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Meaning in the Mind: A contrastive comparison between the role of semantics in the Language of Thought theory and Connectionism

KAROL NATALY ZAMBRANO
PhD Scholar, School of Foreign Languages
Shanghai University, China

Abstract

Two of the most relevant characteristics of language are its referential dimension and its compositional nature. Language, generally speaking, is the product of the grouping of signs which find their reference in the physical world and have a meaning by themselves and in combination. The study of the meaning of these linguistic signs or forms related to the states of the world and to mental representations is what we called semantics (in a narrow definition). Semantics in natural languages have been largely proved as part of the quintessence of human communication. But, what about the language inside our mind? How can the mind have semantics? And, if the mind has one, how does it work? Is it realized by a similar way to how it is done in natural languages? The aim of the present paper is to briefly guide the reader to possible answers to these questions and to some others that may appear along the discussion as it builds upon the contrastive notions of Language of Thought (LT) and Connectionism (CN) theories, as well as in some foundational concepts of Cognitive Sciences (CS) found principally in the articles by Fodor (1980), Crane (1990) and Ulbaek (1998). In order to accomplish this goal the present document will be divided into three main parts. In the first part, the conception of semantics in the Language of Thought (LT) will be presented. In the second part, the realization of meaning according to Connectionism (CN) will be discussed. Finally, in the third part, some contrastive arguments from both theories will be used to draw a personal conclusion.

Keywords: Meaning, mind, Language of Thought, Connectionism, Cognitive sciences, semantics, syntax.

INTRODUCTION

Semantics, in general, is the study of the meaning in language. It comes from the Greek root *sēme* which means "sign" and "to signify" (Lyons 1968:400). Thus, semantics, in linguistics, is the study of the meaning of the signs that are encoded through language and their signification when isolated or clustered in a given context. For instance, *lexical semantics* is concerned with the meanings of words and the meaning of the relationships among those

words while *phrasal semantics* is concerned with the meaning of syntactic units larger than the word. Altogether, semantics is concerned with relations between words and things, therefore, semantics is at least "partly a matter of reference" (Crane, 1990). This reference is made in relation with the physical world (in a sense or another) and it is constructed in a compositional way (the meaning of a structure depends on the meaning of its units) (Frege's principle of compositionality).

When we analyze a natural language, a reference is an apparent relation between a word and the world. Although sometimes words pair a specific reference, two sentences can express different propositions while having the same truth value as the meaning of a sentence is not only determined by its reference but also by its content. Thus, some content may have different references and the same reference may differ in content (Semantic theory of reference). Moreover, to complicate this matter further, there are expressions that apparently refer to nothing in the physical world, namely, *unicorn*, and some others that might have a reference but not a context, namely, *Socrates*. So, although there is a certain relationship between linguistic signs and objects or realities in the physical world, this relationship is not always crystal-clear. This is the reason why linguistic symbols should be considered as *arbitrary* rather than *natural*. Hence, if we agree that language is made of conventions stem from shared beliefs in order to communicate, it should be plain that it is the belief of the users that determine how the words are used; so "the meaning of a word is constituted by the use to which it is put" (Wittgenstein, 1953:432 in Crane, 1990) or is the result of "the intentional states of the user of the word" (Grice, 1957: Bennet 1976 in Crane, 1990). This is due to the language proper function of communicating and sharing information (Ulbaek, 1998). But what about thoughts? If there is a LT then symbols could not be arbitrary because sentences in LT do not have to be understood (Crane, 1990). If there is not a LT, how does the mind convey meaning between itself in thinking processes?

