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Fuzzy Grammar and the Performance/Competence Terminology Game

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I. Fuzzy Grammar

Anyone who has taught or taken an introductory syntax course can tell you that speakers do not always make clear or uniform judgments about whether sentences are well-formed or what they mean. Almost every syntactic or semantic phenomenon has a shadowy area in which speakers become unclear with respect to judgments about meaning and well-formedness. For the past few years, this phenomena has been studied intensively by Ross. His general results are as follows:

- (i) Rules of grammar do not simply apply or fail to apply; rather they apply to a degree.
- (ii) Grammatical elements are not simply members or nonmembers of grammatical categories; rather they are members to a degree.
- (iii) Grammatical constructions are not simply islands or nonislands; rather they may be islands to a degree.
- (iv) Grammatical constructions are not simply environments or non-environments for rules; rather they may be environments to a degree.
- (v) Grammatical phenomena form hierarchies which are largely constant for speaker to speaker, and in many cases, from language to language.
- (vi) Different speakers (and different languages) will have different acceptability thresholds along these hierarchies.

Ross has made these claims in the absence of a theory of fuzzy grammar; no current theory of grammar can even begin to accommodate the facts that Ross has observed. What I would like to do in this paper is ask some detailed questions about how current theories of grammar might be changed to accommodate even the most basic of Ross' observations. I would like to make clear at the outset that I do not have a theory of fuzzy grammar to propose; the best I can do is make extremely tentative suggestions for beginning to deal with a handful of Ross' phenomena and to provide a framework for further inquiry.

Let us begin with some facts about adverb preposing. Surface adverbials prepose most freely in simple sentences, such as those in (1).

- (1) a. Tomorrow Sam will leave town.
 b. In Berkeley there will be a riot.
 c. Carefully Sam sliced the salami.

Adverbials can also prepose into higher clauses, but with varying degrees of freedom, determined in part by the following hierarchy:

- (2) time adverbs
 place adverbs
 manner adverbs

Of these, time adverbs prepose most freely, place adverbs second, manner adverbs third.

- (3) a. Tomorrow it's likely that Sam will leave town.
 b. ?In Berkeley it's likely that there will be a riot.
 c. *Carefully it's likely that Sam will slice the salami.

Other adverbials fit into the hierarchy at various points. If-clauses are about as free as time adverbs, instrumental and means adverbs fall in between place and manner adverbs, etc. Ross and I interpret facts like these as follows. We define the notion of accessability, which will depend on various factors. In this case there are two factors at work: (i) the position of the affected element (that is, the adverb to be preposed) on the adverb hierarchy, and (ii) the position of the S-node which is the complement of likely on the hierarchy of island-forming nodes. These two factors determine a degree of accessability. The degree to which a given rule applies in a given situation will be a function of the degree of accessability and what I have called the degree of triggering. Consider (4).

- (4) a. Tomorrow it's likely that John will leave.
 b. It's likely that tomorrow John will leave.

As (4b) shows, adverb preposing can occur within the complements of certain predicates (such as likely); we will say that those predicates trigger adverb preposing. The trigger in (4a) is the deleted predicate of saying. Ross and I have found that both islands and triggers form hierarchies, and that where they can be compared, they seem to match up exactly. (5) and (6) are samples of fudgy, incomplete hierarchies for islandhood and triggering.

(5) Island hierarchy

- possible, likely, etc.
- want, expect, etc.
- believe, think, etc.
- Complement of say
- know
- inchoative factives: a. realize
b. find out, discover
- emotive factives: a. surprised
b. regret, amazed
- mention
- the + picture noun
- possessive + picture-noun
- the + noun complement
- possessive + noun complement
- part of a conjunct
- indirect question
- relative clauses a. generic head
b. indefinite determiners
c. definite determiners
- whole conjuncts



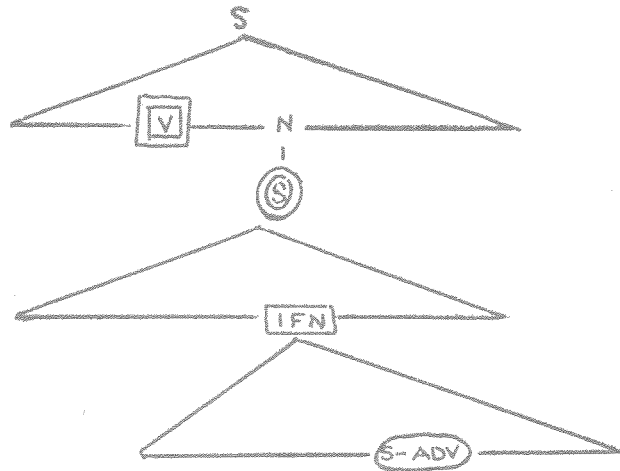
(6) Trigger hierarchy

- deleted performative verb of saying
- possible, likely, etc.
- expect
- believe, think, etc.
- say
- know
- inchoative factives: a. realize
b. find out, discover
- emotive factives: a. surprised
b. regret, amazed
- mention
- noun complements
- part of a conjunct
- relative clauses

