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**Frankfurt School – Working Paper Series**

**No. 153**

**Meaning and Function**

**in the Theory of Consumer Choice:**

**Dual Selves in Evolving Networks**

by Carsten Herrmann-Pillath



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## Abstract

Building on the philosophy of Charles Sanders Peirce, recent advances in biosemiotics have resulted into a concise framework for the analysis of signs in living systems. This paper explores the potential for economics and shows how biosemiotics can integrate two different research agendas, each of which are also connected with biological theories, namely neuroeconomics and the theory of networks. I introduce the triadic conceptual framework established by Peirce which distinguishes between object, sign and interpretant and the corresponding causal forces in evolving hierarchical systems. This framework is used to systematize recent results of neuroeconomics in the form of the dual selves approach, following early contributions of James Coleman, partitioning the individual into the acting self and the object self. This distinction implies that there is a fundamental information asymmetry between the two selves. Against this background, the semeiotic process is an information generating and processing dynamics, which is driven by the internal selection of classificatory schemes of actions chosen and the population level dynamics of sign selection, with mimetic behavior as a driver. This can be further analyzed by means of the theory of signal selection. A central insight is that the internal information gap between acting self and object self implies a systematic role of sign processing in social networks for any kind of consumer choice. I exemplify my approach with empirical references to food consumption as a most universal and simple form of consumer choice.

Key words: consumer choice; biosemiotics; dual selves; networks; signal selection

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## 1 Introducing the theory of signs into the economic model of the individual

Economic life is replete with signs: In fact, every item on the shelves of a supermarket is a sign that refers to the future flow of benefits from using it. Yet, this simple fact is not fully recognized in economic theory. Most attention is paid to the role of signals in the context of communication about hidden qualities and the creation of reputation in strategic interaction (subsequently, I use the term ‘signs’ in the semeiotic context and the term ‘signal’ in the standard economic and the biological context). However, these approaches do not touch upon the underlying fundamentals. Especially, the role of signs is not recognized in the fundamental model of the individual that forms the foundational part of the theories of signalling in economics. The standard model of the individual is behavioristic in the sense that there is a direct causal connection between goods and utilities, which also forms the basis for the foundational model of revealed preferences. In this model, there is no distinction between the good, the sign of the good and their respective causal effects resulting into observed choices. To the contrary, I am going to argue that the distinction between ‘goods’ and ‘goods as signs’ is fundamental for the theory of consumer choice.

Corresponding to the controversy between behaviorism and cognitive sciences in the 1960s, this basic distinction is implicit to the recent attempts at opening up the black box of the agent of choice. However, so far the concept of signs does not play an essential role in the pertinent neuroeconomic and behavioral economics research, in spite of the fact that the role of frames is explicitly recognized as a force of top-down causation that adds to the bottom-up explanations focusing on psychological or neuronal mechanisms (Gintis 2006). This is a desideratum, because semeiotics, the science of signs as it was established by Charles Sanders Peirce (for a collection of contributions, see Peirce 1992, 1998), allows to handle two different aspects of signs in one coherent approach, namely signs as internal mental representations and signs as population-level media of information processing, which includes communication and coordination.

The main objective of this paper is to introduce a general conceptual framework which allows integrating signs into the economic theory of the individual (which is not only new to economics, but also to semiotics, which so far touches the issue only superficially, see e.g. Zyphur et al. 2006). This can be achieved by means of building on recent developments in semeiotics, that is, modern versions of Peirce’s theory of signs, as informed by analytical philosophy (to identify this strand of thought, I use the original Peircian ‘semeiotics’, and not ‘semiotics’, which is broader in scope and includes e.g. the pragmatist approach by Charles Morris). I propose a triadic structure of relations between goods, signs and individuals which I then relate to recent research in neuroeconomics. I posit that the theory of signs can be combined with a dual-selves model of decision making which was seminaly proposed by James Coleman (1990) in his monumental ‘Foundations of Social Theory’, in terms of the duality of

‘acting self’ and ‘object self’. This approach matches with recent advances in psychology and neuroscience which distinguish between two aspects of utility in the human individual, namely ‘experience utility’ and ‘decision utility’, or, in the neurosciences, the ‘Liking’ and the ‘Wanting’ system. Dual selves models of the individual correspond to the twofold dualism in triadic semeiotic models, that is, all relations between an object or sensory input and a response, e.g. behavioral output, are mediated via two channels, one the direct physical connection, the other the sign of the object, which is a physical phenomenon, too, with the channels confluing into one behavioral output, which is the interpretant in the semeiotic parlance. So, the Liking system corresponds to the first channel, the Wanting system to the second channel, or, the object self and the acting self, respectively. This distinction has profound consequences, of which the by far most important is that there is asymmetric and incomplete information between the object self and the acting self. In a nutshell, the acting self does not fully know what the object self needs. There are at least two reasons why such an apparently strange split emerged in human evolution: One is that the duality enables behavioral plasticity in adapting to the environment, thus enabling cultural niche construction, and the other is that different and fragmented hedonic systems of the object self can be mapped into a more integrated decision system on part of the acting self.

An important consequence of this view is that we can no longer assume that all information that undergirds observed choices is ‘inside’ the individual, because the choices themselves and their consequences become sources of information for the acting self. So, the semeiotic approach fits into recent theories about distributed cognition in which cognitive processes are seen as being externalized to a large degree. I propose that the mechanism that integrates internal and external processes is imitation, hence putting mimesis into the center of semeiotics. To a large extent, mimesis happens beyond the reach of the acting self, so that the observed outcomes can become sources of information for it, especially if they are compared with observed behaviors of others and their outcomes. So, we can add more analytical detail to the process of imitation if we realize that imitation happens in networks of individuals, and that therefore individual cognition, as mediated via the acting self, is externalized to network structures. This is the final stepping stone to achieve integration with network theories of market dynamics and consumer choice. All signs are social in the sense that the meaning of signs is determined by evolutionary forces in communities of sign users. Signs mediate mimesis.

This final step allows linking up the semeiotic approach with models of signal selection which converge between economics and biology, with an emphasis on the latter. Signal selection is an evolutionary force by which truthful information is created by means of competitive interpretive acts of individuals, and by which the complexity of information continuously increases because the underlying semeiotic relations are reflexive, i.e. a sign becomes the object of another sign, or, an information becomes the object of another information, as in the case of a sign that establishes the reliability of another sign (so, for example, a strong body is the sign of a strong body, but may not be reliable as a source of information, so another sign piggybacks on this sign, such as showing off handicaps). For the theory of consumer choice, this means that consumer choice is fundamentally dependent on choices of other individuals, as

the information generating mechanism of the dual selves model is externalized across networks of individuals.

The paper pulls together different strands in the literature, which will be referenced in due course. Two essential building blocks which are so far not mutually related are firstly, the recent neuroeconomic research into individual choice (overviewed in Glimcher et al. 2009), and secondly, the theory of networks (overviewed by Newman 2010). In neuroeconomics, there are compelling reasons why the dual selves model is the appropriate general framework how to analyze individual choice, which have been extensively discussed in the emerging new theory of consumer choice. These are mostly related to insights into the neurophysiological foundations of learning, which presuppose internal representations of goals and mechanisms of assessing degrees of goal attainment, which then reinforce certain behavioral patterns. The dual selves model is a functional model, and does not necessarily imply clear-cut anatomical distinctions in brain architecture. As a functional model, it can claim universality also in face of the constantly changing knowledge about the details of the underlying processes. In comparison to neuroeconomics, which opens up the black box of the individual, network theories deliberately abstract from the internal structure of nodes in networks. Their main contribution is the impact of network structure on individual decision making. The bridge between the two approaches, which I also traverse in this paper, are the theories about social learning and imitation that help to understand how network structure affects information flows, which ultimately guide individual choice.

The fourth strand of literature which I rely on is the recent progress in the philosophical work on the theory of signs of Charles S. Peirce (foremostly, Stone 2007). The connection of this approach and economics is most straightforwardly obtained if we consider the role of von Hayek's theory of mental processes (Hayek 1952) for his evolutionary approach to economics. Semeiotics can explain the process of cognitive classification of physical causal connections between the external environment and the brain. The key point is the naturalization of the process of interpretation. This is a hotly disputed field in biosemeiotics, in particular (see e.g. Emmeche 2002, Vehkavaara 2002 or Brier 2008). If we accept the naturalization hypothesis, we can draw on a general conceptual framework which allows relating the category of meaning with the category of function. This foundational synthesis allows an extension into the dual selves model.