On the other hand, language is undeniably *compositional* or *generative*, in the words of Chomsky (1965). He compares the emergence of language with the formation of a crystal: from a finite number of primitive units and their combinations according to certain rules, an infinity of complex structures are formed (Chomsky, 1965). This is the reason why, to study its nature, language should be considered as a system of representations consisting of expressions belonging to a generated set. Moreover, the meaning of each linguistic unit is not given in a serial way. In other words, normally, a lexical item must make approximately the same semantic contribution to each expression in which it occurs (Crane, 1990). For instance, insofar as *"the" "woman" "loves*" "*Michael*" make the same semantic contribution to "*The woman loves Michael"* that they make to "*Michael loves*

the woman". Nonetheless, with a further analysis, it is possible to realize that this may be encountered only if the semantical properties of the shared constituents are context-independent (Crane, 1990). Hence, compound words and idioms don't have their meaning constituted on each of their parts; it is rather given by the use of speakers and the context. For example, in idioms such as "*the man kicked the bucket"* , the meaning of the whole structure is not given by the meaning of its parts, namely, the meaning of "*kick"* or "*bucket"* , which individual meanings differ largely from the general idea they transmit in this context. The same problem is accounted for compound words like "*blackbird"* where it may refer to a specific kind of bird but not specifically of black color as "*black"* in this case doesn't mean the color for it has neither category nor meaning; it is a bare morphophonological shape (Aronoff, Mark and Janie Rees-Miller, 2002). That is why, at the end, linguistic elements acquire their final meaning depending on the units they are accompanied by and the nature of the relations among them.

Conversely, although it might be possible to find a parallel between the compositional nature of syntax and semantics in a sentence, it is rarely the case. For instance, let us consider the syntactic conjunctive structure in English of S1 and S2 as in:

1. Jake ate a sandwich and Kate ate a sandwich.
2. Kate ate a sandwich.

In this example (1) involves (2) semantically. Hence, the sense of (2) is preserved. And, syntactically speaking, (2) is a constituent of (1). This model would show a language where the syntax of a formula encodes its meaning. Unfortunately, this kind of language doesn't correspond one hundred percent to any natural language of the world. Even though English may have some of these parallel structures, this is not a uniform characteristic of English language. Back to the previous example, we might consider other similar conjunctive structures:

3. Jake and Kate are friends.

   A*Jake are friends- b*Kate are friends
4. The painting is green, blue and white.

   A*the painting is green- b*the painting is blue- c*the painting is white

Here, it is clear that (3) and (4) derived forms (a) (b) (c) don't correspond semantically to their original structure. What is more, some grammatical mistakes are made when trying to decompose the original sentences into similar constituents, as in 3(a) and 3(b).

Through this analysis, it may be accurate to make two assumptions. First, English is not idealistically parallel in its syntactical and semantical structures (as some would claim as a main characteristic of the nature of a

LT). Second, the relation between syntax and semantics might be depicted in a possible LT rather than in logical languages.

The Language of Thought

Throughout history, many philosophers have surmised that being in a mind state might be related to having a sentence in a mental language (Crane, 1990). The American philosopher Jerry Fodor (1935) was the creator of the formal *Language of Thought* theory which describes the nature of thought as possessing language-like or compositional syntactical and semantical structures. On his view, simple concepts combine in systematic ways to build up thought. On the other hand, Stephen Stich (1943), professor of cognitive sciences at Rutgers University, think that there are good reasons to think of the mind as a syntactic engine; although he abandons the idea of a semantic engine. Besides that, a great number of classical psychologists appeal to a possible language of the mind to explain three closely related features of cognition: its productivity, its compositionality and its inferential reference. This traditional assumption derives from the fact that features of cognition are both ruling and explicable only on the basis of mental representations possessing an internal structure (Fodor, 1988). But, why should we apply linguistic notions to the mind? There are many non-linguistic ways in which many aspects of the world are represented, namely, the different color of leaves when changing from one season to another and the rings on a tree's trunk which indicate its age. Besides that, the idea of a language of thought similar to natural languages still seems utterly incredible for some scholars who think of this theory as mere speculation (Churchland 1981; Blackborn, 1984; Schier, 1986; Dennet, 1997).

Nonetheless, according to Fodor (1988) there are three main reasons for considering the validity and relevance of the LT theory. The first one is that LT seems to be helpful for understanding cognitive processes. Cognitive science "needs the picture of the mind as a syntax-driven machine" (Fodor, 1985:93). An LT model appears to be a demonstration that an adequate cognitive theory must recognize not only causal relationships among the mental states, but also their syntactical and semantical relations of constituency; as the mind, in general, could not be merely a Connectionist network (Fodor, 1988). After thirty years, this argument is still intact (Crane, 1990).