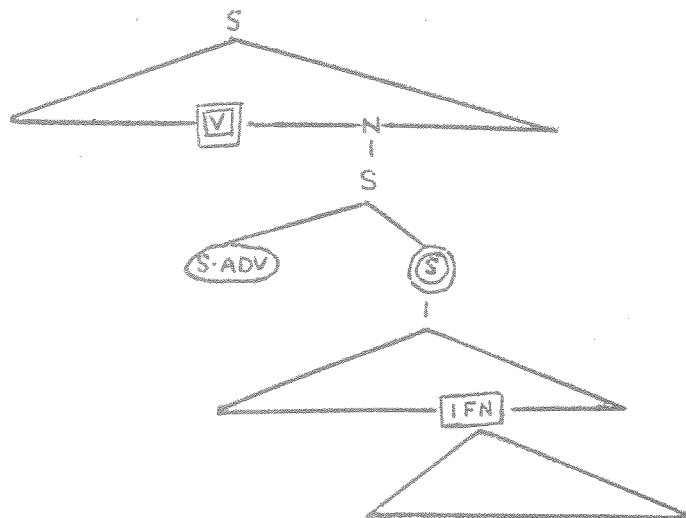


Adverb preposing provides a good example of how these hierarchies work. The island hierarchy can be seen most clearly if we take as fixed trigger the strongest trigger (deleted performative verbs of saying) and as fixed adverbial the most movable adverbial (a time adverbial). The rule works as illustrated in (7). I is input' II is output.

(7) I:



II:



- V -- the complement-taking predicate that triggers the rule.
- S-ADV -- the surface adverbial that the rule applies to
- S -- the node to which the S-ADV is attached
- IFN -- any potential island-forming node

We can get a profile of the island hierarchy by using the strongest trigger for adverb preposing (a deleted performative predicate of saying) and the most movable adverb (a time adverb).

(8) Island hierarchy examples with adverb preposing (using best trigger and most movable adverb)

- a. Tomorrow John will leave.
- b. Tomorrow I think John will leave.
- c. Tomorrow Bill says he'll be able to do your tax return.
- d. Tomorrow I know Bill will be in his office.
- e. ?Tomorrow I realize that Bill will be in his office.
- f.?*Tomorrow I found out that tax returns are due.
- g. *Tomorrow I'm surprised that Bill will be in his office.
- h. *Tomorrow I believe the claim that Bill will be in his office.
- i. *Tomorrow John married Mary and will leave on his honeymoon.
- j. *Tomorrow I knew the girl who John will marry.
- k. *Tomorrow John will see Bill and the day after.

In my speech the cut-off point is around realize and the sentences get progressively worse from there on down. Other speakers have different cut-off points.

In a similar manner we can get a profile of the trigger hierarchy by using the weakest island (no embedded S) and the most movable adverb.

(9) Trigger hierarchy examples (for adverb preposing)

- a. Tomorrow I'll leave.
- b. It's possible that tomorrow I'll leave.
- c. I think that tomorrow I'll be on that plane.
- d. I know that tomorrow I'll be on that plane.
- e. ?I realize that tomorrow you'll be in Honolulu.
- f.?*I found out that tomorrow Sam will be in Honolulu.
- g. *I'm surprised that tomorrow there will be a riot.
- h. *I regret that tomorrow there will be a riot.
- i. *The fact that tomorrow there will be a riot is disturbing.
- j.**The man who tomorrow John will see is a bigwig.

For the trigger hierarchy too, the cut-off point is around realize.

The rule of topicalization (at least in its 'purely syntactic' aspect) resembles adverb preposing, except that a surface nominal is moved rather than a surface adverbial and that the resulting stress differs. The triggering hierarchy and the island hierarchies are the same for both rules, and in my speech the cut-off point for the triggering hierarchy is the same.

(10) Trigger hierarchy examples (for topicalization with weakest island)

- a. Beans I like.
- b. It seems that hot dogs he'll eat.
- c. I think that Sam you can be sure of.
- d. Bill says that rugs you can buy cheaper abroad.
- e. Irv knows that mustard you can sell in Alaska.
- f. ?Irv realizes that Sam he can trust.
- g. *Sam discovered that hot dogs he could get on the West Coast.
- h. *Max was surprised that mustard his dog liked.
- i. **The man who hot dogs liked was fat.

Although the island hierarchy is the same in my speech for topicalization as for adverb preposing, the cut-off points are different. Compare (11) with (8).

(11) Island hierarchy examples for topicalization (with best trigger)

- a. Beans I think John will eat.
- b. Tax returns John says he can do for you.
- c. Flanges I know we can get from that company.
- d. Desks I realize that Bill can get for us.
- e. Rugs I discovered that one can buy more cheaply abroad.
- f. ?Rugs I mentioned that you could buy in New York.
- g. ??Sam I bought the picture of.
- h. *Sam I bought Picasso's picture of.
- i. *Max I sold a book to and closed the store.
- j. *Max I wonder when Mary met.
- k. *Max I know the priest who baptized.
- l. *Max Sue kissed Mary and.

