt dit jaar met de beste\ opleiding aller tijden, wat ervoor zorgt dat de studenten\ helemaal doordraaien. Iedereen bidt namelijk de hele\ dag tot God dat hij moet worden toegelaten tot deze\ prestigieuze master, anders heeft het leven geen zin meer.
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23b. Uit een recent interview met een aantal tuinmannen\ bleek dat het een zeer geisoleerd beroep is.\ Iedere tuinman gaf namelijk met een brok in de\ keel toe dat hij vereenzaamt en bijna elke dag\ heimelijk tegen de bloemen en planten praat om\ toch nog enige aanspraak te hebben.

23c. Uit een recent interview met een tuinman\ bleek dat het een zeer geisoleerd beroep is.\ De tuinman gaf namelijk met een brok in de\ keel toe dat hij vereenzaamt en bijna elke dag\ heimelijk tegen de bloemen en planten praat om\ toch nog enige aanspraak te hebben.
23d. Uit een recent interview met een tuinman\ bleek dat het een zeer geisoleerd beroep is.\ De tuinman gaf het namelijk met een brok in de\ keel toe. Hij vereenzaamt en bijna elke dag\ praat hij heimelijk tegen de bloemen en planten\ om toch nog enige aanspraak te hebben.

24a. Als undercover-agent ben ik erachter gekomen dat\ alle bekende criminelen uit het wereldje willen\ stappen. Iedereen beaamde namelijk tijdens een\ emotioneel gesprek dat hij is veranderd en na tientallen\ liquidaties eigenlijk niet meer in staat is om mensen een\ kopje kleiner te maken.
24b. Als undercover-agent ben ik erachter gekomen dat\ alle bekende criminelen uit het wereldje willen\ stappen. Iedere crimineel beaamde namelijk tijdens een\ emotioneel gesprek dat hij is veranderd en na tientallen\ liquidaties eigenlijk niet meer in staat is om mensen een\ kopje kleiner te maken.
24c. Als undercover-agent ben ik erachter gekomen dat\ een bekende crimineel uit het wereldje wil\ stappen. De crimineel beaamde namelijk tijdens een\ emotioneel gesprek dat hij is veranderd en na tientallen\ liquidaties eigenlijk niet meer in staat is om mensen een\ kopje kleiner te maken.
24d. Als undercover-agent ben ik erachter gekomen dat\ een bekende crimineel uit het wereldje wil\ stappen. De crimineel beaamde het namelijk tijdens een\ emotioneel gesprek. Hij is veranderd en na tientallen\ liquidaties eigenlijk niet meer in staat om mensen een\ kopje kleiner te maken.

Appendix V

Stimuli Experiment 6 & 7 (Chapter 5)

(a = consistent; b = inconsistent; \ = line break; stories 1- 20 = NP1 verbs; stories 21-40 = NP2 verbs)

1a. Dirk en Maartje waren afgelopen zaterdag\ samen gaan winkelen, maar het werd niet\ echt een gezellige dag. Dirk verveelde Maartje\ omdat hij al vanaf het begin van de dag\ ontzettend liep te zeuren.
1b. Dirk en Maartje waren afgelopen zaterdag\ samen gaan winkelen, maar het werd niet\ echt een gezellige dag. Maartje verveelde Dirk\ omdat hij al vanaf het begin van de dag\ eigenlijk geen zin had.

2a. Thea en Paul reden allebei behoorlijk hard. Bij een\ druk kruispunt botsten zij met hun auto's stevig\ op elkaar. Paul bood zijn excuses aan Thea aan\ omdat hij volgens de getuigen van het ongeluk\ alle schuld had.
2b. Thea en Paul reden allebei behoorlijk hard. Bij een\ druk kruispunt botsten zij met hun auto's stevig\ op elkaar. Thea bood haar excuses aan Paul aan\ omdat hij volgens de getuigen van het ongeluk\ geen schuld had.

3a. Niels en Chantal hadden een klassieke\ knipperlichtrelatie. Intussen was het zo vaak\ aan en uit geweest, dat ze er allebei niets\ meer van snapten. Niels belde Chantal\ omdat hij nu toch eindelijk wel eens duidelijkheid\ wilde hebben.
3b. Niels en Chantal hadden een klassieke\ knipperlichtrelatie. Intussen was het zo vaak\ aan en uit geweest, dat ze er allebei niets\ meer van snapten. Chantal belde Niels\ omdat hij nu toch eindelijk wel eens duidelijkheid\ mocht geven.

4a. Meestal zijn de boswandelingen die Laura\ en Hans maken erg leuk, maar nu konden zij\ elkaar wel schieten. Hans ergerde Laura\ omdat hij bij elk plantje of beestje zo lang\ bleef kijken.
4b. Meestal zijn de boswandelingen die Laura\ en Hans maken erg leuk, maar nu konden zij\ elkaar wel schieten. Laura ergerde Hans\ omdat hij bij elk plantje of beestje op haar\ moest wachten.

5a. Eigenlijk was een scheiding de beste\ oplossing voor Freek en Mieke. Hun\ huwelijk was door het vele vreemdgaan\ namelijk een hel geworden. Freek kwelde Mieke\ omdat hij na de vele avontuurtjes nog steeds\ met andere vrouwen sliep.
5b. Eigenlijk was een scheiding de beste\ oplossing voor Freek en Mieke. Hun\ huwelijk was door het vele vreemdgaan\ namelijk een hel geworden. Mieke kwelde Freek\ omdat hij na de vele avontuurtjes nog steeds\ door haar bedrogen werd.

6a. Janine en Maarten waren toevallig allebei\ in de bieb. Zij zaten naast elkaar aan een\ tafel te studeren. Maarten stoorde Janine\ omdat hij tijdens het leren de hele tijd zeer\ irritant kuchte.
6b. Janine en Maarten waren toevallig allebei\ in de bieb. Zij zaten naast elkaar aan een\ tafel te studeren. Janine stoorde Maarten\ omdat hij tijdens het leren de hele tijd haar\ gekuch hoorde.

7a. Max en Paula discussieerden vaak over de\ wereldpolitiek. Bij de laatste discussie\ over de islam schrokken ze een beetje\ van elkaar. Max verontrustte Paula\ omdat hij niet eerder zulke discriminerende\ opmerkingen had gemaakt.
7b. Max en Paula discussieerden vaak over de\ wereldpolitiek. Bij de laatste discussie\ over de islam schrokken ze een beetje\ van elkaar. Paula verontrustte Max\ omdat hij niet eerder zulke discriminerende\ opmerkingen had gehoord.

8a. Anouk en Johan hadden te vaak tegen\ elkaar geschaakt op de schaakclub. Daarom\ was er tijdens het laatste spelletje ook\ geen sprake van spanning. Johan won van Anouk\ omdat hij na enkele tientallen potjes schaak haar\ spel goed kende.
8b. Anouk en Johan hadden te vaak tegen\ elkaar geschaakt op de schaakclub. Daarom\ was er tijdens het laatste spelletje ook\ geen sprake van spanning. Anouk won van Johan\ omdat hij na enkele tientallen potjes schaak haar\ niet kon verassen.

9a. Nico en Lotte vochten samen voor een eerlijke\ en gelijke wereld. Hun samenwerking bleek\ uitermate succesvol. Nico inspireerde Lotte\ omdat hij bij het zien van onrecht altijd direct\ actie wilde ondernemen.
9b. Nico en Lotte vochten samen voor een eerlijke\ en gelijke wereld. Hun samenwerking bleek\ uitermate succesvol. Lotte inspireerde Nico\ omdat hij bij het zien van onrecht altijd op\ haar kon rekenen.

10a. De collega's Maria en Karel hebben allebei\ zeer graag de touwtjes in handen. Laatst\ escaleerde een situatie op het werk tot een\ ware machtstrijd. Karel intimideerde Maria\ omdat hij in de meeste gevallen dan zijn\ zin krijgt.
10b. De collega's Maria en Karel hebben allebei\ zeer graag de touwtjes in handen. Laatst\ escaleerde een situatie op het werk tot een\ ware machtstrijd. Maria intimideerde Karel\ omdat hij in de meeste gevallen dan toch\ snel toegeeft.

11a. Daniel en Irma moesten samen in de werkgroep een\ referaat houden. Zij kregen helaas maar een week\ voor de voorbereiding. Daniel irriteerde Irma\ omdat hij op elke bespreking weer andere ideeën\ opperde.
11b. Daniel en Irma moesten samen in de werkgroep een\ referaat houden. Zij kregen helaas maar een week\ voor de voorbereiding. Irma irriteerde Daniel\ omdat hij op elke bespreking weer andere ideeën\ moest aanhoren.

12a. De relatie van Sabine en Boris had net een crisis\ doorstaan. Zij waren allebei vanaf het begin niet\ zo trouw geweest. Boris bekende alles aan Sabine\ omdat hij per se de waarheid wilde vertellen.
12b. De relatie van Sabine en Boris had net een crisis\ doorstaan. Zij waren allebei vanaf het begin niet\ zo trouw geweest. Sabine bekende alles aan Boris\ omdat hij per se de waarheid wilde horen.

13a. Marcel en Lisa hadden net weer een winkel\ overvallen. Zij waren nu onder een viaduct de\ buit aan het verdelen. Marcel lichtte Lisa op\ omdat hij de vorige keer een flinke som geld door\ haar was misgelopen.
13b. Marcel en Lisa hadden net weer een winkel\ overvallen. Zij waren nu onder een viaduct de\ buit aan het verdelen. Lisa lichtte Marcel op\ omdat hij de vorige keer een flinke som geld van\ haar had gestolen.

14a. De relatie tussen Hester en Gijs was na\ lang geruzie dan toch stukgelopen. Ook in\ de laatste ruzie konden zij niet eerlijk\ tegen elkaar zijn. Gijs loog tegen Hester\ omdat hij de werkelijke reden achter hun problemen\ te pijnlijk voor haar vond.
14b. De relatie tussen Hester en Gijs was na\ lang geruzie dan toch stukgelopen. Ook in\ de laatste ruzie konden zij niet eerlijk\ tegen elkaar zijn. Hester loog tegen Gijs\ omdat hij de werkelijke reden achter hun problemen\ te pijnlijk zou vinden.

15a. Bijna elk weekend gaan Willem en Merel wel\ naar een expositie. Maar bij het zien van de\ Nachtwacht bleek weer eens, dat zij sterk van\ mening verschilden. Willem verbaasde Merel\ omdat hij zo een negatieve reactie had gegeven.
15b. Bijna elk weekend gaan Willem en Merel wel\ naar een expositie. Maar bij het zien van de\ Nachtwacht bleek weer eens, dat zij
sterk van\ mening verschilden. Merel verbaasde Willem\ omdat hij zo een negatieve reactie had gehoord.

16a. Na de ramp met de Titanic dreven Anna en Jan\ hulpeloos in de koude zee. Hun enige redding\ was een stuk ronddobberend hout, groot\ genoeg voor één persoon. Anna smeekte Jan\ omdat hij zonder het kleine stukje hout meer\ kans op overleven had.
16b. Na de ramp met de Titanic dreven Jan en Anna\ hulpeloos in de koude zee. Hun enige redding\ was een stuk ronddobberend hout, groot\ genoeg voor één persoon. Jan smeekte Anna\ omdat hij zonder het kleine stukje hout geen\ enkele kans op overleven had.

17a. Enthousiast waren Simon en Carien samen aan hun\ nieuwe opdracht begonnen. Inmiddels zijn zij een\ tuk minder blij met elkaar. Simon stelde Carien teleur\ omdat hij toch wel wat meer inzet had kunnen tonen.
17b. Enthousiast waren Simon en Carien samen aan hun\ nieuwe opdracht begonnen. Inmiddels zijn zij een\ stuk minder blij met elkaar. Carien stelde Simon teleur\ omdat hij toch wel wat meer inzet had willen zien.

18a. Roos en Harm hadden elk een groot en\ bloeiend bedrijf. Zij probeerden als\ elkaars grootste concurrenten elkaar steeds\ de loef af te steken. Harm misleidde Roos\ omdat hij anders de potentiele nieuwe opdrachtgever\ zou kwijtraken.
18b. Roos en Harm hadden elk een groot en\ bloeiend bedrijf. Zij probeerden als\ elkaars grootste concurrenten elkaar steeds\ de loef af te steken. Roos misleidde Harm\ omdat hij anders de potentiele nieuwe opdrachtgever\ zou wegkapen.

19a. Vanochtend waren Jan en Anna allebei weer\ te laat opgestaan voor het college. Zij stonden\ te dringen in de badkamer. Jan hinderde Anna\ omdat hij voor zijn ochtendritueel alle ruimte\ gebruikte.
19b. Vanochtend waren Jan en Anna allebei weer\ te laat opgestaan voor het college. Zij stonden\ te dringen in de badkamer. Anna hinderde Jan\ omdat hij voor zijn ochtendritueel alle ruimte\ nodig had.

20a. Op het feest werden Loes en Bart door wederzijdse\ vrienden aan elkaar voorgesteld. Zij vonden elkaar\ direct leuk en interessant. Bart fascineerde Loes\ omdat hij een persoon met een sterk karakter bleek\ te zijn.
20b. Op het feest werden Loes en Bart door wederzijdse\ vrienden aan elkaar voorgesteld. Zij vonden elkaar\ direct leuk en interessant. Loes fascineerde Bart\ omdat hij een persoon met een sterk karakter altijd\ interessant vond.

21a. Ruim vier jaar deden Joost en Karin\ onderzoek naar het taalvermogen van\ dolfijnen. In die tijd kregen zij veel\ waardering voor elkaar. Karin respecteerde Joost\ omdat hij zowel theoretische als praktische\ vaardigheden in ruime mate bezat.
21b. Ruim vier jaar deden Joost en Karin\ onderzoek naar het taalvermogen van\ dolfijnen. In die tijd kregen zij veel\ waardering voor elkaar. Joost respecteerde Karin\ omdat hij zowel theoretische als praktische\ vaardigheden in een persoon waardeerde.

22a. De boezemvrienden Anna en Lars zijn sinds\ kort ook buren van elkaar. Na een drukke\ periode hadden ze eindelijk tijd gevonden\ voor een dineetje. Anna bedankte Lars\ omdat hij de afgelopen weken bij de verhuizing zeer\ vaak onmisbaar was gebleken.
22b. De boezemvrienden Anna en Lars zijn sinds\ kort ook buren van elkaar. Na een drukke\ periode hadden ze eindelijk tijd gevonden\ voor een dineetje. Lars bedankte Anna\ omdat hij de afgelopen weken bij de verhuizing haar\ hulp zeer gewaardeerd had.

23a. Lex en Suzan waren van die personen die\ elkaar absoluut niet kunnen uitstaan. Elke\ keer dat hij elkaar tegenkwamen, liep het\ op ruzie uit. Suzan verafschuwde Lex\ omdat hij werkelijk altijd domme en botte opmerkingen\ tegen haar maakte.
23b. Lex en Suzan waren van die personen die\ elkaar absoluut niet kunnen uitstaan. Elke\ keer dat hij elkaar tegenkwamen, liep het\ op ruzie uit. Lex verafschuwde Suzan\ omdat hij werkelijk altijd domme en botte opmerkingen\ van haar hoorde.

24a. Els en Bas deden samen mee aan een\ vraaggesprek over de liefde. Toen hen\ gevraagd werd waarom ze van elkaar hielden,\ was het antwoord duidelijk. Els hield van Bas\ omdat hij altijd ontzettend vrolijk en zichzelf\ was in haar aanwezigheid.
24b. Els en Bas deden samen mee aan een\ vraaggesprek over de liefde. Toen hen\ gevraagd werd waarom ze van elkaar hielden,\ was het antwoord duidelijk. Bas hield van Els\ omdat hij altijd ontzettend vrolijk en zichzelf\ bij haar kon zijn.

25a. Guido en Heleen hadden hard gestudeerd\ voor een tentamen. Jammer genoeg haalden ze\ het allebei niet. Heleen troostte Guido\ omdat hij na het horen van de uitslag toch\ wel erg teleurgesteld had gereageerd.
25b. Guido en Heleen hadden hard gestudeerd\ voor een tentamen. Jammer genoeg haalden ze\ het allebei niet. Guido troostte Heleen\ omdat hij na het horen van de uitslag zag\ hoe moeilijk ze het had.