The second reason for the importance of LT theory is that it allows linguistics to explain how mental processes such as inference work. For instance, the belief "if *p then q"* is the sum of the belief that "*p"* leads to the believe that *"q"*, then it results in *"if p then q", "p" and "q"*. This example shows the logical relation of entailment as being mirrored by a causal relation between token sentences; for mental processes are causal sequences of token

in of mental representation (Fodor, 1987:17). However, LT doesn't claim that the mental sentence is the content of the intentional state. It rather says that this sentence has a content, as natural language do. Whenever anyone believes, desires or hopes something there is a *p* written in the head of the thinker. But how is it written? As computers, mind transforms sentences into patterns of electrical impulses. In LT sentences can be stored in the electrochemical states of the brain (Fodor, 1988).

Finally, only by a representative system with the characteristics of LT we can explain the intentionality of thought from a physicalist point of view. According to physicalists, to take the ascriptions or beliefs of speakers to be literally true or false, we should have a materialistic adequate way of accounting for their truth values. Thus, sentences in a system of internal structures provide a concrete physical structure of the organism for a token sentence might be considered as a concrete object that can have causes and effects (Fodor, 1988). In other words, symbol structures are assumed to correspond to real physical structures in the brain and the combinatorial structure of a representation is entailed to have a counterpart in structural relations among physical properties of the brain (Crane, 1990). The machines which transform these symbols are sensitive to the syntactical structure of the symbols they operate upon. Hence, LT assumes that syntactic relations can be made to parallel semantic relations.

Semantics in LT

If there is a language of thought it must have semantics as well as syntax. If sentences processing is similar to computational processes then LT must have a syntactic structure as in natural languages, and something with a structure must have a content. How could we explain linguistic behavior if it leaves no place for the idea of content in any explanation of the mind? Linguistic behavior, therefore, must be explained in terms of meaning, semantics. Syntax explains how the semantics of the symbols in the LT are relevant to a theory of intentional states, principally, to inference and behavior. Thus, syntax does not replace semantics, it vindicates it.

According to LT theory, speakers don't have an attitude with a particular content, they rather have a particular attitude to a content which means that we put each sentences in the right box of meaning depending on our attitude towards that sentence. To represent this content, it is needed a "casual surrogate", an intrinsic property of a thinker that will produce the appropriate effects when that thinker is in a state with that content. These surrogates are the sentences. They interact in a way that mirrors the logical interactions of the content. If the sentences play a role in the causal structure of the mind, then the famous Bretonn's problem of whether all intentional

phenomena can be accounted for in terms of a materialistic ontology might be solved.

Although the semantics of the mind might look similar to the semantics of languages in these aspects, there are some characteristics of the meaning in natural language which could not apply to symbols in the brain.

Arbitrariness

Most of the symbols that are found in natural languages are created arbitrarily. This is evident when we realize that, in most of the cases, symbols don't have any natural or clear relation with the object or concept they represent. For instance, what is the relation between the word "*tree"* and a tree itself? Hence, we must agree on that meaning is a matter of convention. The meaning of a word is constituted by the shared beliefs of speakers and their use of symbols in certain contexts. This is how mutual understanding can take place in communication. Nonetheless, if symbols in natural languages are mostly conventional, LT symbols cannot share this characteristic. They cannot be arbitrary as sentences in L1 do not have to be understood. Concerning languages, what you cannot be understood, it cannot be learned. So "if LT is not understood, it is not learned either", therefore, it means that LT is innate (Fodor, 1988).