In my speech, the cut-off point for topicalization is lower in the island hierarchy than the cut-off point for adverb preposing.

(12) Comparison of accessibility and triggering midpoints in my speech

	<u>adverb preposing</u>	<u>topicalization</u>
accessibility midpoint:	after nonfactives	after <u>mention</u>
triggering midpoint:	after nonfactives	after nonfactives

So far we have pointed out a relatively small number of facts about two rules as they work for one speaker. Ross' work has indicated that such facts are not uncommon; in fact, they are tame compared to other squishy phenomena. But for the time being let us limit ourselves just to the above-mentioned facts and ask what kind of theory of grammar facts like this give rise to. One thing is clear at the outset: no theory even remotely resembling classical transformational grammar can handle them. In the first place, it doesn't make sense to talk of rules applying to a degree in classical transformational grammar. You have a tree at a given stage of a derivation and either the rule applies and gives you the next tree or it doesn't apply and it leaves you with the old tree. Secondly, it doesn't make any sense in classical transformational grammar to speak of degrees of category membership. Either an element is an adverb or not, a noun or not, an S or not. However, as we saw above we need to speak of degrees of membership in the category surface adverbial, and Ross has shown that we also need to characterize degrees of nouniness and degrees of clausiness.

I would like to suggest that what I have called correspondence grammars provide a framework in which it makes sense to talk of fuzzy grammatical phenomena. Correspondence rules are the direct descendants of so-called 'local rules' (see Lakoff, 1969), which turned out not to be local most of the time. Such rules are well-formedness conditions on adjacent pairs of trees in a derivation. Given a random sequence of trees in a derivation, correspondence rules, as they have been thought of in the past, tell which adjacent pairs are well-formed or ill-formed. However, we can adjust correspondence rules so that now they will specify a degree of well-formedness between 1 and 0 for any pair of trees in a random sequence. The degree of well-formedness of an entire derivation will be some function of the degrees of well-formedness of the individual adjacent pairs of trees together with the degrees of well-formedness given by global rules.

Degrees of category membership can be made sense of in global correspondence grammar if we make use of the notion of 'secondary category' (see Lakoff, 1970). As noted in (Lakoff, 1970), there is no need for a primitive category VP. All the facts that VPs were hypothesized to account for can be handled if there are no VPs and if the rules previously taken to apply to VPs apply instead to Ss that have lost their cyclic subjects. If desirable, one could define a surface VP as a secondary category in terms of the primitive category S and the global notion "not having its cyclic subject". In global correspondence grammar, membership in a secondary category has so far been construed as being a yes-or-no matter. I suggest that Ross' facts can best be handled by making secondary category membership a matter of degree, dependent on logical category membership and various lower-level derivational factors. For example, a logical structure S will have a degree of surface clausiness somewhere between 1 and 0, depending on whether or not it is subjectless, whether it has a finite verb, an infinitive, a gerund, etc. A surface VP will be a logical S that is subjectless

and tenseless, and so has low surface clausiness. Similarly, an N-node which occurs in logical structure and in surface structure and which does not immediately dominate an S-node with high surface clausiness will be a surface nominal of degree 1. Other surface N-nodes which do not have corresponding nodes in logical structure such as expletive it, expletive there, tabs, etc. will have lesser degrees of surface nouniness.

Given correspondence rules that specify degrees of well-formedness and the use of global information for defining degrees of secondary category membership, it should become possible to begin to formalize some of Ross' observations. However, still more is needed before we can even begin to approach the problem. As was noted above, the degree of well-formedness for a pair of adjacent trees with respect to a given rule will be some function of the degree of triggering and the degree of accessibility of the element affected by the rule. But we do not want to have to mention, say, the entire trigger hierarchy in each rule. Nor do we want to have to mention, for a rule that applies to the secondary category surface nominal, the entire nouniness hierarchy and islandhood hierarchy. Since the same hierarchies are involved in rule after rule, we would like them to be specified as part of universal grammar (to the extent that they are language universal) or as part of the grammar as a whole (to the extent that they are language particular); they should not have to be specified in individual rules. As a first step toward doing this, I suggest that rules be specified according to their functional components. As a first approximation, I would suggest that rules have at most four functional components:

(13) Functional components of correspondence rules

- a. Trigger
- b. Affected element(s) [what Postal calls 'victims']
- c. Domain specifier
- d. Controller

All correspondence rules will have an affected element and a domain specifier. A rule may optionally have a trigger and/or a controller. (A controller may be either a deletion controller or pronominalization controller.) The 'input' and 'output' conditions in a rule will specify the relations holding among the functional components of the rule. In classical correspondence grammars the relations were PRECEDES, DOMINATES, COMMANDS, etc. However, I would now accept the observations of Keenan, Postal and Perlmutter and take grammatical relations rather than precedence relations as basic. I also tentatively follow the suggestion of Postal and Perlmutter that all cyclic rules involve changes of grammatical relations. I would therefore include such grammatical relations as SUBJECT-OF, DIRECT-OBJECT-OF, INDIRECT-OBJECT-OF, and COMPLEMENT-OF.