26a. Sofie en Martijn hielden van jongs af aan al van\ rollenspelletjes. Zij speelden elke week weer\ een andere situatie na. Sofie strafte Martijn\ omdat hij deze week een zeer vervelende\ schooljongen was.
26b. Sofie en Martijn hielden van jongs af aan al van\ rollenspelletjes. Zij speelden elke week weer\ een andere situatie na. Martijn strafte Sofie\ omdat hij deze week een zeer vervelende\ schoolmeester was.

27a. Sinds lange tijd waren Bob en Wendy werkzaam bij een\ advocatenbureau. Als zij samenwerkten vlogen de\ verwijten over en weer. Wendy bekritiseerde Bob\ omdat hij de hele tijd alle moeilijke beslissingen\ aan haar over liet.
27b. Sinds lange tijd waren Bob en Wendy werkzaam bij een\ advocatenbureau. Als zij samenwerkten vlogen de\ verwijten over en weer. Bob bekritiseerde Wendy\ omdat hij de hele tijd alle moeilijke beslissingen\ helemaal alleen moest nemen.

28a. Olga en Sander zaten in hetzelfde korfbalteam.\ Ze hadden zojuist met dit team een belangrijk\ toernooi gewonnen. Olga feliciteerde Sander\ omdat hij na zo'n goed gespeelde finale een\ schouderklopje zeker wel verdiende.
28b. Olga en Sander zaten in hetzelfde korfbalteam.\ Ze hadden zojuist met dit team een belangrijk\ toernooi gewonnen. Sander feliciteerde Olga\ omdat hij na zo'n goed gespeelde finale een\ schouderklopje wel terecht vond.

29a. Hoewel David en Mirjam al sinds lange tijd\ samen op pianoles zaten, hadden ze totaal geen\ waardering voor elkaar. Mirjam minachtte David\ omdat hij na al die jaren les nog steeds geen\ vooruitgang boekte.
29b. Hoewel David en Mirjam al sinds lange tijd\ samen op pianoles zaten, hadden ze totaal geen\ waardering voor elkaar. David minachtte Mirjam\ omdat hij na al die jaren les nog steeds geen\ vooruitgang zag.

30a. Afgelopen dinsdag vierden Nina en Vincent ieder hun\ elfde verjaardag. Ze hadden allebei om een nieuwe\ mountainbike gevraagd. Nina benijdde Vincent\ omdat hij de zo fel begeerde mountainbike wel\ had gekregen.
30b. Afgelopen dinsdag vierden Nina en Vincent ieder hun\ elfde verjaardag. Ze hadden allebei om een nieuwe\ mountainbike gevraagd. Vincent benijdde Nina\ omdat hij de zo fel begeerde mountainbike niet\ had gekregen.

31a. Luuk en Marije kwamen elkaar tegen in de\ studio's van Hilversum. Zij hadden beide auditie\ gedaan voor een soapserie. Marije prees Luuk\ omdat hij weer een zeer goede prestatie voor de camera\ had neergezet.
31b. Luuk en Marije kwamen elkaar tegen in de\ studio's van Hilversum. Zij hadden beide auditie\ gedaan voor een soapserie. Luuk prees Marije\ omdat hij weer een zeer goede prestatie van haar\ had gezien.

32a. Carlijn en Steven hadden vanuit hun studievereniging\ voor het eerst samen een congres georganiseerd.\ Na afloop moesten zij alleen nog de laatste\ rommel opruimen. Carlijn complimenteerde Steven\ omdat hij alles zo efficient en snel geregeld had.
32b. Carlijn en Steven hadden vanuit hun studievereniging\ voor het eerst samen een congres georganiseerd.\ Na afloop moesten zij alleen nog de laatste\ rommel opruimen. Steven complimenteerde Carlijn\ omdat hij alles zo efficient en snel geregeld vond.

33a. De rechtbank had het bedrijf van Michiel en Cindy\ failliet verklaard. Zij moesten nu hun schulden\ aflossen. Cindy stelde Michiel verantwoordelijk\ omdat hij het financieel beleid van begin af aan\ had tegengewerkt.
33b. De rechtbank had het bedrijf van Michiel en Cindy\ failliet verklaard. Zij moesten nu hun schulden\ aflossen. Michiel stelde Cindy verantwoordelijk\ omdat hij het financieel beleid van begin af aan\ had afgekeurd.

34a. Sandra en Hugo hadden een nogal verhitte\ geschiedenis vol ruzies en nijd. Zij konden\ elkaar inmiddels wel schieten. Sandra haatte Hugo\ omdat hij zo veel achterbakse en vuile streken had\ uitgehaald.
34b. Sandra en Hugo hadden een nogal verhitte\ geschiedenis vol ruzies en nijd. Zij konden\ elkaar inmiddels wel schieten. Hugo haatte Sandra\ omdat hij zo veel achterbakse en vuile streken had\ moeten incasseren.

35a. Guus en Zita werkten beiden op dezelfde afdeling\ van een bedrijf voor mobiele telefonie. Helaas,\ door slechte winstresultaten moest het bedrijf\ snijden in het personeel. Zita ontsloeg Guus\ omdat hij nu eenmaal niet genoeg vertrouwen van de\ leiding had.
35b. Guus en Zita werkten beiden op dezelfde afdeling\ van een bedrijf voor mobiele telefonie. Helaas,\ door slechte winstresultaten moest het bedrijf\ snijden in het personeel. Guus ontsloeg Zita\ omdat hij nu eenmaal niet genoeg vertrouwen in haar\ capaciteiten had.

36a. Op het Rietveld-academie waren Ellen en Frits\ elkaar voor het eerst tegen gekomen. Sindsdien\ deelden zij samen een atelier. Ellen bewonderde Frits\ omdat hij een groot talent voor beeldhouwen had laten\ zien.
36b. Op het Rietveld-academie waren Ellen en Frits\ elkaar voor het eerst tegen gekomen. Sindsdien\ deelden zij samen een atelier. Frits bewonderde Ellen\ omdat hij een groot talent voor beeldhouwen in haar\ had herkend.

37a. Tot een jaar geleden hadden Mark en Rachel samen voor\ een internetbedrijf gewerkt. Zij waren helaas op\ slechte voet uit elkaar gegaan. Rachel klaagde Mark aan\ omdat hij een grote som geld van het bedrijf\ verduisterd bleek te hebben.
37b. Tot een jaar geleden hadden Mark en Rachel samen voor\ een internetbedrijf gewerkt. Zij waren helaas op\ slechte voet uit elkaar gegaan. Mark klaagde Rachel aan\ omdat hij een grote som geld van het bedrijf\ tegoed bleek te hebben.

38a. Op de schermschool hadden Tanja en Karl zich\ ingeschreven voor een wedstrijd. Omdat zij\ voor het eerst elkaars tegenstander waren,\ overwogen zij elkaars kansen. Tanja vreesde Karl\ omdat hij door vele jaren van ervaring meer\ kans had.
38b. Op de schermschool hadden Tanja en Karl zich\ ingeschreven voor een wedstrijd. Omdat zij\ voor het eerst elkaars tegenstander waren,\ overwogen zij elkaars kansen. Karl vreesde Tanja\ omdat hij door vele jaren van ervaring haar\ klasse zag.

39a. Hercules en Athena woonden temidden van andere\ goden beiden op de Olympus. Zij kenden elkaar\ letterlijk al eeuwen. Athena aanbad Hercules\ omdat hij als een echte griekse god zo vaak al\ haar wensen had vervuld.
39b. Hercules en Athena woonden temidden van andere\ goden beiden op de Olympus. Zij kenden elkaar\ letterlijk al eeuwen. Hercules aanbad Athena\ omdat hij als een echte griekse god zo vaak viel\ voor de dochters van Zeus.

40a. Babet en Thijs waren al jaren verbonden\ aan hetzelfde natuurkundig instituut. Als\ team hadden zij al voor meerdere theoretische\ doorbraken gezorgd. Babet waardeerde Thijs\ omdat hij als wetenschapper altijd goede feedback\ aan haar gaf.
40b. Babet en Thijs waren al jaren verbonden\ aan hetzelfde natuurkundig instituut. Als\ team hadden zij al voor meerdere theoretische\ doorbraken gezorgd. Thijs waardeerde Babet\ omdat hij als wetenschapper altijd goede feedback\ van haar kreeg.

Appendix VI

Stimuli Experiment 8 (Chapter 5)

(a = consistent-want; b = inconsistent-want; c = consistent-maar; d = inconsistent-maar; e = consistent-en; f = inconsistent-en; \ = line break; stories 1- 24 = NP1 verbs; stories 25-48 = NP2 verbs)

1a. Dirk en Maartje waren afgelopen zaterdag samen gaan\ winkelen maar het werd niet echt een gezellige dag.\ Dirk verveelde Maartje want hij liep al vanaf het begin\ van de dag ontzettend te zeuren over het weer.
1b. Dirk en Maartje waren afgelopen zaterdag samen gaan\ winkelen maar het werd niet echt een gezellige dag.\ Maartje verveelde Dirk want hij liep al vanaf het begin\ van de dag alleen maar dameswinkels in en dameswinkels uit.
1c. Dirk en Maartje waren afgelopen zaterdag samen gaan\ winkelen maar het werd niet echt een gezellige dag.\ Dirk verveelde Maartje maar hij liep al vanaf het begin\ van de dag zijn uiterste best te doen het leuk te houden.
1d. Dirk en Maartje waren afgelopen zaterdag samen gaan\ winkelen maar het werd niet echt een gezellige dag.\ Maartje verveelde Dirk maar hij liep al vanaf het begin\ van de dag zijn uiterste best te doen dat niet te laten merken.
1e. Dirk en Maartje waren afgelopen zaterdag samen gaan\ winkelen maar het werd niet echt een gezellige dag.\ Dirk verveelde Maartje en hij liep al vanaf het begin\ van de dag ontzettend te zeuren over het weer.
1f. Dirk en Maartje waren afgelopen zaterdag samen gaan\ winkelen maar het werd niet echt een gezellige dag.\ Maartje verveelde Dirk en hij liep al vanaf het begin\ van de dag te snakken naar een biertje.

2a. Thea en Paul reden allebei behoorlijk hard. Bij\ een druk kruispunt botsten zij met hun auto's stevig\ op elkaar. Paul bood zijn excuses aan Thea\ aan want hij was volgens de getuigen van het\ ongeluk de veroorzaker van alle ellende.
2b. Thea en Paul reden allebei behoorlijk hard. Bij\ een druk kruispunt botsten zij met hun auto's stevig\ op elkaar. Thea bood haar excuses aan Paul\ aan want hij was volgens de getuigen van het\ ongeluk niet de veroorzaker van alle ellende.
2c. Thea en Paul reden allebei behoorlijk hard. Bij\ een druk kruispunt botsten zij met hun auto's stevig\ op elkaar. Paul bood zijn excuses aan Thea\ aan maar hij was volgens de getuigen van het\ ongeluk niet de veroorzaker van alle ellende.
2d. Thea en Paul reden allebei behoorlijk hard. Bij\ een druk kruispunt botsten zij met hun auto's stevig\ op elkaar. Thea bood haar excuses aan Paul\ aan maar hij was volgens de getuigen van het\ ongeluk de veroorzaker van alle ellende.
2e. Thea en Paul reden allebei behoorlijk hard. Bij\ een druk kruispunt botsten zij met hun auto's stevig\ op elkaar. Paul bood zijn excuses aan Thea\ aan en hij was volgens de getuigen van het\ ongeluk erg in de war door de situatie.
2f. Thea en Paul reden allebei behoorlijk hard. Bij\ een druk kruispunt botsten zij met hun auto's stevig\ op elkaar. Thea bood haar excuses aan Paul\ aan en hij was volgens de getuigen van het\ ongeluk gelukkig in staat haar excuses te aanvaarden.

3a. Niels en Chantal hadden een klassieke knipperlichtrelatie.\ Intussen was het zo vaak aan en uit geweest dat\ ze er allebei niets meer van snapten. Niels belde\ Chantal want hij moest nu toch eigenlijk wel eens\ duidelijkheid krijgen over hun toekomst samen.
3b. Niels en Chantal hadden een klassieke knipperlichtrelatie.\ Intussen was het zo vaak aan en uit geweest dat\ ze er allebei niets meer van snapten. Chantal belde\ Niels want hij moest nu toch eigenlijk wel eens\ duidelijkheid geven over hun toekomst samen.

3c. Niels en Chantal hadden een klassieke knipperlichtrelatie.\ Intussen was het zo vaak aan en uit geweest dat\ ze er allebei niets meer van snapten. Niels belde\ Chantal maar hij moest nu toch eigenlijk wel toegeven\ dat dit waarschijnlijk de laatste keer was.
3d. Niels en Chantal hadden een klassieke knipperlichtrelatie.\ Intussen was het zo vaak aan en uit geweest dat\ ze er allebei niets meer van snapten. Chantal belde\ Niels maar hij moest nu toch eigenlijk wel nadenken\ of hij haar nog wilde spreken.
3e. Niels en Chantal hadden een klassieke knipperlichtrelatie.\ Intussen was het zo vaak aan en uit geweest dat\ ze er allebei niets meer van snapten. Niels belde\ Chantal en hij moest nu toch eigenlijk wel toegeven\ dat er geen toekomst meer in hun relatie zat.
3f. Niels en Chantal hadden een klassieke knipperlichtrelatie.\ Intussen was het zo vaak aan en uit geweest dat\ ze er allebei niets meer van snapten. Chantal belde\ Niels en hij moest nu toch eigenlijk wel eens\ duidelijkheid geven over hun toekomst samen.

4a. Meestal zijn de boswandelingen die Laura en Hans maken\ erg leuk. Ze konden elkaar nu echter wel schieten. Hans\ ergerde Laura want hij heeft eigenlijk de hele dag alleen\ maar over zijn werk gepraat.
4b. Meestal zijn de boswandelingen die Laura en Hans maken\ erg leuk. Ze konden elkaar nu echter wel schieten. Laura\ ergerde Hans want hij heeft eigenlijk de hele dag naar\ haar gezeur over haar werk moeten luisteren.
4c. Meestal zijn de boswandelingen die Laura en Hans maken\ erg leuk. Ze konden elkaar nu echter wel schieten. Hans\ ergerde Laura maar hij heeft eigenlijk de hele dag niets\ fout gedaan.
4d. Meestal zijn de boswandelingen die Laura en Hans maken\ erg leuk. Ze konden elkaar nu echter wel schieten. Laura\ ergerde Hans maar hij heeft eigenlijk de hele dag verpest\ door alleen maar te zeuren.
4e. Meestal zijn de boswandelingen die Laura en Hans maken\ erg leuk. Ze konden elkaar nu echter wel schieten. Hans\ ergerde Laura en hij heeft eigenlijk de hele dag geen\ enkele poging gedaan dat te voorkomen.
4f. Meestal zijn de boswandelingen die Laura en Hans maken\ erg leuk. Ze konden elkaar nu echter wel schieten. Laura\ ergerde Hans en hij heeft eigenlijk de hele dag zijn\ mond niet meer open gedaan.

5a. Eigenlijk was een scheiding de beste oplossing voor\ Freek en Mieke. Hun huwelijk was door het vele\ vreemdgaan namelijk een hel geworden. Freek kwelde\ Mieke want hij had na die vele avontuurtjes van haar\ zin om wraak op haar te nemen.
5b. Eigenlijk was een scheiding de beste oplossing voor\ Freek en Mieke. Hun huwelijk was door het vele\ vreemdgaan namelijk een hel geworden. Mieke kwelde\ Freek want hij had na die vele avontuurtjes van hem\ geen recht meer op een prettig leven.
5c. Eigenlijk was een scheiding de beste oplossing voor\ Freek en Mieke. Hun huwelijk was door het vele\ vreemdgaan namelijk een hel geworden. Freek kwelde\ Mieke maar hij had na die vele avontuurtjes van hem\ al wel geprobeerd zijn excuses aan te bieden.
5d. Eigenlijk was een scheiding de beste oplossing voor\ Freek en Mieke. Hun huwelijk was door het vele\ vreemdgaan namelijk een hel geworden. Mieke kwelde\ Freek maar hij had na die vele avontuurtjes van hem\ natuurlijk kunnen voorspellen dat ze wraak zou nemen.
5e. Eigenlijk was een scheiding de beste oplossing voor\ Freek en Mieke. Hun huwelijk was door het vele\ vreemdgaan namelijk een hel geworden. Freek kwelde\ Mieke en hij had na die vele avontuurtjes van haar\ geen zin meer ooit nog aardig te zijn.
5f. Eigenlijk was een scheiding de beste oplossing voor\ Freek en Mieke. Hun huwelijk was door het vele\ vreemdgaan namelijk een hel geworden. Mieke kwelde\ Freek en hij had na die vele avontuurtjes van hem\ eigenlijk het gevoel dat dat ook wel terecht was.