Compositionality

According to Fodor (1988) "what makes thought like language is its compositional structure" (p 138). Previously, in the introduction of this paper, through the analysis of compositionality in natural languages, it was found that any natural language depicts a perfect relation between syntactic and semantic structures. This is because meaning is not transferred totally in accordance with a specific syntactical structure as there are many possible syntactical configurations to convey a specific meaning. Thus, syntax in logical languages is ambiguous; not in thought, though. LT sentences cannot be ambiguous since then it would be required to have a "lower" level of thought to provide disambiguation" (Fodor, 1988:9). Therefore, syntax in LT might operate in parallel with semantic content and it might supervene on shape; there would be no difference in syntax without a difference in shape. The sentences in LT must have their causes and effects "in virtue of their intrinsic properties" (Fodor, 1988) and then, "since there is no difference in syntax without a difference in shape, the syntax of the LT is actually the causal mechanism for the interactions of internal states" (Pylyshyn, 1984:39). In order to illustrate the previous point, let us consider the mind as a machine similar to a tape recorder on which expressions are written. So whenever a token of the form P & Q is presented, the form *P* appears. Then, in an

inference process whenever a form P & Q is ascribed, it will cause a tokening of the type P and a tokening of the type Q. In other words, the objects to which the content P&Q is ascribed will literally contain the objects to which the content of its parts P and Q is ascribed. In conclusion, the semantics of an expression P&Q is determined in a uniformed way by the semantics of its constituents.

Connectionism

The connectionist theory is a "paradigm shift". In the last years, it has become more popular among scholars as it gives solace both to philosophers who think that the semantic notions of folk philosophy are a pseudo-science that leads to a computational cognitive approach (Churchland, 1981; Dennet, 1986), and to those who believe that cognition can only be understood in terms of neuroscience (Arbid, 1975; Sejnowsky, 1981).

On the other hand, connectionism is appealing as it proposes to design systems that can exhibit intelligence without storing, retrieving or operating on a structured symbolic system. According to the connectionist model, the mind works with networks consisting on a great amount of units (neurons) that are simple but highly interconnected. Each unit receives real-valued activity (excitatory, inhibitory or both) alone its input lines (dendrites), sums the activity and changes its state as function. Then each connection is allowed to modulate the activity which is transmitted as a function of an intrinsic property called its weight. Thus, the behavior of the network as a whole is a function of the initial state of the activity and the weight of its connections which serve as its only form of memory (Fodor, 1988).

Deriving from this main model, there are two sub-models which vary on the way they perceive the functioning and forming of the networks. The first sub-model is called *associated networks of propositions.* This model portrait the mind as a series of nodes (ideas) and links (connections) interconnected in a serial network. Mind works to encode (symbolize) incoming stimuli and then transforms them into internal mental representations that are stored in memory and are retrieved in remembering past occurrences and used to encode similar configurations of stimuli. This theory conceives different types of symbolic memory, being the propositional code the most important, as events are commonly translated into propositions or semantic descriptions. The propositions are formed by ideas (nodes) that are linked to constitute a network. When one node is activated by incoming stimuli, the activation spreads along the links to other nodes in the memory of the network; this is called *spreading activation* or recalling of ideas that are related. According to Sharon (2002), "the more we utilize particular pathways of association to recall and encode certain ideas together, the stronger the links between these notions become" (no page).

The second sub-model has been the representative model of connectionism in the last 25 to 30 years as it offers a new alternative computational perspective on memory. According to this theory, processes such as recognition, recalling, judgment and emotions require form multiple sub-symbolic unit to converge. A number of dispersed units are simultaneously activated or inhibit to form a recognizable pattern- a concept or a response. Different from the associated *networks of propositions* theory, this model conceives the memory processes to work parallel, not serial. That is to say that each unit doesn't have a solely function; instead, each memory unit contribute to form many different patterns and no single unit represents a specific concept or image. This conception of a parallel operation of the brain has become highly accepted and valued among many scholars since it constitutes "a conceptual bridge to the recent rise of constructivism and evolutionary theories of learning". (p 11)

Semantics in connectionism

Differently from the classical model where the operation of expressions depends upon the structure of these symbolic expressions, in connectionism, there is not structural relation that holds between the nodes- no parts, not a whole. Instead, intentional content will be assigned to a machine state and the nodes may just be labeled to indicate their representational content. However, these labels may have a combinatorial syntax and semantics but not the nodes themselves; as they don't have constituents, they cannot have semantically interpreted parts (Crane, 1990). This is the reason why syntax is not a determining part of the meaning in the connectionist theory for the operation of the labels doesn't make part of the analysis of connectionism.