To get an idea of what correspondence rules would look like

stated in terms of their functional components, consider the rules discussed above, adverb preposing and topicalization.

(14) Oversimplified formulations of adverb-preposing and topicalization

ADVERB-PREPOSING	TOPICALIZATION
OPTIONAL, f	OPTIONAL, f'
TR: V	TR: V
DS: COMP(TR)	DS: COMP(TR)
AE: S-ADV	AE: N
I: D(DS,AE)	I: D(DS,AE)
II: LCA(AE,DS)	II: LCA(AE,DS) & 1-STRESS(AE)

We can see how adverb-preposing works by looking at (7). The trigger is the V in the double-box. The domain specifier (DS) is the S in the double-circle. The affected element (AE) is the S-ADV in the oval. I specifies the conditions defining what in transformational grammar would be called the 'input' to the rule; II specifies the 'output'. 'D' means 'dominates' and 'LCA' means 'is a left Chomsky-adjunct of' and 'COMP' means 'complement of'.

Once a rule picks out a triggering node, the trigger hierarchy should specify the degree of triggering. Once a rule picks out an affected element, a degree of accessibility will be defined as a function of (i) degree of category membership of the AE and (ii) the degree of islandhood of any island-forming node. Any node dominated by DS and dominating AE will be a potential island-forming node. Given a degree of triggering and degree of accessibility, each rule will have associated with it a function defining the associated degree of well-formedness. Figuring out just what all these functions do will, of course, be the hard part of fuzzy grammar.

One nice result of adopting a theory of grammar in which the functional components of correspondence rules are explicitly mentioned is that it allows us to limit the class of correspondence rules possible in a natural language. For example, (15) lists some tentative universal constraints on correspondence rules.

(15) Tentative universal constraints

- If a rule contains a TR, then TR commands AE in both I & II.
- DS either dominates or commands AE in both I & II.
- CR (controller) is never asymmetrically commanded by AE in either I or II.
- DS either immediately commands or is a clause-mate of TR.
- CR has either the same reference or same sense as AE.

Any given rule will have at most four functional components, limited at least in the above way. A great proportion of 'crazy rules' will

thereby be eliminated.

Incidentally, I assume that in governed rules, the governing element is the trigger. Equi-NP deletion is an example of a rule with both a trigger and a deletion controller. Among the rules without triggers are Q-lowering and conjunction-reduction (which may, after all, be the same rule).

Rules in classical correspondence grammar were either optional or obligatory, with optional and obligatory defined as in (16).

(16) Oversimplified definitions of 'optional' and 'obligatory' correspondence rules

OPTIONAL: $P_i/I \ \& \ P_{i+1}/II \ \supset \ d(i,R) = f(\text{tr}, \text{ac})$

[$d(i,R)$ = degree to which the pair P_i, P_{i+1}
is well-formed with respect to rule R]

OBLIGATORY: same as above, plus:

$P_i/I \ \& \ P_{i+1}/II \ \supset \ d(i,R) = 1 - f(\text{tr}, \text{ac})$

To get classical (two-valued) grammar, let: $\text{ac} = 0$ or 1
 $\text{tr} = 0$ or 1
 $f = \text{multiplication}$

'ac' = degree of accessibility

'tr' = degree of triggering

To get fuzzy grammar, let ac and tr vary between 0 and 1, and let f be some complex function (which will differ from rule to rule). As the chart on (12) shows, f cannot always be simple multiplication or multiplication with a 'rule constant' multiplied in. Multiplication functions will not give a distribution like that of (12), where two rules have the same triggering midpoint, but different accessibility midpoints. The functions associated with rules will have to be more complex than multiplication, in ways that have not yet begun to be investigated.

In two-valued global correspondence grammar, global rules either block a derivation or fail to block it. In a fuzzy grammar, global rules will block derivations to a degree. The need for fuzzy global rules has been demonstrated by Will Leben (personal communication), who has observed that quantifiers form a hierarchy.

(17) Leben's quantifier hierarchy

one, some, several, many, every, all, no	
wide	wide
scope	scope
easier	harder

—————→

In my speech, narrow scope is possible in all of the following cases. 'w' will stand for "wide scope reading possible"; '*w' for "wide scope reading impossible"; '?w' for "fading judgment on whether wide scope is possible"; and '?*w' for "wide scope reading pretty hard to get".

- (18) John believes that Sam is dating
- | | |
|-------|--------------------------|
| a. w | one girl. |
| b. w | some girls. |
| c. ?w | several girls. |
| d. *w | every girl on the block. |
- cutoff-----

- (19) Every man likes
- | | |
|-------|----------------|
| a. w | one woman. |
| b. w | some women. |
| c. ?w | several women. |
| d. *w | many women. |
- cutoff

- (20) John didn't see
- | | |
|--------|-------------------|
| a. w | one woman. |
| b. w | several women. |
| c. ?*w | many women. |
| d. *w | every woman. |
| e. *w | all of the women. |
- cutoff

In my speech, the cutoff point is after several in all of these cases.