6a. Janine en Maarten waren toevallig allebei in de bibliotheek.\ Zij zaten naast elkaar aan een tafel te lezen. Maarten\ stoorde Janine want hij had eigenlijk de hele middag al\ erg veel herrie gemaakt.
6b. Janine en Maarten waren toevallig allebei in de bibliotheek.\ Zij zaten naast elkaar aan een tafel te lezen. Janine\ stoorde Maarten want hij had eigenlijk de hele middag al\ erg veel last van haar gemompel.
6c. Janine en Maarten waren toevallig allebei in de bibliotheek.\ Zij zaten naast elkaar aan een tafel te lezen. Maarten\ stoorde Janine maar hij had eigenlijk de hele middag nog\ niets fout gedaan.
6d. Janine en Maarten waren toevallig allebei in de bibliotheek.\ Zij zaten naast elkaar aan een tafel te lezen. Janine\ stoorde Maarten maar hij had eigenlijk de hele middag al\ geprobeerd geen aandacht aan haar te besteden.
6e. Janine en Maarten waren toevallig allebei in de bibliotheek.\ Zij zaten naast elkaar aan een tafel te lezen. Maarten\ stoorde Janine en hij had eigenlijk de hele middag niets\ anders gedaan dan mensen storen.
6f. Janine en Maarten waren toevallig allebei in de bibliotheek.\ Zij zaten naast elkaar aan een tafel te lezen. Janine\ stoorde Maarten en hij had eigenlijk de hele middag al\ schoon genoeg van haar.

7a. Max en Paula discussieerden vaak over de wereldpolitiek.\ Bij de laatste discussie over de Islam schrokken ze\ een beetje van elkaar. Max verontrustte\ Paula want hij had in de afgelopen dagen eerder\ zulke discriminerende opmerkingen gemaakt over allochtonen.
7b. Max en Paula discussieerden vaak over de wereldpolitiek.\ Bij de laatste discussie over de Islam schrokken ze\ een beetje van elkaar. Paula verontrustte\ Max want hij had in de afgelopen dagen vaker\ discriminerende opmerkingen uit haar mond gehoord.
7c. Max en Paula discussieerden vaak over de wereldpolitiek.\ Bij de laatste discussie over de Islam schrokken ze\ een beetje van elkaar. Max verontrustte\ Paula maar hij had in de afgelopen dagen wel duidelijk\ gemaakt dat zijn uitspraken niet altijd even serieus zijn.
7d. Max en Paula discussieerden vaak over de wereldpolitiek.\ Bij de laatste discussie over de Islam schrokken ze\ een beetje van elkaar. Paula verontrustte\ Max maar hij had in de afgelopen dagen zelf ook\ hatelijke opmerkingen gemaakt over allochtonen.
7e. Max en Paula discussieerden vaak over de wereldpolitiek.\ Bij de laatste discussie over de Islam schrokken ze\ een beetje van elkaar. Max verontrustte\ Paula en hij had in de afgelopen dagen moeite\ gedaan om haar een beetje gerust te stellen.
7f. Max en Paula discussieerden vaak over de wereldpolitiek.\ Bij de laatste discussie over de Islam schrokken ze\ een beetje van elkaar. Paula verontrustte\ Max en hij had in de afgelopen dagen moeite\ gedaan om haar radicale standpunt af te zwakken.

8a. Anouk en Johan hadden te vaak tegen elkaar geschaakt\ op de schaakclub. Daarom was er tijdens het laatste\ spelletje ook geen sprake van spanning. Johan won van\ Anouk want hij kon na enkele tientallen potjes schaak\ haar spel wel dromen.
8b. Anouk en Johan hadden te vaak tegen elkaar geschaakt\ op de schaakclub. Daarom was er tijdens het laatste\ spelletje ook geen sprake van spanning. Anouk won van\ Johan want hij kon na enkele tientallen potjes schaak\ niet meer voor een verassing zorgen.
8c. Anouk en Johan hadden te vaak tegen elkaar geschaakt\ op de schaakclub. Daarom was er tijdens het laatste\ spelletje ook geen sprake van spanning. Johan won van\ Anouk maar hij kon na enkele tientallen potjes schaak\ haar spel dan ook wel dromen.
8d. Anouk en Johan hadden te vaak tegen elkaar geschaakt\ op de schaakclub. Daarom was er tijdens het laatste\ spelletje ook geen sprake van spanning. Anouk won van\ Johan maar hij kon na enkele tientallen potjes verloren\ te hebben nog steeds uit zijn mond krijgen dat het\ mazzel was.
8e. Anouk en Johan hadden te vaak tegen elkaar geschaakt\ op de schaakclub. Daarom was er tijdens het laatste\ spelletje ook geen sprake van spanning. Johan won van\ Anouk en hij kon na enkele tientallen potjes schaak\ toch wel zeggen dat hij de betere was.
8f. Anouk en Johan hadden te vaak tegen elkaar geschaakt\ op de schaakclub. Daarom was er tijdens het laatste\ spelletje ook geen sprake van spanning. Anouk won van\ Johan en hij kon na enkele tientallen potjes schaak\ eindelijk toegeven dat zij de betere was.

9a. Nico en Lotte vochten samen voor een eerlijke en gelijke\ wereld. Hun samenwerking bleek uitermate succesvol. Nico\ inspireerde Lotte want hij had de afgelopen vijf jaar bij het\ zien van onrecht steeds precies geweten wat hij moest doen.
9b. Nico en Lotte vochten samen voor een eerlijke en gelijke\ wereld. Hun samenwerking bleek uitermate succesvol. Lotte\ inspireerde Nico want hij had de afgelopen vijf jaar steeds\ op haar kunnen rekenen als hij iemand nodig had.
9c. Nico en Lotte vochten samen voor een eerlijke en gelijke\ wereld. Hun samenwerking bleek uitermate succesvol. Nico\ inspireerde Lotte maar hij had de afgelopen vijf jaar niet\ zoveel actie meer ondernomen als voorheen.
9d. Nico en Lotte vochten samen voor een eerlijke en gelijke\ wereld. Hun samenwerking bleek uitermate succesvol. Lotte\ inspireerde Nico maar hij had de afgelopen vijf jaar niet\ meer zoveel laten merken dat hij haar waardeerde.
9e. Nico en Lotte vochten samen voor een eerlijke en gelijke\ wereld. Hun samenwerking bleek uitermate succesvol. Nico\ inspireerde Lotte en hij had de afgelopen vijf jaar dan ook\ veel complimentjes gekregen van haar.
9f. Nico en Lotte vochten samen voor een eerlijke en gelijke\ wereld. Hun samenwerking bleek uitermate succesvol. Lotte\ inspireerde Nico en hij had de afgelopen vijf jaar dan ook\ veel complimentjes aan haar gegeven.

10a. De collega's Maria en Karel hebben allebei zeer graag\ de touwtjes in handen. Laatst escaleerde de situatie\ op het werk tot een ware machtsstrijd. Karel intimideerde\ Maria want hij heeft in een vergelijkbare situatie van een\ paar jaar geleden gemerkt dat zij daar gevoelig voor is.

10b. De collega's Maria en Karel hebben allebei zeer graag\ de touwtjes in handen. Laatst escaleerde de situatie\ op het werk tot een ware machtsstrijd. Maria intimideerde\ Karel want hij heeft in een vergelijkbare situatie van een\ paar jaar geleden laten zien dat hij daar gevoelig voor is.
10c. De collega's Maria en Karel hebben allebei zeer graag\ de touwtjes in handen. Laatst escaleerde een situatie\ op het werk tot een ware machtsstrijd. Karel intimideerde\ Maria maar hij heeft in een vergelijkbare situatie van een\ paar jaar geleden al ondervonden dat zij daar niet gevoelig\ voor is.
10d. De collega's Maria en Karel hebben allebei zeer graag\ de touwtjes in handen. Laatst escaleerde de situatie\ op het werk tot een ware machtsstrijd. Maria intimideerde\ Karel maar hij heeft in een vergelijkbare situatie van een\ paar jaar geleden al laten zien dat hij daar niet gevoelig\ voor is.
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10f. De collega's Maria en Karel hebben allebei zeer graag\ de touwtjes in handen. Laatst escaleerde de situatie\ op het werk tot een ware machtsstrijd. Maria intimideerde\ Karel en hij heeft in een vergelijkbare situatie van een\ paar jaar geleden laten zien dat hij daar gevoelig voor is.

11a. Jochem en Irma moesten samen in de werkgroep\ een referaat houden. Zij kregen helaas maar een\ week voor de voorbereiding. Jochem irriteerde\ Irma want hij had al vanaf het begin af aan geen\ enkel teken van inzet getoond.
11b. Jochem en Irma moesten samen in de werkgroep\ een referaat houden. Zij kregen helaas maar een\ week voor de voorbereiding. Irma irriteerde\ Jochem want hij had al vanaf het begin af aan geen\ enkel teken van inzet van haar mogen aanschouwen.
11c. Jochem en Irma moesten samen in de werkgroep\ een referaat houden. Zij kregen helaas maar een\ week voor de voorbereiding. Jochem irriteerde\ Irma maar hij / had al vanaf het begin af aan het\ gevoel dat zij zich domweg aan alles en iedereen\ irriteerde.
11d. Jochem en Irma moesten samen in de werkgroep\ een referaat houden. Zij kregen helaas maar een\ week voor de voorbereiding. Irma irriteerde\ Jochem maar hij had al vanaf het begin af aan de\ innerlijke kracht om daar niet aan toe te geven.
11e. Jochem en Irma moesten samen in de werkgroep\ een referaat houden. Zij kregen helaas maar een\ week voor de voorbereiding. Jochem irriteerde\ Irma en hij had al vanaf het begin af aan door\ dat hij niets kon doen om dat te voorkomen.
11f. Jochem en Irma moesten samen in de werkgroep\ een referaat houden. Zij kregen helaas maar\ een week voor de voorbereiding. Irma irriteerde\ Jochem en hij / had al vanaf het begin af aan het\ idee dat hun samenwerking op een fiasco zou uitlopen.

12a. De relatie van Sabine en Boris had net een\ crisis doorstaan. Zij waren allebei vanaf het begin\ niet zo trouw geweest. Boris bekende alles aan\ Sabine want hij wilde nu echt de waarheid\ over hun relatie vertellen.
12b. De relatie van Sabine en Boris had net een\ crisis doorstaan. Zij waren allebei vanaf het begin\ niet zo trouw geweest. Sabine bekende alles aan\ Boris want hij wilde nu echt de waarheid over\ hun relatie horen.
12c. De relatie van Sabine en Boris had net een\ crisis doorstaan. Zij waren allebei vanaf het begin\ niet zo trouw geweest. Boris bekende alles aan\ Sabine maar hij wilde nu echt de waarheid\ ook uit haar mond horen.
12d. De relatie van Sabine en Boris had net een\ crisis doorstaan. Zij waren allebei vanaf het begin\ niet zo trouw geweest. Sabine bekende alles aan\ Boris maar hij wilde nu echt de waarheid niet\ meer horen.
12e. De relatie van Sabine en Boris had net een\ crisis doorstaan. Zij waren allebei vanaf het begin\ niet zo trouw geweest. Boris bekende alles aan\ Sabine en hij wilde nu echt de waarheid over\ hun relatie vertellen.
12f. De relatie van Sabine en Boris had net een\ crisis doorstaan. Zij waren allebei vanaf het begin\ niet zo trouw geweest. Sabine bekende alles aan\ Boris en hij wilde nu echt de waarheid over hun\ relatie horen.

13a. Marcel en Lisa hadden net weer een winkel\ overvallen. Zij waren nu onder een viaduct\ de buit aan het verdelen. Marcel lichtte\ Lisa op want hij had na de vorige overval\ een flinke som geld door haar verloren.
13b. Marcel en Lisa hadden net weer een winkel\ overvallen. Zij waren nu onder een viaduct\ de buit aan het verdelen. Lisa lichtte\ Marcel op want hij had na de vorige overval\ een flinke som geld van haar gestolen.
13c. Marcel en Lisa hadden net weer een winkel\ overvallen. Zij waren nu onder een viaduct\ de buit aan het verdelen. Marcel lichtte\ Lisa op maar hij had na de vorige overval\ ook alle reden om haar terug te pakken.
13d. Marcel en Lisa hadden net weer een winkel\ overvallen. Zij waren nu onder een viaduct\ de buit aan het verdelen. Lisa lichtte\ Marcel op maar hij had na de vorige overval\ precies hetzelfde bij haar gedaan.
13e. Marcel en Lisa hadden net weer een winkel\ overvallen. Zij waren nu onder een viaduct\ de buit aan het verdelen. Marcel lichtte\ Lisa op en hij had na de vorige overval alle\ reden om haar te benadelen.

13f. Marcel en Lisa hadden net weer een winkel\ overvallen. Zij waren nu onder een viaduct\ de buit aan het verdelen. Lisa lichtte\ Marcel op en hij had na de vorige overval\ eigenlijk wel verwacht dat ze zoiets zou proberen.

14a. De relatie tussen Hester en Gijs was na lang geruzie\ dan toch stukgelopen. Ook in de laatste ruzie konden\ zij niet eerlijk tegen elkaar zijn. Gijs loog tegen\ Hester want hij zou de werkelijke reden van\ hun problemen nooit aan haar kunnen vertellen.
14b. De relatie tussen Hester en Gijs was na lang geruzie\ dan toch stukgelopen. Ook in de laatste ruzie konden\ zij niet eerlijk tegen elkaar zijn. Hester loog tegen\ Gijs want hij zou de werkelijke reden van hun problemen\ veel te pijnlijk vinden.
14c. De relatie tussen Hester en Gijs was na lang geruzie\ dan toch stukgelopen. Ook in de laatste ruzie konden\ zij niet eerlijk tegen elkaar zijn. Gijs loog tegen\ Hester maar hij zou de werkelijke reden van hun problemen\ toch ooit wel een keer willen bespreken.
14d. De relatie tussen Hester en Gijs was na lang geruzie\ dan toch stukgelopen. Ook in de laatste ruzie konden\ zij niet eerlijk tegen elkaar zijn. Hester loog tegen\ Gijs maar hij zou de werkelijke reden van hun problemen\ toch wel horen van één van haar vriendinnen.
14e. De relatie tussen Hester en Gijs was na lang geruzie\ dan toch stukgelopen. Ook in de laatste ruzie konden\ zij niet eerlijk tegen elkaar zijn. Gijs loog tegen\ Hester en hij zou de werkelijke reden van hun problemen\ nooit aan haar kunnen vertellen.
14f. De relatie tussen Hester en Gijs was na lang geruzie\ dan toch stukgelopen. Ook in de laatste ruzie konden\ zij niet eerlijk tegen elkaar zijn. Hester loog tegen\ Gijs en hij zou de werkelijke reden van hun problemen\ nooit te weten komen.