Therefore, my paper starts with a brief exposition of the fundamental naturalistic model in semeiotics. In the next step, I apply this approach on the dual selves model and give a brief empirical illustration in discussing the theory of food consumption. Then I complete the conceptual framework by introducing imitation and signal selection as evolutionary forces in networks of individuals. I summarize the main results in the final section.



## 2 The triadic approach to meaning and function: implications for economic analysis

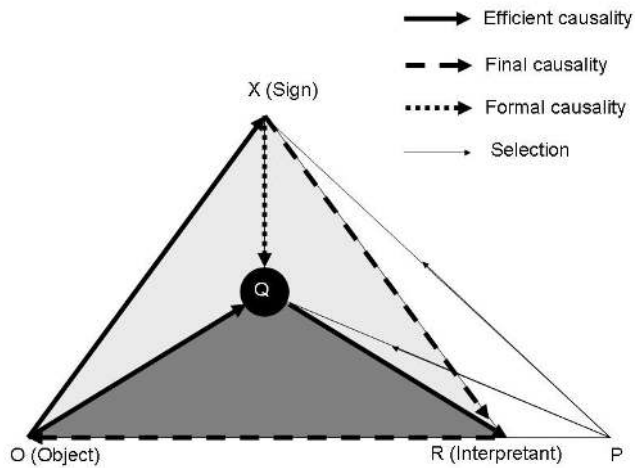
### 2.1 The Peircian framework

The central conceptual problem in analyzing semeiosis, that is, the emergence, diffusion and function of signs, is the relation between meaning and function in evolutionary contexts. In the generic use of the term, evolution operates via the processes of variation, selection and retention, such that through time functions emerge which relate certain traits of a system with a fitness landscape which defines their adaptive value. Functions relate with meanings if the relation between external selective forces and adaptive functional responses is mediated via internal representations of the former. Typically, an internal representation has been equated with a ‘mental phenomenon’; however, an internal representation is not a mental phenomenon per se, but is always involved, for example, in the biochemical and neurophysiological causal chains that connect an external stimulus to an organismic response qua function (Dretske 1995, Neander 2006, 2009). So, the question results whether meaning can be completely reduced to function, both in the sense of meaning evolving out of selection (modelled e.g. in terms of evolutionary game theory, as in Skyrms 1996, 2004) and in the sense of meaning supervening on functions (Millikan 1998, Macdonald and Papineau 2006a, Adams and Aizawa 2010).

More than a century ago, the American philosopher Charles Sanders Peirce has developed a comprehensive theoretical framework to analyze evolutionary processes which involve the emergence of meaning. Peirce himself vacillated between mentalism and naturalism, and favored the former even with panpsychistic tendencies (overview in Burch 2010). In the recent years, this framework has been substantially extended and clarified in terms of a naturalistic approach to meaning (Stone 2007). In a nutshell, meaning is an emergent property in systems with evolving functions, and which relates to the role of signs in mediating causal chains between systems and their environment.

Following and modifying a diagrammatic exposition proposed by Robinson and Southgate (2010), Herrmann-Pillath and Salthe (2010) summarize the main features of naturalistic semeiotics in figure 1.

**Figure 1: The triadic structure of semeiosis**



Peirce introduced a triadic approach to the analysis of evolution, in which the relation between environment and organism is always seen as being mediated via a sign: For example, there is fire, and there is an animal which flees, and the relation is intermediated by smoke as a sign. In the terminology proposed by Stone (2007), the object  $O$  (environment, as mediated via a sensory input) relates with a response  $R$  of a biological system via the intermediation of the sign  $X$ . In the naturalistic view, the response  $R$  corresponds to Peirce's original notion of 'interpretant'. There are two different causal chains in the triadic scheme: The causal relation between  $O$  and  $R$  is always a physical one, which runs via  $Q$  in the diagram (so, fire causes smoke, smoke causes sensory effects in the organism, alongside with other physical causes such as heat).  $Q$  corresponds to certain structural characteristics of the respective system which enable the causal connections between  $O$  and  $R$ . This  $O$ - $Q$ - $R$  relation establishes the physical structure of the function that underlies the organismic response (the animal flees). But if we want to explain *why* smoke is a sign of fire, and *why* the perception of smoke (and not just the heat of the fire, when staying closer to it) triggers a particular behavioral response, we have to refer to an evolutionary process in which the response emerged as a function that fulfills a general purpose  $P$ , and which involves certain internal representations of the object  $O$ , the signs  $X$  (in more detail, see Stone 2007: 156ff.). This general purpose results from evolutionary forces, in turn, such as 'survival' or 'reproduction', and it relates with functions in a many-to-one mapping: There are many possible functions that fulfill the same purpose. Now, selection works in two directions, because it shapes the emergence of certain physical causal chains  $O$ - $Q$ - $R$ , but also the emergence of sign relations  $O$ - $X$ - $R$ . So, a particular instance of semeiosis, such as the smoke example, goes back on the co-evolution of semeiotic and physical causal connections. The smoke elicits certain causal chains in the organism which ultimately result into the workings of a function (to flee fire), but this presupposes that the organ

ism treats smoke as a sign of fire. The latter relation conjoins the two dimensions of meaning and function in the evolutionary argument.

According to Peirce's views, the difference between the two chains results from the fact that different causal modes are implied, in spite of that the single steps in the semeiotic chain are physical, too, in the sense of efficient causality (i.e.  $O$  efficiently causes  $X$ , and  $X$  efficiently causes  $R$ ). This conjunction of meaning and function can be further analyzed in terms of the Peircian triad of causal modes, which go back to the classical Aristotelian distinctions between efficient, final and formal causality (Stone 2007: 136ff.). In the conceptual structure of figure 1, efficient causality refers to the physical causal connections between the different events in semeiosis,  $O$ - $Q$ - $R$ . Final causality refers to the role of the general purpose in selecting particular causal chains in the entire set of possible causal chains, so relates to the  $O$ - $X$ - $R$  chain. This is not a teleological concept, but a logical one in the sense that the question, "why does smoke cause the animal to flee?" cannot be only explained by saying, "because there is fire", thus pointing towards the efficient causal part of the entire causal pattern. A full explanation needs to add, "and fire is threatening survival", thus introducing a reference to a general purpose: 'Fleeing fire because of sensing smoke' has been selected for ensuring survival, i.e. a general purpose. So, the efficient-causal explanation is supplemented by a final-causal one. Further, the relation between the sign  $X$  and the efficient-causal chain  $O$ - $Q$ - $R$  is a formal-causal one. Formal causality refers to the process of internal organization of sensory data into cognitive categories, such as distinguishing smoke from fog, or different degrees of thickness of smoke, which result into the internal selection of different causal chains connecting with different responses  $R$ . Thus, formal causality defines the relation between meaning and function, since it underlies the classification of external efficient causes into different sets of variations among resulting functions  $R$ . An important consequence of this conjunction is that 'misrepresentation' becomes possible, i.e. certain efficient-causal chains can end up with functional failures if they fail to be classified properly, with reference to the general purpose  $P$  (the animal interprets smoke as fog, and thus is trapped in the fire) (on misrepresentation, see Southgate and Robinson 2010, and the debate about teleosemantics, e.g. Matthen 2006).

So, meaning becomes a property that designates a conjunction between efficient, final and formal causality in semeiosis, but has no independent role to play. Yet, this does not result into functional reductionism, in the sense of pure adaptationism, because the semeiotic process implies a central role of the evolving structure of the internal representations (which keeps the original von Uexküll view in biosemiotics, see Cannizarro 2010). A final important insight already achieved by Peirce is that the semeiotic process is dynamical in the sense of generating information about the object. In figure 1, this is indicated by the broken arrows that run from  $X$  via  $R$  to  $O$  in the reverse direction. This happens because, considering a population of agents which basically can be described by a particular type of triadic structure, in the flow of actions under selection of token variants of the type, the changing responses qua interpreters improve the fulfilment of the general purpose, insofar as the sign relation generates new variants of the  $O$ - $Q$ - $R$  relations through which the information about the object improves. For example, initially smoke and fog might not be distinguished, but later a more fine-grained response pattern emerges that is enabled by internal representations of fog and smoke which allow their distinction. Since the external world is only accessible via the semeiotic process,

which is internally shaped by formal causality, this also implies that the external world, as represented to the individual, evolves ('dynamical object', in Peirce's terms). So, the naturalistic approach to semeiosis corresponds to a generalized Darwinian view on the emergence of increasingly complex internal mappings of the external world, which improve the functioning of the respective living systems (see e.g. Dennett 1995). However, it is important to keep in mind for our further discussion, that those internal mappings are causally fused with external facts, and in this sense externalized in an essential way: Signs are physical phenomena in the external world.