I would suggest that such facts might be handled by a quantifier-crossing constraint as indicated in (21).

- (21) Possible format for fuzzy global rules (example: Q-crossing)

Q-CROSSING

COND: $[P_s/I \ \& \ \neg (P_1/II:P_s/III)] \supset \ d(D) = f(\geq_Q, 1, 2)$

I:CM(1,2)

II:C(1,2)

III:P(1,2)

In (21), 'd(D)' refers to the degree of deviance assigned to the derivation D by an application of the constraint. 'f($\geq_Q, 1, 2$)' is a function from the quantifier hierarchy in (17) and the particular quantifiers designated by nodes 1 and 2 to the real numbers between 0 and 1. (Again, the hard part is figuring out just what the function looks like.) Note that such a fuzzy global rule would specify the degree to which a given surface structure could be matched with a given logical structure, that is, the degree to which a given sentence has a given reading. This is in general the case in generative semantics; fuzzy grammars specify the degree to which a given surface structure can be matched with various logical structures. In cases where there is no well-formed (or even partially well-formed) derivation relating a logical structure and a surface structure, we say that the sentence is ill-formed. Within

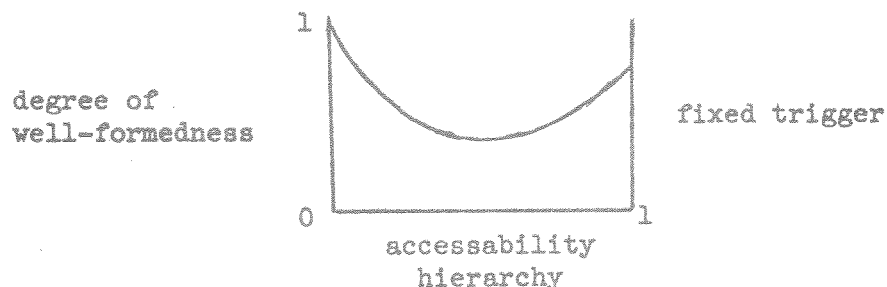
generative semantics, fuzzy grammar allows us to use the same mechanism to account for both the degree to which a sentence has a given reading and the degree to which it is well-formed (i.e., the maximum degree to which it is well-formed on any reading).

Ross' work has shown that hierarchies are pervasive in the grammar of English, and that the same hierarchies emerge in case after case. For example, if you determine a hierarchy of islandhood using one rule (say, relativization) and then try another rule (say, question-formation), the well-formedness judgments may vary but the hierarchies remain the same. Ross has hypothesized that such linearity is characteristic of grammar and that linear hierarchies are always preserved. This would be nice if it were true, but I don't think it is. I have found a construction where, given the usual accessibility hierarchy -- the inverse of the islandhood hierarchy -- as input, one does not get a linear hierarchy as output. Instead there is a dip -- sort of a parabola -- where the curve falls for a while, reaches a low point around the middle of the accessibility hierarchy, and then rises again. The phenomena in question are relative clauses where a pronoun has been left behind, like "John is the kinda guy that, once you get to know him, you like him a lot." Such sentences are never fully well-formed in my speech, but some of them get very close to being fully well-formed, and none of them are as bad, as, say, violations of the coordinate structure constraint with normal relative clause formation (without a pronoun left behind). These constructions are characteristic of informal speech, and are best triggered by generic head NPs like "the kinda fella that...". To be good at all, the NPs must be in predicate nominal position and the predicate that is a clause-mate of the pronoun left behind in the relative clause must be generic. If we limit our observation to relative clauses of this very special type, we find that they map the accessibility hierarchy into a sort of parabolic curve. In the examples below, my subjective judgment as to degree of well-formedness (on a scale from 0 to 1) appears to the left of each sentence. As always, there is a certain amount of variation among speakers. Some speakers find all the sentences completely well-formed. Others find them completely ill-formed. But these, so far as I have been able to tell are in a minority. Most of the speakers I have asked, though their judgments of individual sentences vary (as would be expected) also find a dip at more or less the same place as I do.

(22) A nonlinear phenomenon

- a. (.8) John is the kinda fella that accidents naturally happen to him.
- b. (.7) John is the kinda fella that it's likely that accidents'll happen to him.
- c. (.6) John is the kinda fella that people think that accidents naturally happen to him.
- d. (.5) John is the kinda fella that I know that accidents happen to him.

- e. (.4) John is the kinda fella that I realize that accidents happen to him.
- f. (.3) John is the kinda fella that you find out that accidents happen to him.
- g. (.6) John is the kinda fella that you're surprised that accidents happen to him.
- h. (.7) John is the kinda fella that you're sorry that accidents happen to him.
- i. (.8) John is the kinda fella that the fact that accidents happen to him bothers you.
- j. (.8) John is the kinda fella that you can easily believe the claim that he was once a millionaire.
- k. (.8) John is the kinda fella that people who he recommends are gonna be dependable.
- l. (.9) John is the kinda architect that makes you hate both him and houses.