15a. Bijna elk weekend gaan Wim en Merel wel naar een\ expositie. Maar bij het zien van de Nachtwacht bleek weer\ eens dat zij sterk van mening verschilden. Wim verbaasde\ Merel want hij had tijdens hun vele bezoekjes nog nooit\ zo'n negatief oordeel over een meesterwerk gegeven.
15b. Bijna elk weekend gaan Wim en Merel wel naar een\ expositie. Maar bij het zien van de Nachtwacht bleek weer\ eens dat zij sterk van mening verschilden. Merel verbaasde\ Wim want hij had tijdens hun vele bezoekjes nog nooit\ zo'n negatief oordeel gehoord uit haar mond.
15c. Bijna elk weekend gaan Wim en Merel wel naar een\ expositie. Maar bij het zien van de Nachtwacht bleek weer\ eens dat zij sterk van mening verschilden. Wim verbaasde\ Merel maar hij had tijdens hun vele bezoekjes dan ook niet\ eerder gezegd dat hij Rembrandt niet goed vond.
15d. Bijna elk weekend gaan Wim en Merel wel naar een\ expositie. Maar bij het zien van de Nachtwacht bleek weer\ eens dat zij sterk van mening verschilden. Merel verbaasde\ Wim maar hij had tijdens hun vele bezoekjes dan ook\ niet eerder een negatief woord over Rembrandt gehoord.
15e. Bijna elk weekend gaan Wim en Merel wel naar een\ expositie. Maar bij het zien van de Nachtwacht bleek weer\ eens dat zij sterk van mening verschilden. Wim verbaasde\ Merel en hij had tijdens hun vele bezoekjes aan het\ museum nog niet eerder die reactie teweeggebracht.
15f. Bijna elk weekend gaan Wim en Merel wel naar een\ expositie. Maar bij het zien van de Nachtwacht bleek weer\ eens dat zij sterk van mening verschilden. Merel verbaasde\ Wim en hij had tijdens hun vele bezoekjes niet eerder\ gemerkt dat zij zo'n slechte smaak had.

16a. Tijdens een intense ruzie tussen Marcia en John\ liepen de emoties hoog op. Hun relatie dreigde\ nu echt op de klippen te lopen. John smeekte\ Marcia want hij wilde na twintig jaar huwelijk\ niet zomaar gaan scheiden.
16b. Tijdens een intense ruzie tussen Marcia en John\ liepen de emoties hoog op. Hun relatie dreigde\ nu echt op de klippen te lopen. Marcia smeekte\ John want hij wilde na twintig jaar huwelijk\ zomaar gaan scheiden.
16c. Tijdens een intense ruzie tussen Marcia en John\ liepen de emoties hoog op. Hun relatie dreigde\ nu echt op de klippen te lopen. John smeekte\ Marcia maar hij wilde na twintig jaar huwelijk\ eigenlijk ook wel eens wat nieuws.
16d. Tijdens een intense ruzie tussen Marcia en John\ liepen de emoties hoog op. Hun relatie dreigde\ nu echt op de klippen te lopen. Marcia smeekte\ John maar hij wilde na twintig jaar huwelijk\ gaan scheiden.
16e. Tijdens een intense ruzie tussen Marcia en John\ liepen de emoties hoog op. Hun relatie dreigde\ nu echt op de klippen te lopen. John smeekte\ Marcia en hij wilde na twintig jaar huwelijk\ dat zij op zijn minst naar hem zou luisteren.
16f. Tijdens een intense ruzie tussen Marcia en John\ liepen de emoties hoog op. Hun relatie dreigde\ nu echt op de klippen te lopen. Marcia smeekte\ John en hij wilde na twintig jaar huwelijk\ nog één poging wagen.

17a. Enthousiast waren Simon en Carien samen aan hun\ nieuwe opdracht begonnen. Inmiddels zijn zij een\ stuk minder blij met elkaar. Simon stelde\ Carien teleur want hij heeft de afgelopen drie\ weken nog veel te weinig werk verricht.
17b. Enthousiast waren Simon en Carien samen aan hun\ nieuwe opdracht begonnen. Inmiddels zijn zij een\ stuk minder blij met elkaar. Carien stelde\ Simon teleur want hij heeft de afgelopen drie\ weken geen enkele inzet van haar gezien.
17c. Enthousiast waren Simon en Carien samen aan hun\ nieuwe opdracht begonnen. Inmiddels zijn zij een\ stuk minder blij met elkaar. Simon stelde\ Carien teleur maar hij heeft de afgelopen drie\ weken dan ook niet bepaald zijn best gedaan.
17d. Enthousiast waren Simon en Carien samen aan hun\ nieuwe opdracht begonnen. Inmiddels zijn zij een\ stuk minder blij met elkaar. Carien stelde\ Simon teleur maar hij heeft de afgelopen drie\ weken eigenlijk ook veel te veel van haar verwacht.
17e. Enthousiast waren Simon en Carien samen aan hun\ nieuwe opdracht begonnen. Inmiddels zijn zij een\ stuk minder blij met elkaar. Simon stelde\ Carien teleur en hij heeft de afgelopen drie\ weken tevergeefs geprobeerd Carien weer tevreden\ te stellen.
17f. Enthousiast waren Simon en Carien samen aan hun\ nieuwe opdracht begonnen. Inmiddels zijn zij een\ stuk minder blij met elkaar. Carien stelde\ Simon teleur en hij heeft de afgelopen drie\ weken helemaal geen zin meer gehad om aan de\ opdracht te werken.

18a. Roos en Harm hadden elk een groot en bloeiend bedrijf.\ Zij probeerden als elkaars grootste concurrenten\ elkaar steeds de loef af te steken. Harm misleidde\ Roos want hij wilde al jarenlang heel graag dat haar\ bedrijf failliet zou gaan.
18b. Roos en Harm hadden elk een groot en bloeiend bedrijf.\ Zij probeerden als elkaars grootste concurrenten\ elkaar steeds de loef af te steken. Roos misleidde\ Harm want hij wilde al jarenlang heel graag gevoelige\ informatie over haar bedrijf bemachtigen.
18c. Roos en Harm hadden elk een groot en bloeiend bedrijf.\ Zij probeerden als elkaars grootste concurrenten\ elkaar steeds de loef af te steken. Harm misleidde\ Roos maar hij wilde al jarenlang heel graag met deze\ verachtelijke praktijken stoppen.
18d. Roos en Harm hadden elk een groot en bloeiend bedrijf.\ Zij probeerden als elkaars grootste concurrenten\ elkaar steeds de loef af te steken. Roos misleidde\ Harm maar hij wilde al jarenlang heel graag met deze\ verachtelijke praktijken stoppen.
18e. Roos en Harm hadden elk een groot en bloeiend bedrijf.\ Zij probeerden als elkaars grootste concurrenten\ elkaar steeds de loef af te steken. Harm misleidde\ Roos en hij wilde al jarenlang heel graag dat zijn\ bedrijf de meeste winst zou maken.
18f. Roos en Harm hadden elk een groot en bloeiend bedrijf.\ Zij probeerden als elkaars grootste concurrenten\ elkaar steeds de loef af te steken. Roos misleidde\ Harm en hij wilde al jarenlang heel graag met zijn\ bedrijf naar een andere regio verhuizen.

19a. Vanochtend waren Jasper en Rianne allebei weer\ te laat opgestaan voor het college. Zij stonden\ te dringen in de badkamer. Jasper hinderde\ Rianne want hij had tijdens zijn ochtendritueel echt\ alle ruimte bij de wastafel opgeëist en hij stond\ haar dus ontzettend in de weg.
19b. Vanochtend waren Jasper en Rianne allebei weer\ te laat opgestaan voor het college. Zij stonden\ te dringen in de badkamer. Rianne hinderde\ Jasper want hij had tijdens zijn ochtendritueel echt\ alle ruimte bij de wastafel nodig en zij stond hem\ dus ontzettend in de weg.
19c. Vanochtend waren Jasper en Rianne allebei weer\ te laat opgestaan voor het college. Zij stonden\ te dringen in de badkamer. Jasper hinderde\ Rianne maar hij had tijdens zijn ochtendritueel echt\ geprobeerd haar de ruimte te geven en zij moest\ dus niet zeuren.
19d. Vanochtend waren Jasper en Rianne allebei weer\ te laat opgestaan voor het college. Zij stonden\ te dringen in de badkamer. Rianne hinderde\ Jasper maar hij had tijdens zijn ochtendritueel echt\ geen zin om daar ruzie over te maken en hij hield\ dus zijn mond.
19e. Vanochtend waren Jasper en Rianne allebei weer\ te laat opgestaan voor het college. Zij stonden\ te dringen in de badkamer. Jasper hinderde\ Rianne en hij had tijdens zijn ochtendritueel echt\ een humeur om bang van te worden dus zij hield\ haar mond maar.
19f. Vanochtend waren Jasper en Rianne allebei weer\ te laat opgestaan voor het college. Zij stonden\ te dringen in de badkamer. Rianne hinderde\ Jasper en hij had tijdens zijn ochtendritueel echt\ een humeur om bang van te worden dus zij stopte\ maar snel met tandenpoetsen.
20a. Op het feest werden Loes en Bart door wederzijdse\ vrienden aan elkaar voorgesteld. Zij vonden\ elkaar direct leuk en interessant. Bart fascineerde\ Loes want hij bleek een persoon met een sterk\ karakter en veel humor te zijn.

20b. Op het feest werden Loes en Bart door wederzijdse\ vrienden aan elkaar voorgesteld. Zij vonden\ elkaar direct leuk en interessant. Loes fascineerde\ Bart want hij bleek een persoon met een sterk\ karakter en veel humor voor zich te hebben.
20c. Op het feest werden Loes en Bart door wederzijdse\ vrienden aan elkaar voorgesteld. Zij vonden\ elkaar direct leuk en interessant. Bart fascineerde\ Loes maar hij bleek een persoon met een vreemde\ fascinatie voor boomknuffelen te zijn.
20d. Op het feest werden Loes en Bart door wederzijdse\ vrienden aan elkaar voorgesteld. Zij vonden\ elkaar direct leuk en interessant. Loes fascineerde\ Bart maar hij bleek een persoon met een hogere\ opleiding toch de voorkeur te geven.
20e. Op het feest werden Loes en Bart door wederzijdse\ vrienden aan elkaar voorgesteld. Zij vonden\ elkaar direct leuk en interessant. Bart fascineerde\ Loes en hij bleek een persoon met een erg groot\ inlevingsvermogen te zijn.
20f. Op het feest werden Loes en Bart door wederzijdse\ vrienden aan elkaar voorgesteld. Zij vonden\ elkaar direct leuk en interessant. Loes fascineerde\ Bart en hij bleek een persoon met een sterk karakter\ en veel humor te zijn.

21a. Op een zonnige dag gingen Roos en Piet een fietstocht\ maken. Na een aantal kilometer fietsen bleek dat ze\ niets te eten hadden in hun fietstas. Piet verontschuldigde\ zich tegenover Roos want hij had tijdens hun uitgebreide\ voorbereidingen alle broodjes al opgegeten.
21b. Op een zonnige dag gingen Roos en Piet een fietstocht\ maken. Na een aantal kilometer fietsen bleek dat ze\ niets te eten hadden in hun fietstas. Roos verontschuldigde\ zich tegenover Piet want hij had tijdens hun uitgebreide\ voorbereidingen nog wel gezegd dat ze de broodjes niet\ moest vergeten.
21c. Op een zonnige dag gingen Roos en Piet een fietstocht\ maken. Na een aantal kilometer fietsen bleek dat ze\ niets te eten hadden in hun fietstas. Piet verontschuldigde\ zich tegenover Roos maar hij had tijdens hun uitgebreide\ voorbereidingen gelukkig niet vergeten iets te drinken\ mee te nemen.
21d. Op een zonnige dag gingen Roos en Piet een fietstocht\ maken. Na een aantal kilometer fietsen bleek dat ze\ niets te eten hadden in hun fietstas. Roos verontschuldigde\ zich tegenover Piet maar hij had tijdens hun uitgebreide\ voorbereidingen ook niet meer gedacht aan de broodjes\ op het aanrecht.
21e. Op een zonnige dag gingen Roos en Piet een fietstocht\ maken. Na een aantal kilometer fietsen bleek dat ze\ niets te eten hadden in hun fietstas. Piet verontschuldigde\ zich tegenover Roos en hij had tijdens hun uitgebreide\ voorbereidingen er ook niet aan gedacht flesjes drinken\ in te pakken.\
21f. Op een zonnige dag gingen Roos en Piet een fietstocht\ maken. Na een aantal kilometer fietsen bleek dat ze\ niets te eten hadden in hun fietstas. Roos verontschuldigde\ zich tegenover Piet en hij had tijdens hun uitgebreide\ voorbereidingen niet gedacht dat ze de broodjes weer\ zou vergeten.

22a. Plien en Tom gingen op een mooie dag\ in mei trouwen. Ze dachten dat de bruiloft\ tot in de puntjes geregeld was. Tom maakte\ Plien woedend want hij was bij het regelen van\ de bruiloft vergeten haar broer een uitnodiging\ te sturen.
22b. Plien en Tom gingen op een mooie dag\ in mei trouwen. Ze dachten dat de bruiloft\ tot in de puntjes geregeld was. Plien maakte\ Tom woedend want hij was bij het regelen van\ de bruiloft gaan inzien dat zij alleen maar\ haar zin wilde doordrijven.
22c. Plien en Tom gingen op een mooie dag\ in mei trouwen. Ze dachten dat de bruiloft\ tot in de puntjes geregeld was. Tom maakte\ Plien woedend maar hij was bij het regelen van\ de bruiloft gaan inzien dat dat door de\ grote spanning kwam.
22d. Plien en Tom gingen op een mooie dag\ in mei trouwen. Ze dachten dat de bruiloft\ tot in de puntjes geregeld was. Plien maakte\ Tom woedend maar hij was bij het regelen van\ de bruiloft eigenlijk gewoon de hele tijd\ flink humeurig.
22e. Plien en Tom gingen op een mooie dag\ in mei trouwen. Ze dachten dat de bruiloft\ tot in de puntjes geregeld was. Tom maakte\ Plien woedend en hij was bij het regelen van\ de bruiloft eigenlijk steeds minder zin in\ het feest gaan krijgen.
22f. Plien en Tom gingen op een mooie dag\ in mei trouwen. Ze dachten dat de bruiloft\ tot in de puntjes geregeld was. Plien maakte\ Tom woedend en hij was bij het regelen van\ de bruiloft eigenlijk steeds minder zin in\ het feest gaan krijgen.

23a. Anne en Hans waren op vakantie in Thailand.\ Ze liepen daar een groot risico om een\ tropische ziekte op te lopen. Hans besmette\ Anne want hij was bij de voorbereidingen van\ de maaltijd vergeten zijn handen te wassen.
23b. Anne en Hans waren op vakantie in Thailand.\ Ze liepen daar een groot risico om een\ tropische ziekte op te lopen. Anne besmette\ Hans want hij was bij de voorbereidingen van\ de reis vergeten zich te laten inenten.

23c. Anne en Hans waren op vakantie in Thailand.\ Ze liepen daar een groot risico om een\ tropische ziekte op te lopen. Hans besmette\ Anne maar hij was bij de voorbereidingen van\ de maaltijd erg nauwkeurig te werk gegaan.
23d. Anne en Hans waren op vakantie in Thailand.\ Ze liepen daar een groot risico om een\ tropische ziekte op te lopen. Anne besmette\ Hans maar hij was bij de voorbereidingen van\ de reis gelukkig niet vergeten medicijnen\ mee te nemen.
23e. Anne en Hans waren op vakantie in Thailand.\ Ze liepen daar een groot risico om een\ tropische ziekte op te lopen. Hans besmette\ Anne en hij was bij de voorbereidingen van\ de reis helaas vergeten een goede reisverzekering\ voor haar af te sluiten.
23f. Anne en Hans waren op vakantie in Thailand.\ Ze liepen daar een groot risico om een\ tropische ziekte op te lopen. Anne besmette\ Hans en hij was bij de voorbereidingen van\ de reis helaas vergeten een goede reisverzekering\ voor zichzelf af te sluiten.