Meaning is conceived, then, as the resulting mental representations made by the interconnection of the nodes and the deepening (memorizing) of those connections by the recalling of specific neural paths (networks).

CONCLUSION

Certainly, when we think we use language as a means. But, is our mind limited by language to communicate among itself? Or, is it language a capacity beyond what we have conceived it to be? The answer of these questions may give us more clues about the forming of meaning in the mind; no one has provided a final conception of these inquiries, thought. However, there are some important contributions for the understanding of the language in the mind provided by the classical model of LT as well as by the connectionist paradigm, for instance, the generative nature of language, its compositionality and its systematic but flexible operation. Undoubtedly, sentences are used to express thoughts, so, "if the ability to use some sentences is connected with the ability to use some others, semantically

related sentences, then the ability to think some thoughts must be connected with the ability to think certain others"(Fodor, 1988:30). This confirms the fact that, first, language as thought is generative (from a finite number of structures an infinite set of combinations can be produced), and, second, meaning plays a crucial part in the interconnecting of ideas to elaborate basic concepts into complex conceptions. Moreover, this assumption provides a proof of the mind operating in parallel rather than in a serial way. For if the ability to think certain thoughts is interconnected, then the corresponding representational capacities must be interconnected in a non-simple way. But, can we only think the thoughts that our mental representations can express?

Personally, I would say no. I dare to say that it is not possible to have syntax without semantics but it is possible to have semantics without the kind of syntax we are used to in our natural language, in a deeper conception. This is the reason why, in my opinion, the classical LT theory and the novel connectionist theory don't contradict each other. Actually , they both explain how the mind works in different levels, being the connectionist approach the deepest one, as it parts from the biological functioning of the brain, followed by the LT theory which explains how the labels of neurons create a structure to produce language (internal and external). This would confirm the assumption of the relevance of semantics over syntax since in the connectionist approach the structure doesn't play a dependent role in the constructing of meaning. Besides that as it has been already mentioned, there are several ways to communicate apart from natural language.

For instance, animals may be considered as thinking beings if we take for granted the *Peircian semiotic* concept of thinking as a "calculation across symbolic tokens or mental representations". Animals have this capacity, although some more than other. As an example, cognitive capacities such as problem-solving, organized knowledge, inference and learning through imitation have been proved to operate in apes (See Ulbaek, 1998; Tolman, 1933). However, although apes can encode mental content into physical tokens, they don't have the syntactic machinery for syntactic processes. So, if language developed from cognition the ape is the last common ancestor of men (Ulbak,1998) Thus, according to Ulbak, language at ancient times evolved thanks to the need of sharing information and the development of the functioning of communicating thoughts among other group members deliberately. This would show a possible cognitive pre-state of the mind without syntax. Connectionism, then, might be valid in the sense of giving us biological clues to understand the functioning of the mind from the very beginning, even before language as it is conceived now.

Nonetheless, not many people would agree on this view. For instance, Chomsky is opposed to give any fixed function to language and conceives the mind as a purely syntactical machine. Furthermore, this previous assumption

would contradict Saussure's perspective of the relation between language and the mind: "Without language, thought is a vague, uncharted nebula. There are not existing ideas, and nothing is distinct before the appearance of language" (Saussure, 1966:112). However, in the 21th century it is quite impossible to deny the founding of science about the neural network functioning and its relation with the evolutionary theories of the mind. These founding have proved that a cognitive pre-state of thinking without language is possible. Nevertheless, on the other hand, what makes us humans is, certainly, the capacity to reflect on language and to communicate complex thoughts to other, and this is possible to do thanks to the syntactical system of the mind. This evinces the relevance of the LT theory in understanding the functioning of this more superficial level of conception of thoughts as it provides a clear paradigm of analysis based on what we already know from natural languages operation. Without LT theory there is no way to study how language takes place in the mind and how ideas are interrelated semantically in the brain.

In conclusion, although there are still a lot of questions without a final answer, both LT theory and connectionism offer a different but not contradictory explanation of the functioning of the mind that may help us to pursue further research on the field as its complexity may require from researches to grasp answers from different perspectives and realms of knowledge.

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