I would interpret such results in the following way. Most of the functions associated with rules (for example, the \underline{f} and \underline{f}' of (14) and the $f(\geq_Q, 1, 2)$ of (21)) that yield well-formedness values are monotonic. But there are other, more specialized marked cases, where the functions are more or less parabolic. Such cases are not unprecedented in the study of language. They are common in the realm of semantics--see, for example, the discussion of hedges like sort of, rather, and pretty in (Lakoff, 1972), especially Figure 9. What is extraordinary is that such nonlinear functions, which make good sense in semantics and which serve a real communicative purpose there, should show up in isolated, dinky syntactic constructions. I find it very strange that such a phenomenon should exist in syntax.

We have not yet taken up the question of what happens when hierarchies interact. So far we have picked a single good trigger and have let accessability vary, or we have picked a very accessible construction and let degree of triggering vary. What happens when we let both vary at once. As it turns out, the results are not what one would expect. One would (at least I would) think that if, for a given rule, we take a good trigger and a construction with good accessability, and we put them together, the result would be

a good sentence. That is sometimes true, but not always. Let us consider some topicalization examples.

- (23) a. It's possible that Mary he'll want to take out.
 b. I suppose that rugs he thinks he can get cheap.
 c. I know that rugs he thinks he can get cheap.
 d. ?I know that rugs he knows he can get cheap.
 d'. I know that rugs he can get cheap.
 d''. Rugs he knows he can get cheap.
 e. ?I realize that rugs he thinks he can get cheap.
 f. ?*I realize that rugs he knows he can get cheap.
 g. ??*I realize that rugs he realizes that he can get cheap.
 h. *I realize that Sam he's surprised that he hit.

Compare (23 d, d', and d''). (23 d' and d'') are both well-formed in my speech, as the examples in (10) and (11) would suggest. 'Know' is both a good trigger for topicalization and does not form an island with respect to topicalization in simple sentences. However, when you put two occurrences of 'know' in the same sentence, one as a trigger and the other as a potential island-former, the well-formedness is noticeably decreased. But similar cases with 'possible', 'want', 'suppose' and 'think', which are all higher than 'know' in the hierarchies, do not yield the same results, and so increased length cannot be invoked as the determining factor.

The same sort of thing happens with adverb-preposing, although well-formedness falls more precipitously there, since adverb-preposing, as we say in (12), has a higher accessibility midpoint than topicalization (that is, sentences start getting worse at a higher point in the hierarchy).

- (24) a. ?It's possible that tomorrow he wants to leave.
 b. ?I think that tomorrow he thinks he'll leave.
 c. ?*I know that tomorrow he thinks he'll leave.
 d. *I know that tomorrow he knows he'll leave.

Ross (personal communication) has suggested a way of describing what is going on in such cases. If one looks at people's judgments about sentences, they do not cover an uncountably infinite range, as the scale from 0 to 1 would indicate. Rather judgments fall into more or less five categories: GOOD, PRETTY GOOD, IN BETWEEN, PRETTY BAD, DEFINITELY OUT. In some cases, speakers can make finer discriminations, in other cases, less fine ones. If one strings these out on a scale from 0 to 1, one gets the following picture:

(25)	1)	GOOD
	.8)	PRETTY GOOD
	.6)	IN BETWEEN
	.4)	PRETTY BAD
	.2)	DEFINITELY OUT
	0)	

Ross suggests that, though people may judge two sentences as both being good, they actually make finer (unconscious) discriminations. For example, in my speech the (a) - (d) sentences in (8) and (9) are all GOOD. Ross suggests that there are subtle distinctions among the GOOD sentences, that the (a) sentences are better than the (b) sentences, and the (b) sentences better than the (d) sentences. These sentences, he suggests, should really receive values in descending order between 1 and (let us say for the sake of discussion) .8. Incidentally, exact numbers like .8 are not to be taken very seriously; see (Lakoff, 1972) for discussion.

Now let us suppose further that the effect of combining two hierarchies is not, say, to take the lowest value of the two, but rather to multiply them, or something like that--as we say in the discussion of (12) above, multiplication is not a serious alternative. But for the sake of illustration, let us use multiplication. Let us say that the (a) sentences in (8) and (9) have value 1, the (b) sentences .9, and the (d) sentences .8. (26) indicates what happens under multiplication.

(26)	TRIGGER	PRODUCT	ACCESSABILITY
	1	1	1
	.8	.8	.8
	.6	.6	.6
	.4	.4	.4
	.2	.2	.2
	0	0	0

If trigger and accessibility values are both 1, the product will be 1. If both are .9, the product will be about .8, still in the GOOD range. But if both drop to .8, the product will be .64, which is toward the bottom of the PRETTY GOOD range and well out of the GOOD range. Similarly, if both are .7 (which is in the

PRETTY GOOD range), the product will be about .5 (which is IN BETWEEN). Though multiplication cannot be taken seriously as a viable alternative, (26) does give an approximation to the facts of (23) that is not completely off base. There does seem to be something like a multiplicative effect when the hierarchies are combined.