24a. Maria en Ted liepen laat in de avond door\ het bos. Ze liepen snel door zodat ze\ eerder thuis zouden zijn. Ted maakte\ Maria bang want hij had de hele weg naar\ huis enge spookverhalen verteld.
24b. Maria en Ted liepen laat in de avond door\ het bos. Ze liepen snel door zodat ze\ eerder thuis zouden zijn. Maria maakte\ Ted bang want hij had de hele weg naar huis\ naar haar enge spookverhalen moeten luisteren.
24c. Maria en Ted liepen laat in de avond door\ het bos. Ze liepen snel door zodat ze\ eerder thuis zouden zijn. Ted maakte\ Maria bang maar hij had de hele weg naar\ huis lopen janken toen Maria hem een keer\ liet schrikken.
24d. Maria en Ted liepen laat in de avond door\ het bos. Ze liepen snel door zodat ze\ eerder thuis zouden zijn. Maria maakte\ Ted bang maar hij had de hele weg naar\ huis wraak genomen door zich steeds te\ verstoppen en enge geluiden te maken.
24e. Maria en Ted liepen laat in de avond door\ het bos. Ze liepen snel door zodat ze\ eerder thuis zouden zijn. Ted maakte\ Maria bang en hij had de hele weg naar\ huis keihard lopen lachen toen zij bijna\ moest huilen van angst.
24f. Maria en Ted liepen laat in de avond door\ het bos. Ze liepen snel door zodat ze\ eerder thuis zouden zijn. Maria maakte\ Ted bang en hij had de hele weg naar\ huis wraak genomen door zich steeds te\ verstoppen en enge geluiden te maken.

25a. Ruim vier jaar deden Joost en Karin onderzoek naar\ het taalvermogen van dolfijnen. In die tijd kregen\ zij veel waardering voor elkaar. Karin respecteerde\ Joost want hij had in de afgelopen jaren zowel zijn\ theoretische als zijn praktische vaardigheden\ laten zien.
25b. Ruim vier jaar deden Joost en Karin onderzoek naar\ het taalvermogen van dolfijnen. In die tijd kregen\ zij veel waardering voor elkaar. Joost respecteerde\ Karin want hij had in de afgelopen jaren erg veel\ steun van haar gekregen.
25c. Ruim vier jaar deden Joost en Karin onderzoek naar\ het taalvermogen van dolfijnen. In die tijd kregen\ zij veel waardering voor elkaar. Karin respecteerde\ Joost maar hij had in de afgelopen jaren toch wel\ een paar grote fouten in het onderzoek gemaakt.
25d. Ruim vier jaar deden Joost en Karin onderzoek naar\ het taalvermogen van dolfijnen. In die tijd kregen\ zij veel waardering voor elkaar. Joost respecteerde\ Karin maar hij had in de afgelopen jaren toch niet\ het gevoel dat ze echt vrienden waren.
25e. Ruim vier jaar deden Joost en Karin onderzoek naar\ het taalvermogen van dolfijnen. In die tijd kregen\ zij veel waardering voor elkaar. Karin respecteerde\ Joost en hij had in de afgelopen jaren erg veel\ steun van haar gekregen.
25f. Ruim vier jaar deden Joost en Karin onderzoek naar\ het taalvermogen van dolfijnen. In die tijd kregen\ zij veel waardering voor elkaar. Joost respecteerde\ Karin en hij had in de afgelopen jaren veel gedaan\ om dat aan haar te laten zien.

26a. De boezemvrienden Anna en Lars zijn sinds kort ook\ buren van elkaar. Na een drukke periode hadden ze\ eindelijk tijd gevonden voor een dineetje. Anna bedankte\ Lars want hij had de afgelopen weken bij de verhuizing\ erg vaak meegeholpen.
26b. De boezemvrienden Anna en Lars zijn sinds kort ook\ buren van elkaar. Na een drukke periode hadden ze\ eindelijk tijd gevonden voor een dineetje. Lars bedankte\ Anna want hij had de afgelopen weken bij de verhuizing\ haar hulp zeer gewaardeerd.
26c. De boezemvrienden Anna en Lars zijn sinds kort ook\ buren van elkaar. Na een drukke periode hadden ze\ eindelijk tijd gevonden voor een dineetje. Anna bedankte\ Lars maar hij had de afgelopen weken bij de verhuizing\ wel wat vazen laten vallen.

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26e. De boezemvrienden Anna en Lars zijn sinds kort ook\ buren van elkaar. Na een drukke periode hadden ze\ eindelijk tijd gevonden voor een dineetje. Anna bedankte\ Lars en hij had de afgelopen weken bij de verhuizing al\ gemerkt dat zij erg blij met hem was.
26f. De boezemvrienden Anna en Lars zijn sinds kort ook\ buren van elkaar. Na een drukke periode hadden ze\ eindelijk tijd gevonden voor een dineetje. Lars bedankte\ Anna en hij had de afgelopen weken bij de verhuizing\ eigenlijk wel een beetje gevoelens voor haar gekregen.

27a. Lex en Suzan waren van die personen die elkaar absoluut\ niet konden uitstaan. Elke keer dat zij elkaar\ tegenkwamen kon het op ruzie uitlopen. Suzan verafschuwde\ Lex want hij was als er meer mensen bij waren altijd een\ ontzettende opschepper.
27b. Lex en Suzan waren van die personen die elkaar absoluut\ niet konden uitstaan. Elke keer dat zij elkaar\ tegenkwamen kon het op ruzie uitlopen. Lex verafschuwde\ Suzan want hij was als er meer mensen bij waren altijd\ haar pispaaltje.
27c. Lex en Suzan waren van die personen die elkaar absoluut\ niet konden uitstaan. Elke keer dat zij elkaar\ tegenkwamen kon het op ruzie uitlopen. Suzan verafschuwde\ Lex maar hij was als er meer mensen bij waren vaak\ irritant charmant.
27d. Lex en Suzan waren van die personen die elkaar absoluut\ niet konden uitstaan. Elke keer dat zij elkaar tegenkwamen\ kon het op ruzie uitlopen. Lex verafschuwde\ Suzan maar hij was als er meer mensen bij waren\ altijd correct tegen haar.
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27f. Lex en Suzan waren van die personen die elkaar absoluut\ niet konden uitstaan. Elke keer dat zij elkaar tegenkwamen\ kon het op ruzie uitlopen. Lex verafschuwde\ Suzan en hij was als er meer mensen bij waren altijd\ bang dat hij zich niet in zou kunnen houden.

28a. Els en Bas deden samen mee aan een vraaggesprek over\ de liefde. Ze waren duidelijk dol op elkaar. Els hield van\ Bas want hij was sinds het begin van hun verkering\ ontzettend lief voor haar geweest.
28b. Els en Bas deden samen mee aan een vraaggesprek over\ de liefde. Ze waren duidelijk dol op elkaar. Bas hield van\ Els want hij was sinds het begin van hun verkering heel\ blij geweest met haar opgewekte humeur.
28c. Els en Bas deden samen mee aan een vraaggesprek over\ de liefde. Ze waren duidelijk dol op elkaar. Els hield van\ Bas maar hij was sinds het begin van hun verkering te weinig\ thuis geweest naar haar mening.
28d. Els en Bas deden samen mee aan een vraaggesprek over\ de liefde. Ze waren duidelijk dol op elkaar. Bas hield van\ Els maar hij was sinds het begin van hun verkering te\ verlegen geweest om het tegen haar te zeggen.
28e. Els en Bas deden samen mee aan een vraaggesprek over\ de liefde. Ze waren duidelijk dol op elkaar. Els hield van\ Bas en hij was sinds het begin van hun verkering heel trots\ dat zij zijn vriendin was.
28f. Els en Bas deden samen mee aan een vraaggesprek over\ de liefde. Ze waren duidelijk dol op elkaar. Bas hield van\ Els en hij was sinds het begin van hun verkering heel trots\ dat zij zijn vriendin was.

29a. Guido en Heleen hadden hard gestudeerd voor\ een belangrijk tentamen. Jammer genoeg\ haalden ze het allebei niet. Heleen troostte\ Guido want hij had na het horen van zijn\ uitslag wel wat steun nodig.
29b. Guido en Heleen hadden hard gestudeerd voor\ een belangrijk tentamen. Jammer genoeg\ haalden ze het allebei niet. Guido troostte\ Heleen want hij had na het horen van haar\ cijfer meteen veel medelijden met haar.
29c. Guido en Heleen hadden hard gestudeerd voor\ een belangrijk tentamen. Jammer genoeg\ haalden ze het allebei niet. Heleen troostte\ Guido maar hij had na het horen van zijn cijfer\ eigenlijk meer behoefte om even alleen te zijn.
29d. Guido en Heleen hadden hard gestudeerd voor\ een belangrijk tentamen. Jammer genoeg\ haalden ze het allebei niet. Guido troostte\ Heleen maar hij had na het horen van zijn cijfer\ zelf ook een schouder nodig om op uit te huilen.
29e. Guido en Heleen hadden hard gestudeerd voor\ een belangrijk tentamen. Jammer genoeg\ haalden ze het allebei niet. Heleen troostte\ Guido en hij had na het horen van haar troostende\ woorden weer goede moed voor de toekomst.
29f. Guido en Heleen hadden hard gestudeerd voor\ een belangrijk tentamen. Jammer genoeg\ haalden ze het allebei niet. Guido troostte\ Heleen en hij had na het horen van haar cijfer\ zelfs een relativerend grapje gemaakt.

30a. Sofie en Martijn hielden van jongs af aan al van\ rollenspelletjes. Zij speelden elke week weer\ een andere situatie na. Sofie strafte\ Martijn want hij speelde deze hele week al\ de rol van een vervelend schooljongetje.
30b. Sofie en Martijn hielden van jongs af aan al van\ rollenspelletjes. Zij speelden elke week weer\ een andere situatie na. Martijn strafte\ Sofie want hij speelde deze hele week al\ de rol van een strenge schoolmeester.
30c. Sofie en Martijn hielden van jongs af aan al van\ rollenspelletjes. Zij speelden elke week weer\ een andere situatie na. Sofie strafte\ Martijn maar hij speelde de hele week al met\ tegenzin de rol van een vervelend schooljongetje.
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30f. Sofie en Martijn hielden van jongs af aan al van\ rollenspelletjes. Zij speelden elke week weer\ een andere situatie na. Martijn strafte\ Sofie en hij speelde de hele week al met\ overtuiging zijn rol van strenge schoolmeester.

31a. Sinds lange tijd waren Bob en Wendy werkzaam bij een\ advocatenbureau. Als zij samenwerkten vlogen\ de verwijten over en weer. Wendy bekritiseerde\ Bob want hij kreeg steeds meer het idee dat hij alle\ belangrijke beslissingen kon maken zonder te overleggen.
31b. Sinds lange tijd waren Bob en Wendy werkzaam bij een\ advocatenbureau. Als zij samenwerkten vlogen\ de verwijten over en weer. Bob bekritiseerde\ Wendy want hij kreeg steeds meer het idee dat zij\ zich nooit echt voor de zaak interesseerde.
31c. Sinds lange tijd waren Bob en Wendy werkzaam bij een\ advocatenbureau. Als zij samenwerkten vlogen\ de verwijten over en weer. Wendy bekritiseerde\ Bob maar hij kreeg steeds meer het idee dat zij\ totaal niet wist waarover ze het had.
31d. Sinds lange tijd waren Bob en Wendy werkzaam bij een\ advocatenbureau. Als zij samenwerkten vlogen\ de verwijten over en weer. Bob bekritiseerde\ Wendy maar hij kreeg steeds meer het idee dat zij\ zich daar helemaal niets van aantrok.
31e. Sinds lange tijd waren Bob en Wendy werkzaam bij\ een advocatenbureau. Als zij samenwerkten vlogen\ de verwijten over en weer. Wendy bekritiseerde\ Bob en hij kreeg steeds meer het idee dat zij\ misschien maar niet meer samen aan een zaak\ moesten werken.
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32a. Olga en Sander zaten in hetzelfde korfbalteam.\ Ze hadden zojuist met dit team een belangrijk\ toernooi gewonnen. Olga feliciteerde\ Sander want hij had tijdens de zeer spannende\ finale de winnende bal erin gegooid.
32b. Olga en Sander zaten in hetzelfde korfbalteam.\ Ze hadden zojuist met dit team een belangrijk\ toernooi gewonnen. Sander feliciteerde\ Olga want hij had tijdens de zeer spannende\ finale een superieure Olga mogen aanschouwen.
32c. Olga en Sander zaten in hetzelfde korfbalteam.\ Ze hadden zojuist met dit team een belangrijk\ toernooi gewonnen. Olga feliciteerde\ Sander maar hij had tijdens de zeer spannende\ finale niet zijn normale niveau gehaald.
32d. Olga en Sander zaten in hetzelfde korfbalteam.\ Ze hadden zojuist met dit team een belangrijk\ toernooi gewonnen. Sander feliciteerde\ Olga maar hij had tijdens de zeer spannende\ finale wel wat grote fouten van haar moeten oplossen.
32e. Olga en Sander zaten in hetzelfde korfbalteam.\ Ze hadden zojuist met dit team een belangrijk\ toernooi gewonnen. Olga feliciteerde\ Sander en hij had tijdens de zeer spannende\ finale genoten van hun samenspel.
32f. Olga en Sander zaten in hetzelfde korfbalteam.\ Ze hadden zojuist met dit team een belangrijk\ toernooi gewonnen. Sander feliciteerde\ Olga en hij had tijdens de zeer spannende finale\ genoten van hun samenspel.

33a. Hoewel David en Mirjam al sinds lange tijd\ samen op pianoles zaten hadden ze totaal geen\ waardering voor elkaar. Mirjam minachtte\ David want hij had na al die jaren pianoles\ nog steeds geen vooruitgang geboekt.

33b. Hoewel David en Mirjam al sinds lange tijd\ samen op pianoles zaten hadden ze totaal geen\ waardering voor elkaar. David minachtte\ Mirjam want hij had na al die jaren pianoles\ nog steeds geen vooruitgang bij haar gezien.
33c. Hoewel David en Mirjam al sinds lange tijd\ samen op pianoles zaten hadden ze totaal geen\ waardering voor elkaar. Mirjam minachtte\ David maar hij had na al die jaren pianoles\ meer vooruitgang geboekt dan Mirjam.
33d. Hoewel David en Mirjam al sinds lange tijd\ samen op pianoles zaten hadden ze totaal geen\ waardering voor elkaar. David minachtte\ Mirjam maar hij had na al die jaren pianoles\ minder vooruitgang geboekt dan Mirjam.
33e. Hoewel David en Mirjam al sinds lange tijd\ samen op pianoles zaten hadden ze totaal geen\ waardering voor elkaar. Mirjam minachtte\ David en hij had na al die jaren pianoles\ besloten om naar een andere muziekschool te gaan.
33f. Hoewel David en Mirjam al sinds lange tijd\ samen op pianoles zaten hadden ze totaal geen\ waardering voor elkaar. David minachtte\ Mirjam en hij had na al die jaren pianoles\ nog nooit een vriendelijk woord met haar gewisseld.

34a. Afgelopen dinsdag vierden Nina en Vincent ieder\ hun elfde verjaardag. Ze hadden allebei om een\ nieuwe mountainbike gevraagd. Nina benijdde\ Vincent want hij had de zo fel begeerde mountainbike\ wel gekregen en zij niet.
34b. Afgelopen dinsdag vierden Nina en Vincent ieder\ hun elfde verjaardag. Ze hadden allebei om een\ nieuwe mountainbike gevraagd. Vincent benijdde\ Nina want hij had de zo fel begeerde mountainbike\ aan zijn neus voorbij zien gaan.
34c. Afgelopen dinsdag vierden Nina en Vincent ieder\ hun elfde verjaardag. Ze hadden allebei om een\ nieuwe mountainbike gevraagd. Nina benijdde\ Vincent maar hij had de zo fel begeerde mountainbike\ toch liever willen inruilen voor de crossfiets die\ Nina's vader voor haar had gekocht.
34d. Afgelopen dinsdag vierden Nina en Vincent ieder\ hun elfde verjaardag. Ze hadden allebei om een\ nieuwe mountainbike gevraagd. Vincent benijdde\ Nina maar hij had de zo fel begeerde mountainbike\ gelukkig een paar dagen later toch ook nog gekregen.
34e. Afgelopen dinsdag vierden Nina en Vincent ieder\ hun elfde verjaardag. Ze hadden allebei om een\ nieuwe mountainbike gevraagd. Nina benijdde\ Vincent en hij had de zo fel begeerde mountainbike\ een middag aan Nina uitgeleend.
34f. Afgelopen dinsdag vierden Nina en Vincent ieder\ hun elfde verjaardag. Ze hadden allebei om een\ nieuwe mountainbike gevraagd. Vincent benijdde\ Nina en hij had de zo fel begeerde mountainbike\ voor een middag van Nina mogen lenen.