## **2.2 An economic application: Laibson's cue-theory of consumption**

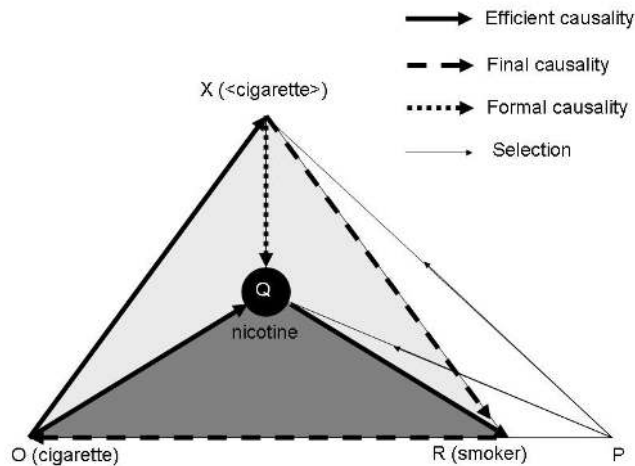
I will now present a direct economic application of the semeiotic framework both in order to demonstrate the relevance of semeiotic analysis for established economic theories, and to prepare the ground for the further discussion of consumer choice. In his cue-based theory of consumption, Laibson (2001) has presented an extension and modification of the original Beckerian approach to habit-formation, including the so-called theory of rational addiction (for related theories, see e.g. Bernheim and Rangel 2004). The central idea is that environmental cues elicit changes in the preferences of individuals, thus inducing changes in the marginal utilities of consumption. This happens because cues activate memories of past consumption. Our example will be smoking, so, for example, perceiving a box of cigarettes activates a stronger desire for smoking, because the cue moves the schedule of expected marginal utility, as well as the actual marginal utility of lightening the cigarette.

What is a cue? Firstly, a cue is a sensory input. But this sensory input is different from the sensory input that actually creates the utility of a particular good and activity. There is a spectrum of possibilities here, reaching from arbitrary environmental items to the physical embodiment of the respective good. So, for example, if somebody mostly smokes in a pub, her craving for nicotine will differ if staying in a pub environment as compared to a gym. Moreover, and most interesting for our discussion, the cigarette itself is a cue, which differs from the physiological chain connecting the activity of smoking with nicotine infusion into the organism. That implies, if the different properties of cue of the cigarette are changed, the marginal utility of smoking will change, too. For example, a male smoker accustomed to regular cigarettes may feel less satisfaction when smoking an ultra-thin 'lady' cigarette, even with the same content of nicotine, or may feel less satisfaction when chewing a gum with nicotine. The same happens with food, when the visual impression of the dish raises appetite and hence the satisfaction from eating. So, biologically, cues relate with Pavlovian reinforcement mechanisms which change the individual's dispositions to react on the stimulus, both in the sense of preparing the organism and also compensating for negative effects. So, an organism that is not ready for eating, because it has not received a cue, might have a lower capacity to digest certain food items.

The Laibson model grasps these effects in introducing a meta-utility function which includes the cue-based physiological mechanisms, which are seen as biologically determined. So, the standard utility function is nested into this meta-function in the sense that the actual choices of the individual become dependent on the history of consumption experience, which have evolved certain patterns of cues and correlated behaviors, and therefore are contingent on the environment (this establishes a relation with the human capital approach to consumption developed by Becker 1996). An important consequence of this model is that individuals who are aware of the role of cues in eliciting behavior will be possibly willing to manage cues directly in order to influence their own behavior. So, for example, a smoker might avoid pubs if he intends to quit smoking in order to avoid the leveraged cravings which would also cause greater pain of non-smoking. This also implies that cues without subsequent consumption are hedonically aversive. Further, the theory also can explain the phenomena which are normally associated with hyperbolic time preferences, that is, a heightened preference for present consumption. If in the present a cue impacts on choices, momentous marginal utility is leveraged, whereas the anticipated utility of future consumption streams is only based on cue-less evaluations, since the cues must be physically present in order to operate. A final core insight of the cues-theory is that consumption is a public activity, because observed consumption of others is a cue itself, so that public consumption generates positive externalities on other individuals, whose marginal utilities are increased by the cues. Smoking in companionship increases its pleasures.

Laibson's theory is a clear cut example for a semeiotic process as outlined in section 2.1 (see figure 2). Cues are signs. Putting the smoking example into the triadic framework, we immediately recognize that the cue qua sign mediates the  $O-X-R$  causal chain and thereby affects the functioning that is active in the direct chain  $O-Q-R$  (so, economically, the schedule of marginal utility). The latter chain refers to the neurophysiological effects of nicotine in the body, the former chain relates, amongst others, to the sign of the cigarette, which I put in brackets <cigarette>. So, smoking has to be analyzed into two different processes, one is the inhalation of smoke, and the other is the perception of the cigarette, which is a sign. Both processes conflate in the neurophysiological responses of the smoker, i.e. the response, which is the level of satisfaction generated by the activity of smoking. The sign changes the response  $R$  of the individual to the nicotine infusion in terms of changing the degree of satisfaction, as compared to physically similar infusions of nicotine without activation of the sign. Hence, Laibson's notion of changing marginal utilities actually refers to an interpretive process. The original object, the cigarette, triggers two different causal chains that co-evolved during the process of habit formation. This process can be analyzed as resulting from an evolutionary dynamics on different levels, with the central ones being the long-run selection of the underlying biological mechanisms, the medium run of cultural evolution of artefacts and the short-run of individual habit formation (on the applicability of the fundamental VSR model on different levels, including individual reinforcement learning, see Hull et al. 2001, Mesoudi et al. 2006).

**Figure 2: The semeiotic view on cues in smoking**



In terms of the modes of causality, we can further analyze this process. In Laibson's framework, emphasis is on the equilibrium states. Dynamically, the central process is governed by formal causality, i.e. the semeiotic co-evolution between the  $O-Q-R$  and the  $O-X-R$  chain. This is reflected in the semeiotic fields of the notion of a <cigarette>, so, the shape, colour, size etc. of what counts as a cigarette in a particular cultural setting and for a particular smoker. This relation can be broken down onto the brand level and hence, also applies for the analysis of advertisements and individual consumption profiles. Further, dynamically this is a learning process in which the final causality of selection establishes increasingly sophisticated consumption patterns through individual learning. So, the semeiotic approach allows assigning a systematic place to all processes that are the familiar topics in psychology, consumer research or cultural studies, with different levels of generality, reaching from individual idiosyncrasies to larger cultural patterns.

In this paper, I will refrain from analyzing this multi-level semeiotic process in more detail. The results achieved so far suffice to make the fundamental point that the co-evolutionary dynamics relates with a dual view on the individual, which can be substantiated by neuroscientific research. So, I am now going to show that the fundamental process of semeiosis corresponds to a functional dualism in the theory of the individual, the dual-selves model.

### 3 The dual-selves model

#### 3.1 Psychological and neuroscience evidence for the duality of object-self and acting self

I will now introduce the dual selves model of the individual and fit it into the triadic semeiotic structure. Analytically, the dual selves model is an axiomatic alternative to the standard model of the individual in economics (for an early discussion of alternatives, see Elster 1986). The dual selves model has to be seen against the background of evolutionary approaches to the individual which argue that the brain is not a fully integrated, coherent and consistent decision apparatus but consists of different modules which are adapted to different tasks (Tooby and Cosmides 2005, Platt and Padoa-Schioppa 2009). This modularity can be analyzed in both phylogenetic and functional terms. The phylogenetic perspective emphasises the emergence of different brain functions through evolutionary time, thus distinguishing between modules of different age (which is often emphasized in management science adoptions of neuroeconomics, see e.g. Wargo et al. 2010). The functional perspective focuses on the present patterns of module interaction and on how they correspond with task-related behavioral patterns. From this follows that the coordination between modules is a primordial meta-process in the brain.