If we accept Ross' account of facts like those in (23) and (24), or any account along those lines, then we are committing ourselves to a rather interesting position, namely, that when speakers make judgments like GOOD, PRETTY GOOD, IN BETWEEN, etc., they are relying on subtler mental distinctions that they may not be aware of. For this reason, the approach to fuzzy grammar that Ross and I are taking, not just with respect to cases like (23) and (24), but also with respect to cases like (22), is a fundamentally mentalistic approach. We are saying that fuzzy grammar has a mental reality. The judgments that people make, which are matters of degree, are functions, perhaps algebraic functions, of unconscious mental judgments, which are also matters of degree.

II. The Performance/Competence Terminology Game

One of the joys of presenting a paper on a subject like this is that after it's over one gets to play the Performance/Competence Terminology Game. In this game the author is pitted against an adversary who is preferable nonexistent, though occasionally he may be real (which isn't nearly as much fun). The object of the game is for the author to show that he is a Good Guy by demonstrating that what he is doing is studying Competence (rah!) not Performance (hiss!), or in another variation, that he is a Rationalist (yay!) not an Empiricist (boo!). Points are scored by (1) citing a text and showing that the relevant terminology has not been used consistently, (2) inventing plausible-sounding new terminology according to which you turn out to be a Good Guy, and (3) showing that your opponent's position is a notational variant of your position. The winner gets to say "Nyahh, nyahh!" to the loser.

A criticism that might be made of fuzzy grammar and logic is that they are part of the study of performance and not part of linguistic competence at all, and hence they are not part of the study of linguistics. If such a criticism were made, it would be hard to tell what it could mean, in the absence of some clear notion of what "performance" is. For example, in Aspects of the Theory of Syntax, the term is used in at least three very different ways. On page 4, "performance" is defined as "the actual use of language in concrete situations". In other words, it is what people actually do when they speak. This sense of "performance" excludes all mental apparatus. Call this performance-1. By section 2 of Chapter 1, Chomsky has changed (or expanded) his use of the term "performance" to cover not merely what people do,

but rather the abstract perceptual mechanisms that underlie what people actually do. Call this performance-2. Chomsky includes among these a 'performance constraint' ruling out self-embedded sentences. Performance-1 involves actual actions by people; performance-2 involves an abstract "perceptual device". Perceptual devices like those discussed as part of performance-2 would, one would assume, be common to all human beings. They would presumably be part of the processing mechanisms of the human brain, and so would exclude any language-particular rules.

On page 127, Chomsky introduces performance-3. In his discussion of free-word-order languages, Chomsky claims that free word order results not from transformational rules but from "rules of stylistic reordering", of which he says the following: "It might, in fact, be argued that the former are not so much rules of grammar as rules of performance". As it happens, constraints on free word order are very much a language-particular matter, that is, they have to be included in the grammars of particular languages. They are not part of any general perceptual mechanisms common to all human beings. In suggesting that there are language-particular "rules of performance", Chomsky is using the term "performance" in still another new way, this time to include abstract linguistic rules that must be part of grammars of particular languages like Latin, Mohawk, Navaho, etc. Chomsky unfortunately gives no hint as to how the abstract language-particular linguistic rules of performance-3 are to be distinguished from the abstract language-particular linguistic rules that are part of 'competence'.

Until one spells out precisely what is meant by "performance" it makes no sense to ask whether fuzzy grammar is part of "performance". It might, however, make sense to ask whether it is part of performance-1, performance-2, or performance-3.

- (27) Performance-1: What people actually do.
 Performance-2: Perceptual mechanisms common to all human beings.
 Performance-3: Abstract linguistic rules (involving concepts like lexical item, noun, clause, adverb, etc.) which must be at least partly specified in grammars of particular languages (though they may be in part universal).

It is clear that fuzzy grammar and fuzzy logic are not part of performance-1. First, the data in both fields is based on speakers' intuitions, not on what they actually say. Second, the accounts given of intuitive judgments depend on abstract concepts, which are not present in the data itself. For example, in fuzzy logic, the meanings of hedges like strictly speaking, loosely speaking, essentially, and regular were given in a form that assumed that the meanings of predicates had vector values; those hedges pick out

various components of the vectors. On the other hand, hedges like sort of, rather, and pretty were defined in terms of algebraic functions of other fuzzy predicates. Such abstract mechanisms are meant to account for speakers' intuitions; they are not mere catalogues of what speakers actually do. Moreover, fuzzy logic cannot be taken to be part of performance-2. No perceptual mechanisms common to all human beings are going to be able to account for the connotations of lexical items, for example, which is just what a hedge like regular picks out. Connotations of lexical items are part of what a speaker learns about a given language; they are as language-particular as anything could be. And hedges are among the harder things for nonnative speakers to learn. The only possibility left is performance-3. The principles of fuzzy logic with hedges would certainly count as abstract linguistic rules, not perceptual mechanisms.