35a. Luuk en Marije kwamen elkaar tegen in de\ studio's van Hilversum. Zij hadden beide auditie\ gedaan voor een soapserie. Marije prees\ Luuk want hij had eerder die middag een zeer\ goede prestatie voor de camera neergezet.
35b. Luuk en Marije kwamen elkaar tegen in de\ studio's van Hilversum. Zij hadden beide auditie\ gedaan voor een soapserie. Luuk prees\ Marije want hij had eerder die middag een zeer\ goede prestatie van haar gezien.
35c. Luuk en Marije kwamen elkaar tegen in de\ studio's van Hilversum. Zij hadden beide auditie\ gedaan voor een soapserie. Marije prees\ Luuk maar hij had eerder die middag een bericht\ gekregen dat hij niet in de serie zou komen.
35d. Luuk en Marije kwamen elkaar tegen in de\ studio's van Hilversum. Zij hadden beide auditie\ gedaan voor een soapserie. Luuk prees\ Marije maar hij had eerder die middag een meisje\ zien acteren dat eigenlijk beter was dan Marije.
35e. Luuk en Marije kwamen elkaar tegen in de\ studio's van Hilversum. Zij hadden beide auditie\ gedaan voor een soapserie. Marije prees\ Luuk en hij had eerder die middag een bericht\ gekregen dat hij mee mocht spelen in de serie.
35f. Luuk en Marije kwamen elkaar tegen in de\ studio's van Hilversum. Zij hadden beide auditie\ gedaan voor een soapserie. Luuk prees\ Marije en hij had eerder die middag een leuk\ cadeautje voor haar gekocht.

36a. Iris en Frank hadden vanuit hun studievereniging voor het\ eerst samen een congres georganiseerd. Na afloop moesten zij\ alleen nog de laatste rommel opruimen. Iris complimenteerde\ Frank want hij had alle problemen die zich voordeden\ vakkundig het hoofd geboden.
36b. Iris en Frank hadden vanuit hun studievereniging voor het\ eerst samen een congres georganiseerd. Na afloop moesten zij\ alleen nog de laatste rommel opruimen. Frank complimenteerde\ Iris want hij had alle problemen die zich voordeden\ opgelost zien worden door Iris.

36c. Iris en Frank hadden vanuit hun studievereniging voor het\ eerst samen een congres georganiseerd. Na afloop moesten zij\ alleen nog de laatste rommel opruimen. Iris complimenteerde\ Frank maar hij had alle problemen die zich voordeden alleen\ dankzij de hulp van Iris kunnen oplossen.
36d. Iris en Frank hadden vanuit hun studievereniging voor het\ eerst samen een congres georganiseerd. Na afloop moesten zij\ alleen nog de laatste rommel opruimen. Frank complimenteerde\ Iris maar hij had alle problemen die zich voordeden helemaal\ zelf het hoofd geboden.
36e. Iris en Frank hadden vanuit hun studievereniging voor het\ eerst samen een congres georganiseerd. Na afloop moesten zij\ alleen nog de laatste rommel opruimen. Iris complimenteerde\ Frank en hij had alle problemen die zich bij de afronding\ van het congres voordeden voor zijn rekening genomen.
36f. Iris en Frank hadden vanuit hun studievereniging voor het\ eerst samen een congres georganiseerd. Na afloop moesten zij\ alleen nog de laatste rommel opruimen. Frank complimenteerde\ Iris en hij had alle problemen die zich bij de afronding\ van het congres voordeden voor zijn rekening genomen.

37a. De rechtbank had het bedrijf van Koos en Rosa failliet\ verklaard. Zij moesten nu hun schulden aflossen. Rosa stelde\ Koos verantwoordelijk want hij had het financieel beleid van\ het begin af aan geen aandacht geschonken.
37b. De rechtbank had het bedrijf van Koos en Rosa failliet\ verklaard. Zij moesten nu hun schulden aflossen. Koos stelde\ Rosa verantwoordelijk want hij had het financieel beleid van\ Rosa van het begin af aan al niet vertrouwd.
37c. De rechtbank had het bedrijf van Koos en Rosa failliet\ verklaard. Zij moesten nu hun schulden aflossen. Rosa stelde\ Koos verantwoordelijk maar hij had het financieel beleid van\ hun bedrijf aan een derde overgelaten.
37d. De rechtbank had het bedrijf van Koos en Rosa failliet\ verklaard. Zij moesten nu hun schulden aflossen. Koos stelde\ Rosa verantwoordelijk maar hij had het financieel beleid van\ hun bedrijf nooit aan haar alleen mogen overlaten.
37e. De rechtbank had het bedrijf van Koos en Rosa failliet\ verklaard. Zij moesten nu hun schulden aflossen. Rosa stelde\ Koos verantwoordelijk en hij had het financieel beleid van\ hun bedrijf achteraf ook waardeloos genoemd.
37f. De rechtbank had het bedrijf van Koos en Rosa failliet\ verklaard. Zij moesten nu hun schulden aflossen. Koos stelde\ Rosa verantwoordelijk en hij had het financieel beleid van\ Rosa achteraf ook waardeloos genoemd.

38a. Sandra en Hugo hadden een nogal verhitte\ geschiedenis vol ruzies en nijd. Zij konden\ elkaar inmiddels wel schieten. Sandra haatte\ Hugo want hij had van kinds af aan ontelbaar\ veel achterbakse streken met haar uitgehaald.
38b. Sandra en Hugo hadden een nogal verhitte\ geschiedenis vol ruzies en nijd. Zij konden\ elkaar inmiddels wel schieten. Hugo haatte\ Sandra want hij had van kinds af aan ontelbaar\ veel achterbakse streken van haar moeten incasseren.
38c. Sandra en Hugo hadden een nogal verhitte\ geschiedenis vol ruzies en nijd. Zij konden\ elkaar inmiddels wel schieten. Sandra haatte\ Hugo maar hij had van kinds af aan dan ook\ ontelbaar veel achterbakse streken met\ haar uitgehaald.
38d. Sandra en Hugo hadden een nogal verhitte\ geschiedenis vol ruzies en nijd. Zij konden\ elkaar inmiddels wel schieten. Hugo haatte\ Sandra maar hij had van kinds af aan dan ook\ ontelbaar veel streken van haar moeten incasseren.
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38f. Sandra en Hugo hadden een nogal verhitte\ geschiedenis vol ruzies en nijd. Zij konden\ elkaar inmiddels wel schieten. Hugo haatte\ Sandra en hij had van kinds af aan dan ook\ ontelbaar veel achterbakse streken bij\ haar uitgehaald.

39a. Guus en Zita werkten beiden op dezelfde afdeling\ van een bedrijf voor mobiele telefonie. Door\ slechte winstresultaten moest het bedrijf\ helaas snijden in het personeel. Zita ontsloeg\ Guus want hij had volgens veel collega's niet\ genoeg zijn best gedaan het afgelopen jaar.
39b. Guus en Zita werkten beiden op dezelfde afdeling\ van een bedrijf voor mobiele telefonie. Door\ slechte winstresultaten moest het bedrijf\ helaas snijden in het personeel. Guus ontsloeg\ Zita want hij had volgens veel collega's niet\ genoeg vertrouwen in haar capaciteiten.
39c. Guus en Zita werkten beiden op dezelfde afdeling\ van een bedrijf voor mobiele telefonie. Door\ slechte winstresultaten moest het bedrijf\ helaas snijden in het personeel. Zita ontsloeg\ Guus maar hij had volgens veel collega's niet\ echt schuld aan de slechte resultaten.

39d. Guus en Zita werkten beiden op dezelfde afdeling\ van een bedrijf voor mobiele telefonie. Door\ slechte winstresultaten moest het bedrijf\ helaas snijden in het personeel. Guus ontsloeg\ Zita maar hij had volgens veel collega's niet\ genoeg rekening gehouden met haar persoonlijke situatie.
39e. Guus en Zita werkten beiden op dezelfde afdeling\ van een bedrijf voor mobiele telefonie. Door\ slechte winstresultaten moest het bedrijf\ helaas snijden in het personeel. Zita ontsloeg\ Guus en hij had volgens veel collega's niet de\ waardering gekregen voor zijn werk die hij verdiende.\
39f. Guus en Zita werkten beiden op dezelfde afdeling\ van een bedrijf voor mobiele telefonie. Door\ slechte winstresultaten moest het bedrijf\ helaas snijden in het personeel. Guus ontsloeg\ Zita en hij had volgens veel collega's niet\ goed aan haar uitgelegd waarom.\

40a. Op de Rietveld Academie waren Ellen en Frits\ elkaar voor het eerst tegen gekomen. Sindsdien\ deelden zij samen een atelier. Ellen bewonderde\ Frits want hij had een groot talent voor\ beeldhouwen laten zien.
40b. Op de Rietveld Academie waren Ellen en Frits\ elkaar voor het eerst tegen gekomen. Sindsdien\ deelden zij samen een atelier. Frits bewonderde\ Ellen want hij had een groot talent voor beeldhouwen\ in haar herkend.
40c. Op de Rietveld Academie waren Ellen en Frits\ elkaar voor het eerst tegen gekomen. Sindsdien\ deelden zij samen een atelier. Ellen bewonderde\ Frits maar hij had een groot talent voor het\ verbergen van zijn negatieve kanten zoals\ ze later zou merken.
40d. Op de Rietveld Academie waren Ellen en Frits\ elkaar voor het eerst tegen gekomen. Sindsdien\ deelden zij samen een atelier. Frits bewonderde\ Ellen maar hij had een groot talent voor het\ overdrijven van zijn gevoelens zoals ze\ later zou merken.
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40f. Op de Rietveld Academie waren Ellen en Frits\ elkaar voor het eerst tegen gekomen. Sindsdien\ deelden zij samen een atelier. Frits bewonderde\ Ellen en hij had een groot talent voor de\ kleinkunst academie in haar gezien.

41a. Tot een jaar geleden hadden Mark en Rachel samen\ voor een internetbedrijf gewerkt. Zij waren helaas\ op slechte voet uit elkaar gegaan. Rachel klaagde\ Mark aan want hij bleek een grote som geld van\ het bedrijf verduisterd te hebben.
41b. Tot een jaar geleden hadden Mark en Rachel samen\ voor een internetbedrijf gewerkt. Zij waren helaas\ op slechte voet uit elkaar gegaan. Mark klaagde\ Rachel aan want hij bleek een grote som geld van\ haar tegoed te hebben.
41c. Tot een jaar geleden hadden Mark en Rachel samen\ voor een internetbedrijf gewerkt. Zij waren helaas\ op slechte voet uit elkaar gegaan. Rachel klaagde\ Mark aan maar hij bleek een grote som geld die\ zij nog dacht te krijgen van hem al lang op haar\ rekening te hebben gestort.
41d. Tot een jaar geleden hadden Mark en Rachel samen\ voor een internetbedrijf gewerkt. Zij waren helaas\ op slechte voet uit elkaar gegaan. Mark klaagde\ Rachel aan maar hij bleek een grote som geld die\ hij nog dacht te krijgen van haar al lang\ ontvangen te hebben.
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41f. Tot een jaar geleden hadden Mark en Rachel samen\ voor een internetbedrijf gewerkt. Zij waren helaas\ op slechte voet uit elkaar gegaan. Mark klaagde\ Rachel aan en hij bleek een grote som geld van\ haar tegoed te hebben.

42a. Op de schermschool hadden Tanja en Karl zich\ ingeschreven voor een wedstrijd. Omdat zij\ voor het eerst elkaars tegenstander waren\ overwogen zij elkaars kansen. Tanja vreesde\ Karl want hij had door vele jaren ervaring\ natuurlijk meer kans om te winnen.
42b. Op de schermschool hadden Tanja en Karl zich\ ingeschreven voor een wedstrijd. Omdat zij\ voor het eerst elkaars tegenstander waren\ overwogen zij elkaars kansen. Karl vreesde\ Tanja want hij had door vele jaren ervaring\ meteen gezien dat ze een sterke tegenstander was.
42c. Op de schermschool hadden Tanja en Karl zich\ ingeschreven voor een wedstrijd. Omdat zij\ voor het eerst elkaars tegenstander waren\ overwogen zij elkaars kansen. Tanja vreesde\ Karl maar hij had door vele jaren ervaring\ ingezien dat hij haar niet moest onderschatten.
42d. Op de schermschool hadden Tanja en Karl zich\ ingeschreven voor een wedstrijd. Omdat zij\ voor het eerst elkaars tegenstander waren\ overwogen zij elkaars kansen. Karl vreesde\ Tanja maar hij had door vele jaren ervaring\ toch meteen doorzien wat mogelijk haar\ zwakke plek was.

42e. Op de schermschool hadden Tanja en Karl zich\ ingeschreven voor een wedstrijd. Omdat zij\ voor het eerst elkaars tegenstander waren\ overwogen zij elkaars kansen. Tanja vreesde\ Karl en hij had door vele jaren ervaring\ dan ook een imponerende uitstraling.
42f. Op de schermschool hadden Tanja en Karl zich\ ingeschreven voor een wedstrijd. Omdat zij\ voor het eerst elkaars tegenstander waren\ overwogen zij elkaars kansen. Karl vreesde\ Tanja en hij had door vele jaren ervaring\ ondervonden dat je nooit een tegenstander\ mag vrezen.

43a. Hercules en Athena woonden temidden van andere\ goden beiden op de Olympus. Zij kenden\ elkaar letterlijk al eeuwen. Athena aanbad\ Hercules want hij was als echte Griekse God\ een vervuller van al haar wensen.
43b. Hercules en Athena woonden temidden van andere\ goden beiden op de Olympus. Zij kenden\ elkaar letterlijk al eeuwen. Hercules aanbad\ Athena want hij was als echte Griekse God\ al vaak gevallen voor de dochters van Zeus.
43c. Hercules en Athena woonden temidden van andere\ goden beiden op de Olympus. Zij kenden\ elkaar letterlijk al eeuwen. Athena aanbad\ Hercules maar hij was als echte Griekse God\ wel erg jaloers aangelegd.
43d. Hercules en Athena woonden temidden van andere\ goden beiden op de Olympus. Zij kenden\ elkaar letterlijk al eeuwen. Hercules aanbad\ Athena maar hij was als echte Griekse God\ niet gemakkelijk te strikken voor een afspraakje.
43e. Hercules en Athena woonden temidden van andere\ goden beiden op de Olympus. Zij kenden\ elkaar letterlijk al eeuwen. Athena aanbad\ Hercules en hij was als echte Griekse God\ natuurlijk erg gevleid door al haar aandacht.
43f. Hercules en Athena woonden temidden van andere\ goden beiden op de Olympus. Zij kenden\ elkaar letterlijk al eeuwen. Hercules aanbad\ Athena en hij was als echte Griekse God\ natuurlijk meteen gevallen voor haar\ oogverblindende schoonheid.

44a. Babet en Thijs waren al jaren verbonden aan hetzelfde\ natuurkundig instituut. Als team hadden zij al voor\ meerdere theoretische doorbraken gezorgd. Babet waardeerde\ Thijs want hij kwam echt elke keer weer met een origineel\ onderzoeksplan.
44b. Babet en Thijs waren al jaren verbonden aan hetzelfde\ natuurkundig instituut. Als team hadden zij al voor\ meerdere theoretische doorbraken gezorgd. Thijs waardeerde\ Babet want hij kwam echt elke keer weer met plezier op\ zijn werk door haar vrolijke aanwezigheid.
44c. Babet en Thijs waren al jaren verbonden aan hetzelfde\ natuurkundig instituut. Als team hadden zij al voor\ meerdere theoretische doorbraken gezorgd. Babet waardeerde\ Thijs maar hij kwam echt elke keer weer veel te laat op\ hun afspraken.
44d. Babet en Thijs waren al jaren verbonden aan hetzelfde\ natuurkundig instituut. Als team hadden zij al voor\ meerdere theoretische doorbraken gezorgd. Thijs waardeerde\ Babet maar hij kwam echt elke keer weer tot de conclusie\ dat zij hem niet waardeerde.
44e. Babet en Thijs waren al jaren verbonden aan hetzelfde\ natuurkundig instituut. Als team hadden zij al voor\ meerdere theoretische doorbraken gezorgd. Babet waardeerde\ Thijs en hij kwam echt elke keer weer met iets nieuws\ dat haar waardering alleen maar vergrootte.
44f. Babet en Thijs waren al jaren verbonden aan hetzelfde\ natuurkundig instituut. Als team hadden zij al voor\ meerdere theoretische doorbraken gezorgd. Thijs waardeerde\ Babet en hij kwam echt elke keer weer met plezier op\ zijn werk door haar vrolijke aanwezigheid.