Now, if we take modularity as a given, the consequence follows that we cannot reasonably suppose that any kind of functional subunit in the biological individual has complete and perfect information about other subunits or the entire organism: A biological organism is not a centralized hierarchy, but consists of numerous modular units which are governed by partly autonomous functional, or more specifically, homeostatic mechanisms. In neuroeconomic models, this view is commonly introduced in terms of distinctions between conscious and non-conscious processes, and also calculative versus automatic processes (Camerer et al. 2005). The assumption of asymmetries and incompleteness of distributed information in the brain does not need to build on any more specific structural descriptions of the brain, because we can state in a generic way that any sort of mapping relation always implies a loss of information, both because of an evolutionary pressure to economize on information costs, which are actually the energetic costs of brain functioning (a map never represents every aspect of the represented entity) or because there are always random forces at work (cf. Kahre's, 2002, 'law of diminishing information'; for a general economic model, see Brocas and Carrillo 2008).

We can further simplify the argument in considering an elementary form of modularity which considers the minimal duality of a receptor system and an effector system which are connected via a mapping relation. Then, the dual selves approach can be introduced as an axiomatic proposition, stating that in a neuronal system with the minimal distinction between a

receptor system and an effector system, which are connected via mappings, i.e. internal representations, mutual information asymmetry between the subsystems is a generic feature of the system. From this follows that there are fundamental limits to the formation of a perfect and consistent integrated decision system. There is a direct correspondence with established axiomatic approaches on collective decision making: Once we suppose the brain to be a system of partly autonomous modules, hence ‘agents’, the Arrow-Condorcet theorem applies, that is, the individual cannot have a consistent and unique preference function (Steedman and Krause 1986; Ross 2005: 352).

One of the first systematic explorations of the dual selves approach has been presented by the sociologist James Coleman (1990: 503ff.), who distinguishes between ‘object self’ and ‘acting self’, a terminology that I will follow subsequently. As such, this is a purely theoretical distinction in terms of two different aspects or functions in individual choice, with no presumptions about brain locations. One function relates with the evaluation of outcomes of actions (Coleman calls this the ‘receptor’ function), the other function relates with the anticipation of outcomes and the resulting process of choice (Coleman’s ‘actuator’ function). Coleman introduces this approach for several reasons. One is that he argues that in order to understand behavior, the black box containing the interacting components needs to be opened, especially when aiming at analyzing malfunctioning (so, corresponding to the litmus test of misrepresentation in teleosemantics, and also the role of anomalies in economics). The other is to introduce the possibility to analyze sub- and supra-individual decision processes with the same conceptual apparatus, especially corporate agents (so, also re-importing principal-agent theory into the analysis of the individual). Finally, the dual selves approach allows for a proper analysis of ‘interests’, which cannot be simply equated with the subjective interests formalized in standard utility theory, but also with ‘objective interests’ resulting from a position of the acting self in a larger social structure. The dualism between subjective and objective interests reflects the informational limitations to the decision process in individuals with dual selves. To summarize, the dual selves model posits that the anticipation of outcomes and the evaluation of outcomes always differ systematically because of the necessary incompleteness of the information processing across the different modules of the brain.

There are two strands of research in psychology and neuroeconomics that lend strong empirical support to this model. In one strand, the distinction between experience and decision utility has been introduced (Kahnemann et al. 1997), which would relate with the object self and the acting self, respectively: Individuals manifest systematic gaps between what they experience as an outcome during certain actions and what they remember and anticipate, even under very simple experimental situations such as feeling the temperature of water. This implies that choices are taken on the basis of information that does not unequivocally reflect the outcomes. This model of a dual utility measures differs fundamentally from the standard economic model which only focuses on decision utility, especially in the context of the theory of revealed preference, which takes observed behavior as the direct indicator of utilities. This distinction is of relevance in many contexts, such as, for example, in the analysis of psychological phenomena of self-deception (Bénabou and Tirole 2002, Mijovic-Prelec and Prelec 2010).



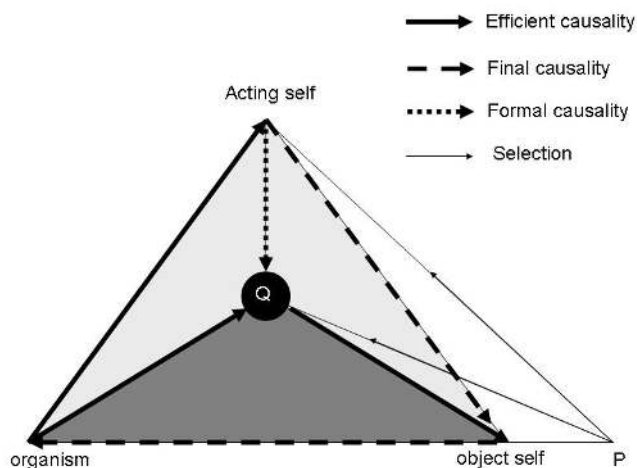
In the neuroeconomics context, a related fundamental distinction has been made in terms of the Wanting vs. the Liking system (sometimes a ‘learning system’ is also introduced, as in Camerer 2006, but this would refer to a process that results from the interaction between the other two). This distinction results from the identification of specific neurophysiological circuits which enable reinforcement learning, and which mainly involve the neurotransmitter dopamine (for a survey, see Schultz 2008). The dopaminergic circuits build on the perceived discrepancy between goal and goal attainment, i.e. the deviations between expectations and outcomes (i.e., coding reward prediction error). Now, the central point is that perceived well-being does not only depend on the actual outcome, but also the general changes and levels of dopamine in the brain. This introduces a systematic differentiation between the process of choice and the evaluation of outcomes, which fits into the object self and acting self dualism, with the dopaminergic circuits being associated with the latter and all other systems indicating proper organismic functioning with the former. This functional differentiation is also reflected in brain architecture, which provides the physical structure in which the dynamic mappings proceed continuously (e.g. Knutson and Wimmer 2007, Knutson et al. 2009).

Whereas the psychological evidence seems to be clearcut, the neuroeconomic knowledge is still in flux. The notion of modularity is complex and might, for example, include also a functional differentiation between systems processing positive (rewards) and negative (losses) outcomes and the signals related with them, which is important for providing a neuroscientific foundation for prospect theory (e.g. Trepel et al. 2005, Knutson and Glerer 2008, Stanton and Welpel 2010). To the contrary, Glimcher (2003, 2009) sees the brain as a unified decision system, as far as the mechanism of choice is concerned (which relates with the ‘common currency’ hypothesis, see Landreth and Bickle 2008). Correspondingly, many economists emphasize this position in the neuroeconomics literature and explicitly reject multiple selves models, e.g. Bernheim and Rangel (2004), against economic dual selves models such as proposed by Fudenberg and Levine (2006) or by Laibson, with explicit reference to brain architecture, see McClure et al. (2007). However, both strands in the literature agree on the functional duality between the Wanting and the Liking system: For example, Glimcher (2009: 509) clearly states that his unified model is a model of choice, but not a model of experienced well-being (which would maintain, amongst others, the emerging divide between the economic theory of choice and the economic analysis of welfare, see Camerer 2006). So, it seems that the discussion sometimes confuses the question of the consistency of the decision (sub)system with the question of the consistency between the Wanting and the Liking system. In particular, observed behavior is a consequence of the individual histories of learning about how to balance the two systems, which is most obvious in the wide variation between mixes of seemingly ‘rational’ and ‘irrational’ behaviors in every human population, especially with regard to dysfunctions such as addiction.

### 3.2 The semeiosis of dual selves in consumer choice

So, both the psychological and the neuroeconomic approaches converge to the general dual selves model. Now, we can put this into the triadic semeiotic framework. We distinguish between the organism as a physical entity and the interface with the physical environment, and the duality of object self and acting self on the other hand. As an interface (i.e. the point where sensory data are generated in the sense of Hayek's), this conflates external world and organism in the sense that there are no other sources of information about the external world than sensory data. This has the important implication for economics and the theory of consumer choice that a 'good' is always a set of sensory inputs, and cannot be naively equated with the physical entity (which, however, fits into the long-standing Lancasterian tradition in modelling goods in certain economic models). This difference matches with an important Peircian distinction, namely between the 'immediate' and the 'dynamical' object, with the former referring to an object as it is mediated in a certain state of the semeiotic system, and the latter as the potential outcome of a learning process which relates to evolving responses  $R$  and the corresponding co-evolving causal chains. Therefore, in the triadic diagrams we show two broken arrows leading back towards the object, thus representing the information-generating dynamics of the evolutionary process.