Similarly, fuzzy grammar can be neither part of performance-1 nor performance-2. Again the data used is that of intuitions of native speakers, not what speakers actually say. Again, the account of the data is given in terms of abstract concepts, in this case abstract hierarchies of grammatical elements (nominals, clauses, adverbs, etc.) and complex functions which apply to these hierarchies. That rules out performance-1. Performance-2 is ruled out on a number of grounds. First, there are language-particular aspects of fuzzy grammar. English idioms and idiom pieces fit into various of Ross' hierarchies. Languages differ with respect to the triggering strength of various types of rules. Second, the concepts used are not perceptual concepts like short-term memory or time; they are concepts like clause, nominal, adverb, verb of saying, etc., in other words linguistic concepts. For these reasons, fuzzy grammar cannot be part of performance-2. Performance-3 is, as would be expected, a candidate, since abstract linguistic rules which are at least in part language-particular are involved.

But as was noted above, there seems to be no distinction between performance-3 and competence--both are the study of abstract linguistic rules. Because the term "performance" has been used in so many different ways as to make it pretty useless for discussion, I suggest that the term be abandoned altogether and be replaced by terms that are better defined, such as actual speech (or writing or signing), perceptual mechanisms, and abstract linguistic rules. It should be clear from the above discussion that both fuzzy logic and fuzzy grammar are part of the study of abstract linguistic rules.

There have been some underground rumblings, not yet in print, suggesting that the study of fuzzy logic and fuzzy grammar by generative linguists represents an abandonment of rationalism and a return to (horrors!) empiricism. To ask whether this is so, we need to consider what these terms mean. The following are definitions which are as appropriate as any I've been able to find.

- (28) a. Empiricism-1: A philosophical theory maintaining that knowledge can only be acquired through the senses.
- b. Empiricism-2: The use of empirical method (i.e., observation and experiment) in any science or art.
- c. Rationalism: A philosophical theory maintaining that some knowledge (not all, of course) can be acquired through reason alone without the use of the senses.

With respect to linguistic matters, these terms have become emotionally charged. To make the emotional content clear, let us consider some further definitions relevant to the issue at hand.

- (28) a. Bad Guy Empiricism-2: The claim that True Science can only be done using the empirical method construed very narrowly, that is, as objective observation and experiment. Within Linguistics, this precludes the use of native speakers' intuitions and requires only the study of so-called 'objective' data such as texts, tape recordings, questionnaires, etc.
- b. Good Guy Empiricism-2: The use of the empirical method, with 'observation' and 'experiment' broadly and sensibly construed to include native speakers' intuitions as the primary data of linguistics, to include what cannot occur as well as what can occur as primary data, and to restrict the use of texts, tape recordings, questionnaires, etc. to the place of secondary data at best, since such data is rife with mistakes, may or may not accord with speakers' intuitions, and does not show what is impossible. It is a form of empiricism-2 in that it uses facts, but differs from Bad Guy Empiricism-2 in its notion of what a fact is.

The first thing to notice is that the issue of fuzziness in itself has nothing whatever to do with either empiricism (1 or 2) or with rationalism. Both are consistent with fuzzy categories and both are consistent with nonfuzzy categories. This is clear both from Dana Scott's investigations into many-valued logics and from Zadeh's studies of fuzzy sets. Scott has observed that classical many-valued logics can be viewed as notational variants of two-valued modal systems with many two-valued valuations related by an alternativeness relation. (See Appendix I to (Lakoff, 1972).) Similarly, Zadeh has observed that fuzzy sets can be replaced by sequences of nonfuzzy sets. By the same token, any fuzzy sense-datum can be represented by some number (possibly very large) of nonfuzzy bits of information (1's and 0's). In fact, it has been suggested that that is exactly how the mind perceives sense-data. Since any fuzzy category can be represented by a system of nonfuzzy categories, any fuzziness-nonfuzziness issue is reducible to an issue about what kinds of nonfuzzy category systems one has: Scott-style or non-Scott-style. It is hard to see how any such issues

have anything to do with the rationalism vs. empiricism-1 debate, in linguistics or any other field. One can be a rationalist and believe in innate categories of the mind which happen to be fuzzy (i.e., equivalent to Scott-style systems of nonfuzzy categories) or nonfuzzy (i.e., not equivalent to Scott-style systems of non-fuzzy categories). An empiricist-1 belief that all knowledge comes through the senses does not force one to distinguish between Scott-style and non-Scott-style systems of nonfuzzy categories.

The second thing to notice is that rationalism as a philosophical theory is compatible with the methodology of good-guy-empiricism-2. Since GGE-2 includes native speakers' intuitions as part of linguistic data, it admits products of the mind alone to the realm of scientific knowledge. Thus GGE-2 is a rationalistic methodology.

It should be clear that the work that has been done in linguistics on both fuzzy logic and fuzzy grammar falls within the realms of both rationalism and good-guy-empiricism-2. The data used in both endeavors are native speakers' intuitions. In both fuzzy logic and fuzzy grammar, abstract linguistic rules have been formulated which require appeal to abstract fuzzy categories which do not themselves show up directly in the data but which are accorded the status of mental reality.

Nyaah, nyaah!

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