45a. John en Sabine liepen door het spookhuis in een pretpark. Ze\ waren nog niet eerder in een interactief spookhuis geweest\ waar ze zelf verkleed werden als geest. Sabine was bang voor\ John want hij had in de pikdonkere ruimte het uiterlijk van\ een lopend lijk.
45b. John en Sabine liepen door het spookhuis in een pretpark. Ze\ waren nog niet eerder in een interactief spookhuis geweest\ waar ze zelf verkleed werden als geest. John was bang voor\ Sabine want hij had in de pikdonkere ruimte het sterke\ voorgevoel dat Sabine hem zou gaan laten schrikken.
45c. John en Sabine liepen door het spookhuis in een pretpark. Ze\ waren nog niet eerder in een interactief spookhuis geweest\ waar ze zelf verkleed werden als geest. Sabine was bang voor\ John maar hij had in de pikdonkere ruimte gelukkig geen\ gelegenheid om haar erg aan het schrikken te maken.
45d. John en Sabine liepen door het spookhuis in een pretpark. Ze\ waren nog niet eerder in een interactief spookhuis geweest\ waar ze zelf verkleed werden als geest. John was bang voor\ Sabine maar hij had in de pikdonkere ruimte gelukkig kans\ gezien ver bij haar vandaan te blijven.
45e. John en Sabine liepen door het spookhuis in een pretpark. Ze\ waren nog niet eerder in een interactief spookhuis geweest\ waar ze zelf verkleed werden als geest. Sabine was bang voor\ John en hij had in de pikdonkere ruimte geprobeerd haar\ gerust te stellen.

45f. John en Sabine liepen door het spookhuis in een pretpark. Ze\ waren nog niet eerder in een interactief spookhuis geweest\ waar ze zelf verkleed werden als geest. John was bang voor\ Sabine en hij had in de pikdonkere ruimte geprobeerd zo\ ver mogelijk bij haar vandaan te blijven.

46a. Joke en Koos waren vorig jaar vijfenveertig\ jaar getrouwd. Deze winter raakten ze echter\ betrokken bij een ernstig ongeluk. Joke rouwde om\ Koos want hij was vlak na het ongeluk overleden\ aan de gevolgen van zijn verwondingen.
46b. Joke en Koos waren vorig jaar vijfenveertig\ jaar getrouwd. Deze winter raakten ze echter\ betrokken bij een ernstig ongeluk. Koos rouwde om\ Joke want hij was vlak na het ongeluk getuige\ geweest van haar laatste woorden.
46c. Joke en Koos waren vorig jaar vijfenveertig\ jaar getrouwd. Deze winter raakten ze echter\ betrokken bij een ernstig ongeluk. Joke rouwde om\ Koos maar hij was vlak na het ongeluk gelukkig nog\ bij haar geweest toen hij zijn laatste adem uitblies.
46d. Joke en Koos waren vorig jaar vijfenveertig\ jaar getrouwd. Deze winter raakten ze echter\ betrokken bij een ernstig ongeluk. Koos rouwde om\ Joke maar hij was vlak na het ongeluk gelukkig nog\ bij haar geweest toen zij haar laatste adem uitblies.
46e. Joke en Koos waren vorig jaar vijfenveertig\ jaar getrouwd. Deze winter raakten ze echter\ betrokken bij een ernstig ongeluk. Joke rouwde om\ Koos en hij was vlak na het ongeluk een\ ambulance in gedragen.
46f. Joke en Koos waren vorig jaar vijfenveertig\ jaar getrouwd. Deze winter raakten ze echter\ betrokken bij een ernstig ongeluk. Koos rouwde om\ Joke en hij was vlak na het ongeluk in een\ zware depressie geraakt.

47a. Wim en Plien leken in niets op elkaar. Ze kwamen\ uit verschillende sociale milieus. Plien walgde van\ Wim want hij vond dat je onder het eten best een\ boer mocht laten.
47b. Wim en Plien leken in niets op elkaar. Ze kwamen\ uit verschillende sociale milieus. Wim walgde van\ Plien want hij vond dat je onder het eten absoluut\ niet met je mond vol mocht praten.
47c. Wim en Plien leken in niets op elkaar. Ze kwamen\ uit verschillende sociale milieus. Plien walgde van\ Wim maar hij vond dat je onder het eten best met\ je mond vol mocht praten.
47d. Wim en Plien leken in niets op elkaar. Ze kwamen\ uit verschillende sociale milieus. Wim walgde van\ Plien maar hij vond dat je onder het eten toch op\ zijn minst met je mond dicht kon eten.\
47e. Wim en Plien leken in niets op elkaar. Ze kwamen\ uit verschillende sociale milieus. Plien walgde van\ Wim en hij vond dat je onder het eten niet mocht\ letten op iemands gewoontes.
47f. Wim en Plien leken in niets op elkaar. Ze kwamen\ uit verschillende sociale milieus. Wim walgde van\ Plien en hij vond dat je onder het eten op zijn\ minst met je mond dicht kon kauwen.

48a. Marieke en Paul hebben het niet altijd even\ gemakkelijk gehad in hun leven. Ze hebben heel\ wat moeten doorstaan. Marieke had medelijden met\ Paul want hij had al tijden niet meer iets van\ zijn ouders gehoord.
48b. Marieke en Paul hebben het niet altijd even\ gemakkelijk gehad in hun leven. Ze hebben heel\ wat moeten doorstaan. Paul had medelijden met\ Marieke want hij had al tijden niet meer een\ lach op haar gezicht gezien.
48c. Marieke en Paul hebben het niet altijd even\ gemakkelijk gehad in hun leven. Ze hebben heel\ wat moeten doorstaan. Marieke had medelijden met\ Paul maar hij had al tijden niet meer zijn best\ gedaan om van zijn psychische problemen af te komen.
48d. Marieke en Paul hebben het niet altijd even\ gemakkelijk gehad in hun leven. Ze hebben heel\ wat moeten doorstaan. Paul had medelijden met\ Marieke maar hij had al tijden niet meer zijn best\ gedaan om haar te helpen bij al haar problemen.
48e. Marieke en Paul hebben het niet altijd even\ gemakkelijk gehad in hun leven. Ze hebben heel\ wat moeten doorstaan. Marieke had medelijden met\ Paul en hij had al tijden niet meer het gevoel\ iets waard te zijn.
48f. Marieke en Paul hebben het niet altijd even\ gemakkelijk gehad in hun leven. Ze hebben heel\ wat moeten doorstaan. Paul had medelijden met\ Marieke en hij had al tijden niet meer zo veel\ pijn in iemands gezicht gezien.

Samenvatting in het Nederlands

Voor een succesvolle interpretatie van *anaforen* (e.g. *hij*, *zijn*, *zich*, *zichzelf*) moet het menselijk taalsysteem informatie van verschillende bronnen samenvoegen. Zo is bijvoorbeeld de abstracte syntactische structuur van de zin waarin het anaforische element is geplaatst, van groot belang tijdens het 'zoekproces' naar het juiste antecedent. Verder maakt ons taalsysteem gebruik van meer pragmatische informatie zoals de context (i.e. discourse) waarin de zin zich bevindt, maar ook algemene wereldkennis kan een belangrijke rol spelen. De rode draad in dit proefschrift is het karakteriseren van het samenspel van deze verschillende bronnen tijdens de verwerking van anaforen. In het eerste gedeelte van dit proefschrift (Hoofdstuk 2, 3 en 4) richt ik me voornamelijk op de effecten van syntactische structuur, en in het tweede gedeelte (Hoofdstuk 5) voornamelijk op de effecten van discourse informatie.

De invloed van zinsstructuur op de correcte interpretatie van een anaforisch element benader ik vanuit het 'Primitives of Binding' (POB) model (Reuland, 2001). De essentie van dit linguïstische model wordt gevangen in de volgende drie kenmerken: *modulariteit*, *serialiteit* en *economie*. Modulariteit weerspiegelt het idee dat de verschillende subcomponenten van het taalsysteem onafhankelijk van elkaar werken, dat wil zeggen, 'ieder doet zijn eigen ding'. In het POB model worden grofweg drie van zulke componenten onderscheiden, te weten, de syntactische, semantische en discourse module. De syntactische module construeert afhankelijkheidsrelaties tussen reflexieven (i.e. *zich*, *zichzelf*) en hun antecedenten door de vorming van een *A-Chain*. De interpretatie van pronomina (e.g. *hij*, *zij*, *zijn*, *haar*) vindt plaats in de semantische of discourse module. Ze worden ofwel 'gebonden' in de semantische module met behulp van het *variable binding* algoritme, ofwel aan een antecedent gekoppeld in de discourse module door het *coreference* algoritme.

De opbouw van het POB model is niet alleen modulair, maar ook serieel van aard. Dit houdt in dat syntactische berekeningen vooraf gaan aan semantische berekeningen, en semantische berekeningen worden op hun beurt uitgevoerd voordat de discourse berekeningen plaatsvinden.

Hoewel ik geregeld terugkom op het modulaire en seriële karakter van het POB model, ligt de focus van mijn proefschrift op het derde kenmerk, economie. In het POB model verwijst de term economie naar de hypothese dat de verwerkingskosten van reflexieve en pronominale afhankelijkheidsrelaties afhangen van de hoeveelheid informatie die getransporteerd moet worden tussen de verschillende modules. Het aantal zogenaamde 'tussen-modulaire' stappen is het kleinst voor syntactische afhankelijkheidsrelaties, iets groter voor semantische afhankelijkheidsrelaties, en het grootst voor discourse afhankelijkheidsrelaties. De economie hiërarchie die hieruit afgeleid kan worden (syntax < semantiek < discourse), stelt ons in staat enkele zeer specifieke voorspellingen te doen betreffende het (lees)gedrag van mensen terwijl ze bezig zijn met de interpretatie van anaforische elementen:

1. De constructie van syntactische anaforische afhankelijkheidsrelaties kost minder moeite dan de constructie van semantische anaforische afhankelijkheidsrelaties.
2. De constructie van semantische anaforische afhankelijkheidsrelaties kost minder moeite dan de constructie van discourse anaforische afhankelijkheidsrelaties.
3. Als een pronomen zowel een semantische als een discourse interpretatie kan hebben, zal ons taalsysteem aanvankelijk kiezen voor de semantische interpretatie, omdat dit de goedkoopste optie is.

De eerste voorspelling werd getest in Hoofdstuk 2. In een oogbewegingstudie vergeleek ik het anaforische element *zich* in twee verschillende zinsstructuren (zie Voorbeelden (1) en (2)).

(1) Coargument reflexive
De astronaut$_i$ die op Mars een Amerikaanse vlag plantte, verbaasde *zich$_i$* toen plotseling een marsmannetje met een nieuwsgierige blik in zijn ogen kwam aanlopen.

(2) Logofoor
De astronaut$_i$ plantte op Mars een grote Amerikaanse vlag naast *zich$_i$* toen plotseling een marsmannetje met een nieuwsgierige blik in zijn ogen kwam aanlopen.

In (1) is *zich* een zogenaamd *coargument reflexief*. Het antecedent *astronaut* en *zich* zijn namelijk allebei een argument van het werkwoord *verbaasde*. In (2) is dit niet het geval, want *zich* is geen argument van het werkwoord *plantte*, maar van het voorzetsel *naast*. Indien het anaforische element *zich* op deze of op een soortgelijke manier gebruikt wordt, dan spreken we niet over een 'echt' reflexief, maar over een *logofoor*. Volgens het POB model kunnen alleen coargument reflexieven geïnterpreteerd worden in de syntactische module. Logoforen worden daarentegen verwerkt in de semantische of discourse module. Met andere woorden, het POB model voorspelt dat coargument reflexieven 'goedkoper' zijn dan logoforen, hetgeen zich in een oogbewegingstudie zou moeten vertalen in langere leestijden voor logoforen. De resultaten van Experiment 1 waren consistent met deze voorspelling: lezers spendeerden meer tijd aan het lezen van een logofoor dan aan het lezen van een coargument reflexief. Aangezien enkele eerdere studies, waarin men gebruik maakte van andere onderzoekstechnieken vergelijkbare resultaten lieten zien (e.g. Burkhardt, 2005; Piñango *et al.*, 2001), kunnen we concluderen dat de totstandkoming van syntactische anaforische afhankelijkheidsrelaties inderdaad wat goedkoper is dan de totstandkoming van semantische/discourse afhankelijkheidsrelaties.

In Hoofdstuk 3 verschuif ik mijn aandacht van reflexieven en logoforen naar pronomina. Een belangrijke aanname in het POB model is dat een pronomen door middel van twee verschillende algoritmes aan een antecedent verbonden kan worden, namelijk door *variable binding* of *coreference*. Volgens de hiërarchie van het POB model vergt variable binding in de semantische module minder inspanning dan coreference in the discourse module. In twee oogbewegingstudies (Experiment 4 en 5) testte ik deze tweede voorspelling. In Experiment 4 lazen de proefpersonen korte verhaaltjes zoals (3) en (4).

(3) Variable binding

Een werkdag in de fabrieken langs het Noordzeekanaal is altijd erg zwaar. Vooral vandaag konden veel arbeiders het nauwelijks aan. *Iedere arbeider die bijna geen energie meer had, vond het heel erg fijn dat hij wat eerder naar huis mocht vanmiddag.* Een hete douche zou de pijn hopelijk verzachten.

(4) Coreference
Een werkdag in de fabrieken langs het Noordzeekanaal is altijd erg zwaar. Vooral vandaag kon de oude arbeider Paul het nauwelijks aan. *Paul had bijna geen energie meer. Het was heel erg fijn dat hij wat eerder naar huis mocht vanmiddag.* Een hete douche zou de pijn hopelijk verzachten.

In verhaaltje (3) is alleen het semantische variable binding mechanisme beschikbaar om het pronomen *hij* te verbinden aan het antecedent *iedere werknemer*. Dit omdat de toevoeging van het kwantificerende element *iedere* tot gevolg heeft dat *iedere werknemer* geen volledige discourse status heeft en daardoor niet door middel van coreference aan een pronomen verbonden kan worden. In (4) is sprake van een gespiegelde situatie. Variable binding is niet van toepassing, omdat dit algoritme vereist dat het antecedent het relevante pronomen *c-commandeert*, hetgeen niet het geval is indien de twee elementen zich in verschillende zinnen bevinden. Dit houdt met andere woorden in dat in (4) *hij* uitsluitend in de discourse module geïnterpreteerd kan worden en het POB model voorspelt daarmee langere leestijden voor het pronomen in dit verhaaltje. Echter, tegen de verwachtingen van de economie hiërarchie in bleek dat de leestijden voor *hij* langer waren in het variable binding verhaaltje.

Experiment 5 liet *wel* het verwachte patroon zien. In dit oogbewegingsexperiment presenteerde ik vergelijkbare korte verhaaltjes zoals (5) en (6). De tweede economie voorspelling kwam uit, want de leestijden van de woorden direct na het relevante pronomen *hij* waren langer in de coreference conditie.