Now, the object self corresponds to the response in the semeiotic approach in so far as this is the evaluation of the outcome of an action that has generated a physical chain of causation  $Q$  which connects external world and outcome. Different from the standard economic approach, this implies that the interpretation relates with a general purpose, i.e. a function that was selected for in the past multi-level evolutionary process. So, considering current economic research, this part of the picture can be grasped by evolutionary approaches to preferences (as proposed e.g. by Robson and Samuelson 2010; for consumer theory, see Saad 2007). However, in the dual selves model these preferences are not directly guiding choices. Choices work via the semeiotic intermediation, which relates with the acting self. This matches with the general characterization of the acting self as a cognitive agency which operates on the basis of representations of the external and internal world, i.e. signs.

**Fig. 3: Object self and acting self in the semeiotic triad**


The relation between the acting self and object self is mediated via the semeiotic categorization of physical chains  $Q$  that link organisms and evaluations. This corresponds to the distinction between decision and experience utility and the involved feedback loops that ultimately select action patterns. So, for example, the organism is in need of nutrients, and the object self evaluates certain intakes according to certain criteria, such as the most simple one, distinguishing between hunger and satiation, and distinguishing according to tastes. However, the selection of those action patterns works via the acting self. The acting self categorizes the different action patterns according to their semeiotic representation. This implies that the relation between acting self and object self is open and indeterminate to a certain degree. For example, choice among food items follows indirect features such as colour which might not directly reflect nutrition values, and, most basically, choice can even fail to meet the elementary target of satiation, thus ending up with overeating. Recently, economists have devoted substantial efforts to understand this process, because obesity is a major dysfunction in modern societies, and because the simple availability of information about appropriate nutrition does not help to solve that problem (Downs et al. 2009). Instead, there is increasing evidence that engineering the cues that guide eating behavior is a more successful strategy, recently dubbed ‘nudging’ (Thaler and Sunstein 2009; compare Wansink et al. 2009).

Let me therefore use the analysis of eating as a workhorse to further substantiate my argument. Food consumption is a multi-level process that involves many different kinds of organismic activities, reaching from closer-loop metabolic circuits to highest-level conscious choices. It is also a most fundamental human need, so there would be reasons to expect that over the course of evolution, information processing about food consumption would have been optimized. The basic structure follows the dualism between the ‘Wanting’ and the ‘Lik

ing' systems, as overviewed by Berridge (2009) (see also e.g. Finlayson et al. 2010). On the one hand, food consumption is regulated by general homeostatic mechanisms which indicate a state of well-being that results from food intake, such as satiation. There are special circuits for indicating satiation and others for the hedonic response. This Liking system differs fundamentally from the Wanting system which treats food as one item in the generalized set of rewards and which focuses on the mesolimbic dopamine circuits. The two systems interact in a twofold way. One is that the Wanting system is a separate source of rewards, as the perception of cues that indicate and accompany food raises the dopamine level. The other is that the Wanting system may change the sensitivity of the Liking system. Both processes can result into dysfunctions such as overeating, if the Wanting system starts to become partly independent from the Liking system. This can be basically conceived as a Pavlovian mechanism of reinforcement learning, such that certain cues of food availability become the main drivers of the actual behavior. In the case of food, this is most obvious from the role of visual and other additional sensory indicators accompanying food consumption. Thus, a dish that looks delicious can be a source of a double reward obtained from eating: Firstly, the food intake activates the homeostatic mechanisms that signal well-being, but second, the Wanting system may be especially activated by the sensory aspects of the food, which trigger an independent dopaminergic response and hence reward, which in turn might change the homeostatic mechanism. So, eating a delicious-looking food may result into eating more than required for satiation, even from the perspective of the object self. In the semeiotic framework, this example can be analyzed in the same way as the smoking example: Actual behavior results from the confluence of different causal forces, with the acting self operating partly independent from the object self because of the underlying fundamental information asymmetries.

The testing ground for this approach are the dysfunctions of the system. Thus, the theory of addiction is also workhorse for dual-selves approaches, and it obtains a central role in the theory of consumer choice if we consider the fact that the phenomenon of addiction grows out of the general process of habit formation, and that there is a broad range of phenomena that are purely cognitive. We can distinguish between two kinds of drugs (for a survey, see Lea and Webley 2006). A psychoactive drug, such as alcohol or heroine, creates a physiological dependency on the chemical substance that is involved in consumption. A cognitive drug does not create this kind of physiological dependency, because it relates to cognized causes exclusively, such as the addiction to computer games or compulsory collection of certain items. In the theory of cognitive drugs, it is regularly assumed that the cognitive drug exploits a pre-existing drive or instinct, but the induced behavior does not lead to its satisfaction. This fact explains the repetitive pattern in the addiction, because the failure of ultimate satisfaction drives the ongoing search for obtaining it.

Now, in recent research on addiction (summarized by Rangel and Bernheim 2004, or Camerer 2006) the hypothesis has been proposed that the dopaminergic circuits are involved not only in a simple way, as in many physiological drugs, such as cocaine, but also more generally. In fact, the involvement of the dopaminergic circuits is the unifying phenomenon in both kinds of addiction. This, again, relates with the distinction of acting self and object self. Presumably, one essential determinant of cognitive drug addiction is the activation of dopaminergic circuits which results if behavior is triggered by cues of the reward. For example, in gam

bling, the feeling of pleasure is caused by the fact that in most gambles, the impression is very often created that a player just missed the target by only a small deviation (for a recent survey of research on gambling, see Clark 2010). This small deviation is a cue that indicates rewards. This reinforces the gambling activity, possibly to a degree that the constant pursuit of a target which actually is mostly missed creates an independent source of satisfaction, which results from the increased levels of dopamine. In other, almost paradoxical words, a gambling addict does not enjoy the gains, but the recurrent small deviations from gains. The acting self relentlessly pursues the signs of gains, but the object self suffers losses over losses.

This approach to addiction can be easily fit into the semeiotic framework, which also allows to explain why all kinds of actions can become a generator of addictive behavior (actually, Ascoli and McCabe 2006 make the important point that all scarce goods can become the object of addiction, given the necessary involvement of dopaminergic circuits in aiming at obtaining scarce goods). This always happens if, for some individual reason, the acting self starts to operate autonomously from the object self, such that the underlying dopaminergic circuits also become partly decoupled, and hence an independent source of satisfaction. In this perspective, cognitive drugs amount to the pure consumption of signs, undergirded by a peculiar selection of mechanisms  $Q$ . An excellent example for this distinction between the consumption of signs of goods as compared to the consumption of goods, hence also the distinction between object self and acting self, are the eating disorders, again. Compulsory eating of sweets does not result into the fulfilment of nutritional functions, but even ends up in organismic dysfunctions, and in many cases also with less perceived well-being. So it can involve a stark contrast between experience and decision utility, as frequently the individual feels very bad after the action, and even tries to restore the original state by forceful action, such as by means of vomiting. So, the choices of the acting self are virtually decoupled from the object self, which also implies the distinction between the good and the sign of the good. In compulsory eating, the individual actually consumes the signs of goods, and the accompanying temporary feeling of satisfaction results from the activation of the underlying dopaminergic circuits.

It is important to realize that the signs themselves are not human universals. This is why we need semeiotic analysis to fully understand human eating habits. So, the view of chicken feet may trigger craving for food with Chinese, but may appear to be repulsive for most Western Europeans. This observation has a very important consequence that we will analyze in more detail in the next section: Eating behavior is based on customary behavior the basis of which is partly externalized in the material environment. Cultural conditioning of eating does not mean that individuals have internalized values of preferences, but is in fact a co-evolution of environmental features and a generalized reward processing mechanism in a dual-selves structure. So, the acting self appears to have a different reach than the object self: Whereas the latter is clearly confined to the borders of the organism, the acting self is a conjunction between internal psychoneural structures and external artefacts. This differs fundamentally from the standard economic model, in which observed behavior is seen as the expression of individual preferences. The 'logic' of revealed preferences rests upon causal structures that transcend the individual.

## 4 Dual selves and signal selection in social networks

### 4.1 The pivotal role of imitation in the dual selves model

I will now turn to the question how to relate the dual selves model with the theory of networks. Again, I start out from some principled observations. The first picks up the problem of internal asymmetric information, again. If the acting self is incompletely informed about the object self, information about the object self partly becomes externalized in the very actions themselves and their consequences. In other words, the cognitive process becomes externalized in the sense that the behavioral outputs also carry information about the underlying preferences, insofar as the action consequences also include the effects on the object self. So, the acting self may choose to indulge into eating more sweets, but observes bad after-effects. These bad after-effects are external sources of information about the object self for the acting self.