(5) Variable binding
Het was oorlog in Soedan en een soldaat aan de frontlinie was constant met de dood bezig. *De soldaat was ontzettend bang dat hij zou sterven op het bloedige slagveld.*

(6) Coreference
Het was oorlog in Soedan en een soldaat aan de frontlinie was constant met de dood bezig. *De soldaat was ontzettend bang. Hij zou sterven op het bloedige slagveld.*

Verder onderzocht ik in Experiment 5 een mogelijke verklaring voor de onverwachte bevindingen van Experiment 4. Burkhardts hiërarchie voor antecedenten (2005) voorspelt namelijk precies het leespatroon dat we observeerden in Experiment 4. Zij stelt dat de verwerkingskosten van een pronomen afhangt van de complexiteit van het antecedent. In haar hiërarchie zijn *'light quantifiers'* zoals *iedereen* een stuk minder complex dan *'referential quantifiers'* zoals *iedere soldaat.* Normale referentiële (niet gekwantificeerde) antecedenten zoals *de soldaat* of *Paul* houden wat complexiteit betreft het midden tussen light en referential quantifiers. Deze hiërarchie zou kunnen verklaren waarom ik in Experiment 4 een niet voorspeld verwerkingsvoordeel vond op het pronomen in de coreference conditie. In deze conditie was het antecedent namelijk een eigennaam (e.g. *Paul,* zie Voorbeeld (3)) en daarmee minder complex dan de referential quantifiers van de variable binding conditie (e.g. *iedere arbeider*, zie Voorbeeld (4)). Ik onderzocht deze mogelijkheid met behulp van verhaaltjes zoals (7) tot en met (9), maar vond echter geen duidelijke aanwijzingen die de complexiteitshiërarchie van Burkhardt verder ondersteunden: het pronomen *hij* en andere relevante regio's werden even snel gelezen in de drie condities.

(7) Light quantifier
Het was oorlog in Soedan en de soldaten aan de frontlinie waren constant met de dood bezig. *Iedereen was ontzettend bang dat hij zou sterven op het bloedige slagveld.*

(8) Referential quantifier
Het was oorlog in Soedan en de soldaten aan de frontlinie waren constant met de dood bezig. *Iedere soldaat was ontzettend bang dat hij zou sterven op het bloedige slagveld.*

(9) Referential antecedent
Het was oorlog in Soedan en een soldaat aan de frontlinie was constant met de dood bezig. *De soldaat was ontzettend bang dat hij zou sterven op het bloedige slagveld.*

Hoewel het dus niet mogelijk is een eenduidige verklaring te geven voor de enigszins conflicterende resultaten, lijkt het er in ieder geval sterk op dat Burkhardts hiërarchie, welke voornamelijk op kwantificatie is gebaseerd, te strikt is. Een wat ruimere benadering van (antecedent) complexiteit lijkt daarmee op zijn plaats.

In tegenstelling tot de resultaten voor de tweede economie voorspelling, die op het eerste gezicht niet altijd even consistent waren, lieten de bevindingen voor de derde voorspelling steeds hetzelfde verwachte patroon zien: in twee oogbewegingsexperimenten hadden lezers een duidelijke voorkeur voor een semantische interpretatie van structuren die zowel een semantische als discourse interpretatie toelieten. In Experiment 3 lazen de proefpersonen bijvoorbeeld verhaaltjes zoals (10) en (11).

(10) <u>Sloppy bias</u>
Lisa en Anouk zijn dol op de muziekzender MTV. *Zij* konden hun geluk niet op toen zij mee mochten doen aan het programma 'Pimp My Room', waarin hun kamers werden opgeknapt. *Maar helaas, Lisa vindt dat haar gepimpte kamer klasse heeft, maar Anouk niet.* Smaken verschillen nu eenmaal.

(11) <u>Strict bias</u>
Lisa en Anouk zijn dol op de muziekzender MTV. *Lisa* kon haar geluk niet op toen zij mee mocht doen aan het programma 'Pimp My Room', waarin haar kamer werd opgeknapt. *Maar helaas, Lisa vindt dat haar gepimpte kamer klasse heeft, maar Anouk niet.* Smaken verschillen nu eenmaal.

De kritieke derde zin is een zogenaamde *ellips*, welke op twee manieren gelezen kan worden. Het tweede gedeelte van de zin (i.e. *maar Anouk niet*) kan namelijk betekenen dat 'Anouk haar eigen kamer niet mooi vindt' (de semantische lezing, ook wel *sloppy* lezing genoemd) of dat 'Anouk de kamer van Lisa niet mooi vindt' (de discourse of *strict* lezing). In de verhaaltjes waarin de context naar de niet geprefereerde discourse lezing stuurde (strict-bias), gingen de proefpersonen niet alleen langzamer lezen in de ellips regio (i.e. *maar Anouk niet*), maar ze keken ook veel langer terug naar de tweede zin van het verhaaltje (i.e. *Lisa kon haar geluk niet op toen zij mee mocht doen aan het programma 'Pimp My Room', waarin haar kamer werd opgeknapt*). Het lijkt er met andere woorden sterk op dat lezers eerst een sloppy lezing construeren om er dan pas achter te komen dat deze lezing slecht in de context past. Om dit probleem op te lossen kijken ze vervolgens terug naar de tweede zin, waarschijnlijk omdat deze zin de cruciale informatie bevat waardoor de ellips ofwel een strict, ofwel een sloppy lezing krijgt.

Een andere interessante bevinding van Experiment 3 was dat lezers eenzelfde soort leesstrategie hadden voor zinstructuren met het linguïstische element *alleen* zoals in '*Alleen Lisa vindt dat haar gepimpte kamer klasse heeft*'. Deze zin bevat een vergelijkbare dubbelzinnigheid als ellipsen, want de zin kan namelijk betekenen dat 'andere mensen denken dat hun eigen kamer geen klasse heeft' (sloppy) of dat 'andere mensen denken dat Lisa's kamer geen klasse heeft' (strict). Ook als de cruciale derde zin een dergelijke *alleen*-structuur was in plaats van een ellips, keken de lezers veel langer terug naar de tweede zin in de strict sturende conditie.

De resultaten van Experiment 4, waarin ik verhaaltjes zoals (12) en (13) aanbood, brachten verdere ondersteuning voor de conclusie dat lezers bij ambiguïteit eerst voor de variable binding (i.e. semantische) optie kiezen.

(12) Variable binding bias
Een werkdag in de fabrieken langs het Noordzeekanaal is altijd erg zwaar. Vooral vandaag konden veel arbeiders, waaronder de oude Paul, het nauwelijks aan. *Iedere arbeider die net als Paul bijna geen energie meer had, vond het heel erg fijn dat hij wat eerder naar huis mocht vanmiddag.* Een hete douche zou de pijn hopelijk verzachten.

(13) Coreference bias
Een werkdag in de fabrieken langs het Noordzeekanaal is altijd erg zwaar. Vooral vandaag kon de oude arbeider Paul het nauwelijks aan. *Iedere arbeider die zag dat Paul bijna geen energie meer had, vond het heel erg fijn dat hij wat eerder naar huis mocht vanmiddag.* Een hete douche zou de pijn hopelijk verzachten.

Hoewel de kritieke derde zin overduidelijk verschilt van ellipsen en *alleen*-structuren is er één belangrijke overeenkomst: ook deze zin kan zowel een semantische als een discourse lezing hebben. De semantische interpretatie ontstaat als de lezer het pronomen *hij* verbindt aan *iedere arbeider*, en de discourse lezing ontstaat als de lezer het aan *Paul* verbindt. Zoals in Experiment 3 lazen de proefpersonen verhaaltjes die ofwel een bias hadden naar de semantische interpretatie ofwel naar de discourse interpretatie. Het bleek dat lezers bij voorkeur het pronomen verbonden aan een c-commanderend antecedent, in dit geval *iedere arbeider*. Net als in Experiment 3 moesten de lezers namelijk het pronomen en andere relevante gedeeltes van de zin heranalyseren om de juiste coreference lezing te verkrijgen in (13). Deze bevinding is in overeenstemming met het idee dat mensen aanvankelijk altijd de voorkeur geven aan een semantische variable binding interpretatie.

De resultaten van de oogbewegingsexperimenten in Hoofdstuk 2 en 3 zijn over het algemeen in overeenstemming met de drie economie voorspellingen van het POB model. In Hoofdstuk 4 probeer ik deze bevindingen te integreren met eerdere studies die zich meer richtten op de twee andere hoofdkenmerken van het POB model, modulariteit en serialiteit. Interessant genoeg blijkt dat ook deze kenmerken terug te vinden zijn in experimenten die gebruik maken van gedragsmetingen zoals oogbewegingen, of van nog directere metingen van het menselijk brein zoals *Event Related Potentials* (ERP) (e.g. Burkhardt, 2005; Harris *et al.*, 2000; Nicol & Swinney, 1989; Osterhout & Mobley, 1995 Sturt, 2003a). Ik concludeer dan ook dat het theoretische POB kader een belangrijke rol kan – of eigenlijk *moet* – spelen bij toekomstig onderzoek naar de mentale processen die de mens in staat stelt afhankelijkheidrelaties tussen anaforische elementen en hun antecedenten te construeren.

Een belangrijke aanname in het POB model is dat pragmatische informatie het begripsproces alleen maar kan beïnvloeden tijdens de discourse verwerkingsfase. Het coreference algoritme is echter in vergelijking met de algoritmes van de syntactische en semantische fase (A-Chain vorming en variable binding) minder duidelijk gespecificeerd. Aangezien het uiteindelijke doel is een model te ontwikkelen dat de vele facetten van de interpretatie van anaforen bestrijkt, probeerde ik in Hoofdstuk 5 enige informatie te verzamelen over de eigenschappen van de discourse fase. Ik heb me daarbij specifiek gericht op een subtiele pragmatische bron van informatie, namelijk de impliciete causaliteit van werkwoorden.

De term impliciete causaliteit verwijst naar een eigenschap van een groep werkwoorden waarbij één van de argumenten de meest waarschijnlijke onderliggende oorzaak is van de actie of mentale staat die dat werkwoord beschrijft (Au, 1986; Brown & Fish, 1983; Garvey & Caramazza, 1974; Garvey *et al.*, 1975; Greene & McKoon, 1995; Long & De Ley, 2000; Stewart *et al.*, 2000). Als je bijvoorbeeld mensen vraagt een zinsfragment zoals *David prees Linda omdat* af te maken, zullen ze sterk geneigd zijn een voortzetting te geven waarin *Linda* de hoofdrol speelt, aangezien zij de meest waarschijnlijke oorzaak van het beschreven voorval is (e.g. *David prees <u>Linda</u> omdat <u>zij</u> de moeilijke opdracht zonder hulp had afgerond*). In Hoofdstuk 5 onderzocht ik in drie leestijdexperimenten *wanneer* en *hoe* deze pragmatische informatiebron gebruikt wordt in het begripsproces van pronomina. In Experiment 6 en 7 richtte ik me op de *wanneer*-vraag. In Experiment 6 (een 'self-paced' leesexperiment) lazen de proefpersonen verhaaltjes zoals (14) en (15).

(14) <u>Consistent pronomen</u>
David en Linda reden allebei behoorlijk hard. Bij een druk kruispunt botsten zij met hun auto's stevig op elkaar. *<u>David</u> bood zijn excuses aan Linda aan omdat <u>hij</u> volgens de getuigen van het ongeluk alle schuld had.*

(15) <u>Inconsistent pronomen</u>
David en Linda reden allebei behoorlijk hard. Bij een druk kruispunt botsten zij met hun auto's stevig op elkaar. *Linda bood haar excuses aan <u>David</u> aan omdat <u>hij</u> volgens de getuigen van het ongeluk geen schuld had.*

In tegenstelling tot het werkwoord *prijzen* heeft het werkwoord *excuses aanbieden* een bias naar het onderwerp. Dit betekent dat in (15) het pronomen *hij* 'inconsistent' is met de bias van het werkwoord. Uit mijn analyses bleek dat impliciete causaliteitsinformatie heel snel gebruikt wordt tijdens het verwerkingsproces van pronomina, aangezien de leestijden van de woorden direct na het pronomen significant langer waren in de inconsistente conditie (i.e. (15)). Deze resultaten werden gerepliceerd in een oogbewegingsstudie (Experiment 7). In dit experiment leek het er zelfs op dat impliciete causaliteitsinformatie nog iets sneller het begripsproces beïnvloedde, want de leestijden van de inconsistente conditie begonnen nu al op te lopen vanaf het kritieke pronomen zelf. In het laatste oogbewegingsexperiment (Experiment 8) concentreerde ik me voornamelijk op de *hoe*-vraag. Ik presenteerde (bijna) dezelfde verhaaltjes, met één cruciaal verschil. In plaats van het voegwoord *omdat* gebruikte ik nu drie verschillende voegwoorden, namelijk *want*, *maar* en *en*. Voor het voegwoord *want* waren de resultaten vergelijkbaar met de eerdere experimenten, maar de effecten van impliciet causaliteit verdwenen indien het voegwoord *maar* of *en* was.

Bovenstaande resultaten zijn in overeenstemming met het zogenaamde 'immediate focusing' model (Greene & McKoon, 1995; Long & De Ley, 2000; McKoon *et al.*, 1993). In dit model wordt verondersteld dat impliciete causaliteit onmiddellijk gebruikt wordt om één van de personages in focus te brengen. Het prominente personage is vervolgens een zeer aannemelijk antecedent voor een pronomen dat eventueel later in de zin (of het verhaaltje) opduikt. Met andere woorden, het pronomen *hij* in (15) zorgt voor verwerkingsproblemen en daarmee langere leestijden, omdat niet *David* het meest prominent is, maar *Linda*. De bevindingen van Experiment 8 laten overigens wel zien dat impliciete causaliteit niet per definitie een kenmerk is van het werkwoord zelf. Het bleek namelijk dat het voegwoord uiteindelijk van doorslaggevende betekenis was op het wel of niet optreden van effecten van impliciete causaliteit. Met andere woorden, de interactie tussen werkwoord en voegwoord zorgt voor een sterke bias naar het onderwerp of lijdend voorwerp, niet per se de betekenis van het werkwoord als zodanig.

De bevindingen van Hoofdstuk 5 vertellen ons dat *focus* en *prominentie* onderdeel zijn van een zeer dynamische subcomponent van het taalsysteem. De focus van een lezer en de prominentieniveaus van de verschillende personages in een verhaaltje veranderen namelijk voortdurend met elk nieuw stukje informatie dat beschikbaar wordt voor het verwerkingssysteem. Een recente ERP-studie (Van Berkum, Koornneef, Otten & Nieuwland, 2007) suggereert zelfs dat impliciete causaliteit in combinatie met het voegwoord *omdat* kan leiden tot specifieke voorspellingen over hoe een zin zich verder zal ontvouwen. Samenvattend kunnen we dus stellen dat de discourse module van het POB model een dynamisch en mogelijk zelfs anticiperend systeem is waarin (pragmatische) informatie zeer snel ingezet wordt tijdens het coreference proces.

Om de resultaten van deze dissertatie in een breder kader te plaatsen, vergelijk ik in het afsluitende hoofdstuk (Hoofdstuk 6) mijn model met het invloedrijke neurocognitieve model van Friederici en collega's (Friederici, 2002; Friederici & Kotz, 2003; Grodzinsky & Friederici, 2006). Hoewel Friederici's model niet specifiek ontwikkeld is voor anaforen, maar meer voor taalverwerkingsprocessen in het algemeen, zijn er interessant genoeg toch veel opvallende gelijkenissen met het POB model. Zo onderscheidt zij ook drie verwerkingsfases. De eerste fase is een syntactische fase waarin de menselijke ontleedmachine een basale syntactische structuur bouwt, voornamelijk gebaseerd op informatie over de woordcategorie. Tijdens de tweede fase worden lexicaal-semantische berekeningen uitgevoerd en worden de thematische rollen toegekend aan de argumenten van een werkwoord. Gedurende de laatste fase wordt alle informatie geïntegreerd en kunnen eventuele fouten hersteld worden. Vooral de recente poging van Grodzinsky en Friederici (2006) om de verschillende verwerkingsfases aan linguïstische functies – zoals

MERGE, MOVE en BIND – en specifieke hersengebieden te verbinden biedt een interessant toekomstperspectief. Het strekt mij namelijk in het idee dat we mogelijk neurale netwerken kunnen onderscheiden die corresponderen met A-Chain vorming (een MERGE operatie), variable binding (een BIND operatie) en coreference. Daarbij zou de slotsom een vrije vertaling van Reulands thesis (2003, p.4) kunnen zijn: "de theoretische verschillen tussen modules van het grammaticale systeem corresponderen met verschillen in processen op het neurale niveau, en omgekeerd".