This notion of the interdependence between preferences and external behavior is nothing entirely new to economics, since Becker's (1996) human capital theory of consumption manifests this feature, though not emphasized in the same way, as there is still the hypothesis of a set of underlying, stable and coherent preferences. However, the principle appears to be the same: Somebody who learns to ski is able to enjoy that activity much better after becoming a well-trained person. Now, how can she know this in advance? While learning to ski, the experience does not produce much pleasure and might even cause some pain. So, the sources of the information about the preferences mainly lie outside the individual. Firstly, she observes others who enjoy skiing, and adopts the belief that, for her, the pleasure will be similar, and secondly, after obtaining the pertinent skills, she knows that she loves skiing. In both senses we can say that the process is to a large degree externalized, with the preferences co-evolving with the actions. Once a pattern is established, we are not justified to state that somebody who loves skiing, loves skiing more than ice-scating, if he never learned the latter. In this case, the revealed preference approach does not hold, because we cannot compare the two activities on the same hypothetical level of skills. Revealed preferences actually refer to path-dependent outcomes of processes of preference formation in particular learning environments (or, in the Beckerian sense, dependent on the structure of the human capital accumulated). So, we apply the methodology of the standard revealed preference model on the relation between acting self and object self, with the acting self obtaining the position of the external observer in the standard use of the theory. In other words, the strength of the revealed preference approach in economics results from the hitherto overlooked fact that this describes an essential feature about the dynamic relation between acting self and object self. We can even say that revealed preferences, as an equilibrium notion, correspond to the Peircian notion of dynamical objects approaching a state in which they relate to a final interpretant, i.e. the state in which all relevant information, with reference to the general purpose  $P$ , has been generated.

In the semeiotic model, this introduces a dynamic component into the relation between acting self and object self, because the process of learning means that the relation  $O-Q-R$  is changing

according to the course of decisions taken by the acting self (e.g. adopting better skills in skiing). This observation allows introducing the dimension of networks, because we recognize the social nature of the signs involved in the decisions of the acting self. Following the private language argument by Wittgenstein (1958) (for an overview, see Candlish 2004), languages cannot be private in principle, because meaning cannot be fixed solipsistically. Regarding signs, this may only apply for conventional signs on first sight, but in fact is relevant for all signs, because the evolution of signs is a population level phenomenon.

Indeed, so far we have implicitly argued on the population level because we are using the concept of selection. Selection only operates on the population level, because it operates on a larger number of variants. This implies, however, that the signals that emerge in this process are population level signs, too. The stability of the signs in the internal processing of the mind/brain depends on the recurrent selective processes on the population level (for an early affirmation of this insight, see Edelman 1987: 308ff.). In other words, signs cannot have internal individual meanings, but only have a function, which is embedded into a pattern of sign uses in a population of sign users. This pattern of sign uses establishes the meaning of the signs, in the sense of Wittgenstein's (meaning as rule following, for a survey, see Lycan 1999). So, ultimately signs are artefacts that are external to the individual, even though their functioning depends on the internal neuronal processes (cf. Auger 2002: 276ff.).

Now, looking at the population level, we can say that every behavioral pattern, or, most generally speaking, trait, is a sign, at least in the sense of being interpretable in terms of information extraction. If a dog bites me, this is a physical fact. But it is also a sign: I might conclude that the dog does not fear me, because it dares to bite me, or may conclude that the dog is scared of me, and takes desparate action. Now, this sort of information is environmental information in the sense that it is not embedded into a sender receiver relation but only depends on the interpretive activity of the receiver (Floridi 2003, 2007). If we consider evolutionary processes, however, we can always assume that such interpretive processes exert a feedback to the original carrier of the information, because all biological processes are embedded into a web of interactions, direct or indirect, since the changes in the interpreting system necessarily imply changes in the selective environment of all other biological systems. So, all signs are embedded into larger 'systems of interpretance' (Salthe 2009), which specifically refers to the fact that the response to a sign is a sign to other processes in a network of interactions. So, for example, if I eat an apple because it is looking fresh and delicious, and I display the relevant behavioral cues, those cues make the information explicit to another observer interacting with me which is generated in the original semeiotic process. Signs relate with other signs, and semeiosis is actually an infinite networked process (about infinite semeiosis, see Atkin 2009). Especially, this includes the possibility that follow-up signs also establish a feedback with the original process, as when I observe my companion to bite into another apple of the same sort, after her having observed my action.

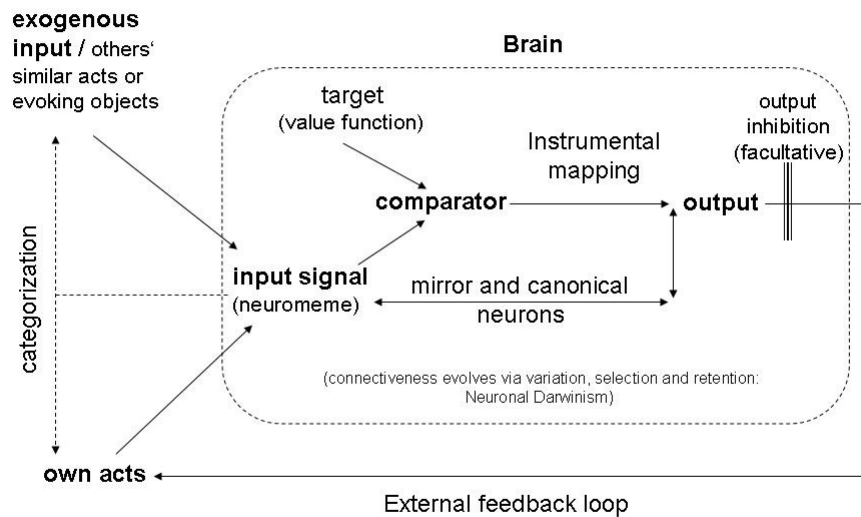
From this follows that signal selection is a most universal feature of evolution: Signal selection is the dynamical process driving the evolution of signs in populations of sign users who interact, thus constitute a network. Looking at sign systems in particular species, like homo sapiens, the signs play a central role in behavioral coordination, independent from the process

of intentionally communicating information. A bodily feature is determined by genetic and ontogenetic factors so cannot be changed intentionally. Still, it is a sign that can be interpreted by others. In fact, evolution has even resulted into many signs that cannot be controlled as a means of communication, such as body language that reveals lies (Ekman 1985), but that can be 'read' by others, possibly also without intention. This fact is exploited in research, when unintended body signals serve to identify the state of well-being, i.e. states of the object self, for instance, in eating (Berridge 2009).

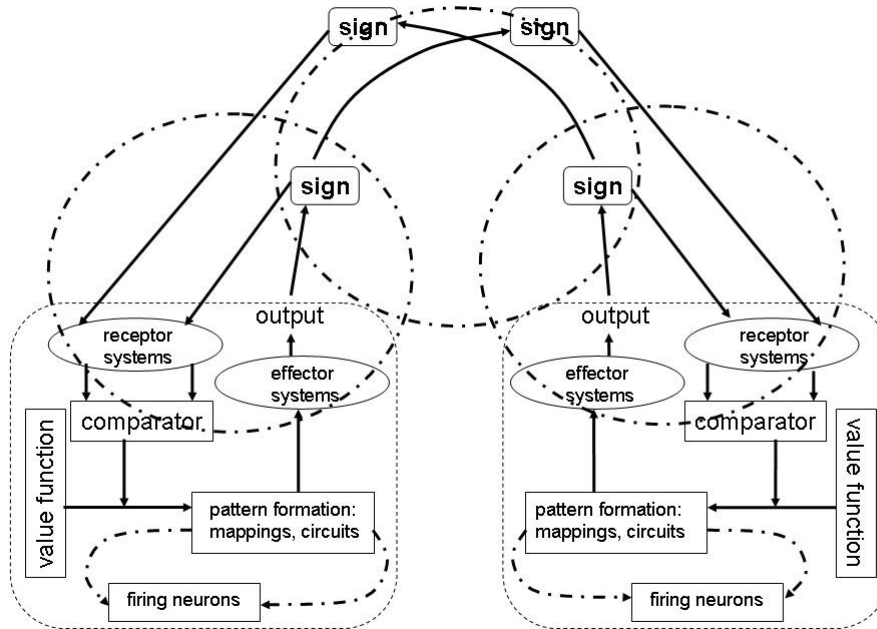
The central mechanism in signal selection is imitation. I posit that imitation is a central feature of the dual-selves model, as far as the dynamics of preference formation is concerned (on the general and unique role of imitation in human behavior, and also related to the brain sciences, see Tomasello 2008). Interestingly, imitation is also a centerpiece in economic theories about competition, and especially in Hayek's approach there is a direct link with his theory of the brain (Basso et al. 2010). Given the internal information asymmetries, the acting self retrieves information about optimal choices from the behavior of others. Imitation is a complex mechanism, and one neuroscience model has been presented by Hurley (2008). In this model, the core process in imitation is the comparison between own observed behavioral outputs and observed behaviors of others, which happens on every level of behavioral complexity, beginning with the mutual observation and imitation of body movements (Oullier and Kelso 2009). Without going into the details here (see fig. 4), imitation is driven by recurrent spontaneous activities of neurons which compete among each other for resources in the brain. The trajectory of imitation is driven by the internal selection processes that obey to certain value functions (such as the hedonic systems, which have deep phylogenetic roots) and the activity of mirror neurons which enable the individual to directly copy certain observed patterns in the environment, of which the own behavioral output is a part (so, for example, if somebody shows smiles when watching chicken feet, she will be able to emphasize this feeling; on empathy in general, see Singer and Lamm 2009, and on mirror systems Frith and Frith 2003, Arbib 2007, Frith and Singer 2008).



**Figure 4: A model of imitation (modified after Hurley 2008)**



In this process, cognitive categorization assumes a central role because this is necessary to be able to compare otherwise varying sensory inputs, especially when comparing own behavior and observed behaviors. At this point, I argue that semeiosis comes into play, again, because this categorization has to rely on signs. The emerging complex picture is overviewed in figure 5, which shows stylized patterns with two interacting brains, and simplifies fig. 4, as far as the part on imitation is concerned (basically, this kind of model corresponds to a 'social neuroeconomics' approach as outlined by Oullier, Kirman and Kelso 2008). There are three different functional circuits that underly imitation in the semeiotic view. One is the processes that lead towards pattern formation in the neuronal dynamics of the brain. Their main function is to achieve internal states of homeostasis, given energetic and other physical constraints on organismic functioning. The causal interaction with the external environment is mediated via two circuits which essentially involve signs. One circuit establishes a feedback mechanism between effector and receptor systems via the observation of own behavior, i.e. the output turned into a sign processed by receptor systems. So, even when I eat the delicious apple, I can also indirectly perceive the response of my face, i.e. the smile. The same sign is also a sign that can be perceived by Alter.

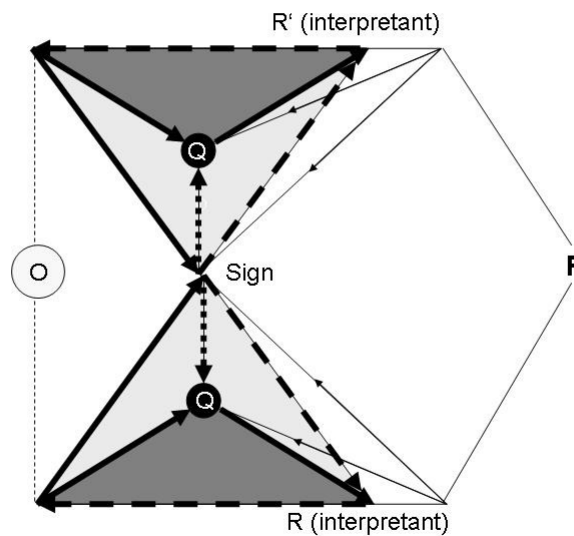
**Fig. 5: Imitation mediated via semeiosis**


The perception of the same sign by Alter introduces the possibility of comparing two signs, namely Ego's output and Alter's output, which both are processed in the receptor systems. These two signs are classified in the system of neuronal categorization. This classification essentially depends on the third circuit, in which the population level patterns of sign use are established. These are, in the Wittgensteinian sense, the rules of sign use, such as, showing a smile when eating a delicious apple. This relation is arbitrary to a large extent, as the huge variety of culinary standards in humans reveals. Whether chicken feet cause a smile, does not primarily depend on the direct nutritional value of chicken feet, but on the population level results of semeiosis.

Therefore, I draw the conclusion that the picture of semeiosis sketched so far is essentially incomplete. A full view of the conceptual framework always needs to focus on the conjunction of two semeiotic processes distributed over two individuals, as the minimal unit (fig. 6). The two individuals form part of a population, with the demarcation of the population referring to the common impact of the same selective environment. This is shown by the twofold convergence first, on the same object, and second on the same general purpose  $P$ . Correspondingly, the results of semeiosis are population level phenomena, conventionally referred to as 'cultural' phenomena. For example, in eating habits, there is a strong linkage between certain environments and the customs of the population living in that environment. In biology,

this has been called the process of niche construction, especially also cultural niche construction (Odling-Smee et al. 2003). Hence, a niche is a semeiotically intermediated environment.

**Fig. 6: Social semeiosis**



The physical entity that establishes the coordination between those two poles is the sign. The sign is external to the individuals as it is a publicly observable physical process in the population of sign users. The sign is the ‘same’, insofar it relates with same objects and environments in the usage patterns, but it is also different, insofar as the internal processes of linking objects and responses manifest variety, for purely physical reasons, again (e.g. random variation in  $Q$ ). This variety feeds the selective process on the population level, and is also observable in terms of individual behavioral variants in reacting towards the same object, though relying on the same set of signs. So, functional varieties in semeiosis establish differences in interpretation, hence ‘meaning’, across different members in a population.

Now, a central issue emerging from this discussion is how semeiosis that is driven by population level phenomena is contributing to proper functioning on the individual level. In most general terms, this can be stated as the question whether the information processed is truthful or not, in the sense of eliciting behavior that is adaptative, given the general purpose  $P$ , and hence guided by correct representations of the environment.

At least as far as the fundamental process of imitation is concerned, the truthfulness of the information is assessed by the simple fact of its spread within a population, including the pos

sible impact of status (these mechanisms have been extensively explored in the theory about cultural transmission, as in Boyd and Richerson 1985, Richerson and Boyd 2005). In any case, this turns the information process frequency-dependent, which also implies that there is the possibility of errors produced by the endogenous dynamics. This is highly important in the dual selves model, because if we talk about imitation, this only relates to the acting self. So, the social nature of semeiosis finds expression on this level, and excludes the object self. From this follows that there is the possibility that a collective process of semeiotically intermediated choices of acting selves may lead towards states of object selves which are not desirable, but neither the acting selves recognize this directly, nor is there any mechanism how to identify this collectively shared state of object selves (this mechanism would closely follow the theory of information cascades, see Bikhchandani et al. 1992, 1996; for a related neuroscience view see Baddeley 2010). This view has to be neatly distinguished from theories about the tyranny of the majority, because in the dual selves model we assume that there is a fundamental information gap between the acting and the object self (e.g. in Kuran's, 1996, model, the agents know their private preferences if they act according to public preferences, so privately, acting and object self are fused).

## **4.2 Signal selection, the handicap principle and status orders in consumption**

So, once we have introduced the role of imitation in networks of interaction between brains, the problem emerges how the information processed via signs can be truthful, i.e. carries information. There is the possibility of error, i.e. misinterpreting signs, and the possibility of cheating, i.e. manipulating signs. Cheating does not imply intentionality, as mimetic phenomena can emerge from any sort of evolutionary process under selection, which might distort information (such as mimicry). So, if we assume that the capacity for detecting truthful information is selected positively in evolution, we can, in principle, identify certain features of this capacity.

Biology and economics strongly converge in the second fundamental feature of signal selection. This starts out from the arbitrary nature of signs, as long as they are cheap to produce. In this case, signs may evolve (intentionally or via selection) that transfer false information, because the opportunity costs in the selection process are low. This induces capacities how to distinguish false from true information, and a most reliable mechanism is to assess the costs of signs. Costly signs are truthful, because they come at a loss, so that the assumption holds, that they contribute positively to the overall performance. This has been called the 'handicap principle' (Zahavi and Zahavi 1996), which is actually a corollary to the 'Red Queen Principle' (Robson 2005). Whereas the Red Queen principle describes the endogenous growth of complexity that results from the 'arms race' in information processing in the course of evolution, the 'handicap principle' can explain why in the long run truthful information emerges (Grafen 1990). Clearly, this also feeds back to the original role of imitation as a strategy of learning. Imitation would only be favoured by selection, if the adopted behavior is beneficial,

in the long run. Hence, the information transmitted by imitation has to be truthful; otherwise imitation would not have persisted in evolution (on the optimality of imitation, see Rendell et al. 2010).

However, in our context there is an additional problem. This is that the production of signs does not take place only on the side of the sender, but, in the case of environmental information, is only connected with the receiver. So, the costs of producing the signal are on the receiver side, strictly speaking. This implies firstly, that receivers of that signal can in turn evaluate these costs, which are not directly related with the source of the information. However, in the evolutionary process there is a feedback mechanism working via the Red Queen effect. If costly information processing on the receiver side turns into adaptive headstarts as compared to the carrier of the signs, there are pressures towards evolving signals that work to the advantage of the latter. This starts the process which ultimately would also follow the handicap principle, that is, triggering costly signalling on the sender side. Secondly, given the fundamental division between acting and object self, the handicap principle will also apply for the internal relations between the selves, insofar as the use of signs implies certain states of the object self which are not directly accessible to the acting self. To go back to the example of skiing: If I have to invest much effort into learning to ski, this is a sign that skiing is truly great fun, because the costs of learning it are incurred, since the costs of learning are expended by the object self. So, learning costs become an internal signal for the acting self that skiing is great fun. In the process of imitation, and totally independent from strategic interaction, the value of a signal becomes dependent on the perceived costs of producing it.

From this we can reach a fundamental conclusion. On the population level, semeiosis will always manifest the working of the handicap principle in signal selection, which induces physical mechanisms resulting into costs of semeiosis that in turn operate as signs that hook up on the original sign. Thus, semeiosis features an endogenous force of growing complexity by means of evolving semeiotic chains, which is itself subject to selection, because it consumes resources.

These considerations straightforwardly apply on the problem of consumer choice. Every good divides into the good and the sign of the good, with the sign embedded into a population level process of signal selection. Further, actions on goods are also signs. Thus, an apple is a good with a certain nutritional value, and an <apple> is a sign of an apple, or biting into an apple can be a sign. The sign carries information about the apple, which differs from the actual physical processes that occur when eating the apple. On the population level, these signs evolve. For example, a convention about certain colours of apples might emerge that transmits certain information, which might even diverge from the actual physical processes. So, for example, a beautiful apple might be much less tasty and with less vitamins than an ugly-looking apple, even systematically. In the process of imitation, Alters' choices of green apples influence Ego's choices, too. In this situation, costs may emerge as a signal. The most straightforward indicator of costs is the price. So, consumers might consider that the expensive green apple is better than the ugly one, because it is more costly. For example, they might consider this as a signal that the true costs of producing the apple were much higher, which

might have translated into higher quality, or they might think that the price signals strong demand and therefore high quality in the eyes of the majority of the population of apple-eaters.

The central insight is that consumer choice is inherently a networked process, even in the case of simple goods such as food, because of the internal division between acting self and object self. If we link back this insight with the triadic framework, we recognize that two dimensions are missing in the traditional approach. One is the role of signs in the partitioning of markets and corresponding goods, which reflects the role of formal causality, and the other is the role of social selection, which reflects the role of final causality. The former grasps the interaction between meaning and function, the latter the social dynamics of choice. This social dynamics of choice is driven by the force of imitation, and this in turn shows the features of signal selection.

In the context of markets for consumer goods, the notion corresponding to the handicap principle is the role of status signals (as analyzed by Podolny 1993, 2005). In elaborating on this, it is most straightforward to point out the differences between the semeiotic framework and the standard approaches to information economics. The standard approach only concentrates on the transaction cost saving role of signals, and their role in overcoming strategic conflicts. In comparison, the status approach recognizes two additional problems. One is to assess the quality of signs, and the other is to recognize that once a certain reputation has been established, this also changes the underlying profile of costs. That is, a high status producer does not only signal high quality by incurring higher costs, but in fact it can also produce any level of quality at relatively lower cost than the low status producer (this phenomenon is also recognized in the biological literature on the handicap principle, see Grafen 1990). The reason is that the higher status allows for lower procurement costs, for instance. However, this means that status endogenizes the cost profiles even to the extent that status may become the determining feature: Any company might attain that position, because it will attain the cost advantages, once status is established. Finally, status, once a status hierarchy is established, is a sign that cannot be mixed with other signs. So, a high status producer cannot produce low-quality goods even if it could also be successful in terms of profit. The low-quality good is a signal of low status. From this follows a partitioning of markets into different segments, which are mostly reflected in brand distinctions.

The status order of the market is a direct reflection of the handicap principle in signal selection and hence concomitant to the role of imitation in naturalized semeiosis. This has been recognized for long in anthropological theories which assign a special role to individuals with status in the dissemination of cultural phenomena, resulting into certain biases as compared with a purely random process (Boyd and Richerson 1985, Bentley and Shennan 2003). In the semeiotic view, the role of status is ultimately rooted in the dual selves model, as status also overcomes the information gap between the acting and the object selves. In consuming goods with a certain status, the acting self actually follows the hypothesis that this good also fulfills the needs of the object self especially well. So, the emergence of status orders bridges both the external and the internal information asymmetries.

So, in the dual selves approach status signals on markets for consumer goods are direct expressions of the more fundamental dual selves model in the context of social networks that mediate semeiosis. Status signals can be very diverse, but in many cases also simply refer to the good itself, without further differentiation. A Louis Vitton bag is a Louis Vitton bag; the good is the sign <good>.

## 5 Conclusion

In this paper I have introduced basic notions of Peircian semeiotics into the analysis of individual choice. The analysis results into a radical departure of the standard economic model, but maintains important principles of economic analysis, especially with reference to the economics that shapes selection, and because semeiosis is seen as a physical, and hence resource-consuming process.

The basic semeiotic model implies a move from a dyadic to a triadic conceptual structure. Traditionally, economics is put into a dyadic framework (supply and demand, or individual and good etc.). Triadism implies two foundational changes. One is that all causal interactions between an object (the ‘good’) and the response or interpretant (the ‘individual’) are running via two channels, namely the direct physical causation of the response, and the intermediation via a sign relation (<good>). Semeiosis emerges from the process of internal categorization of causal neuronal chains in an evolutionary setting, i.e. selection. In this view, meaning supervenes on a complex process that involves three distinct causal mechanisms, efficient, final and formal. I have shown that the transition to triadism has direct consequences for the analysis of the individual: The individual can no longer be described in terms of observed behavior that can be cast into a set of revealed preferences, but according to the dual selves model, with acting self and object self. For this distinction we can harness strong empirical support by psychology and neuroscience.

In the dual selves approach, the information asymmetry between acting self and object self is a core feature. This implies a far-reaching externalization of information processing on part of the acting self, in the sense of recent theories on distributed cognition. The concrete structural form of this externalization are networks of interaction between individuals, the related process is imitation. So, the dual selves model matches with recent research about the ubiquity of imitation in human behavior. Further, I can show that imitation, subject to evolutionary forces, implies the working of the handicap principle in signal selection. On consumer goods markets, the handicap principle is expressed in the role of status signals in market segmentation and consumer choices.

Dual selves and networks provide the ontological foundation for the fusion of meaning and function in the analysis of choice. This is most evident in considering the empirical workhorse

in my argument, food consumption. We can offer a solution to the old controversy between Sahlins (1976) and Harris (1979) about the cultural role of the steak in American society. Sahlins argued that beef consumption is ultimately a cultural category in North America, hence driven by meaning, not by purely functional criteria (nutritional value etc.), whereas Harris pointed out that beef consumption is a part of an ecological-functional system. From the Peircian view, both positions have their own right, if we clearly distinguish between beef and <beef>. The function of eating beef is deeply enmeshed with the signs that accompany beef consumption, and both co-evolved in a particular historical process under particular conditions of multi-level selection. The two anthropologists just got stuck in the straits of the dyadic model. The triadic framework allows for a much richer understanding of the relation between meaning and function, and therefore also of the creative process involved in consumer choice. Preferences are not a given, but emerge from learning, which is non-Bayesian but semeiotic in nature, that is, it pursues a moving target, which is determined by the endogenous dynamics of semeiosis that connects the individual and the population level.



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