

A semantics “outside language”: Operational Semantics

A new semantic theory, based on the nature and structure of thought

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Abstract

In this article, the author briefly introduces a new theory in Semantics, *Operational Semantics* (OS). OS deals with the meanings of all the *basic linguistic elements* that are indispensable for any linguistic expression, that is, mainly all the “grammatical” words (conjunctions, prepositions, articles, most pronouns and corresponding adjectives, fundamental verbs like “to be”, “to have” etc, the main adverbs) and, in the large number of languages that have a more or less rich morphology, almost all morphemes (the ones which indicate cases, in languages that have cases, the number and gender of nouns and adjectives, moods and tenses of verbs etc). The fundamental presupposition of OS is that the meanings of such linguistic elements are essentially sequences of elemental mental *operations*, amongst which the ones of attention play a key role. The author proposes a list of these elemental mental operations and shows how it is possible, by basing ourselves on these, to identify the meanings of the aforesaid linguistic elements. *A new linguistic theory*, dealing with the “deep” structure of language, derives from this. This theory also allows us to define the fundamental concepts of Linguistics (such as “noun”, “subject”, “object” etc) in a simple and clear way, propose new solutions for some other problems in Linguistics and Psycholinguistics, and open new research perspectives.

In the last part of the article, the author also mentions a possible short-term practical application of OS, i.e. a device to improve the quality of machine translation, and highlights the limits of OS.

Keywords

mind, mental operations, consciousness, attention, thought, language, Italian Operational School, operational semantics, linguistics, psycholinguistics, neurolinguistics, semantics, grammar, philosophy, cognitive psychology, neurobiology

Introduction

Among the various aspects of what we call “human consciousness” (Baars 1988; Bieri 1992; Chalmers 1996; Churchland, Sejnowski 1992; Damasio 1994; Dennett 1991; Edelman 1989, 1992; Searle 1984, 1994; Stich 1996; Zeman 2001), language has always been sensed as the most specifically human and the feature that places the human being in a different position from animals. This opinion is widely diffused even at a popular level. It has been repeatedly expressed at a philosophical (in this regard, Descartes is probably the most quoted philosopher) and scientific level as well. Various studies have been conducted on the communication and possible linguistic abilities of animals, both natural and induced. Some studies, especially those on the possibility of inducing a man-animal linguistic interaction, have given results considered positive by some, but contested by others. Nevertheless, the opinion that in the animal world there are many kinds of communication, even very ingenious ones, but that the human language has some features that make it an absolutely unique phenomenon, is widely diffused (Yule 1996).

Language has been studied from various points of view and its study has produced a great deal of results. Nevertheless, the most important (from a certain point of view) aspect of language, the “deep” one—Semantics—has proved to be the most problematic (Chomsky 1987, Bloomfield 1933, Lehmann 1992). In this paper, I shall consider language right from the point of view of Semantics, introducing a radically new theory in this field. I call this theory *Operational Semantics* (OS). The theory is broad and complex, and therefore the space required for a complete and in-depth presentation is a book, not an article. Here, only a brief exposition is possible. I hope it will be clear enough, even if it cannot be exhaustive. A book with a more complete presentation is being prepared.

This article has been conceived to be read by as wide a public as possible. Therefore, a specialised foundation has been avoided.

The origins of Operational Semantics

OS partly derives from, or coincides with, Silvio Ceccato’s (1914-1997) thought, and is partly an innovative development of this and partly very different. Ceccato’s thought started developing in the 1950s and reached its full maturity in the 60s and 70s (Ceccato 1964, 1966, 1968, 1969, 1970, 1972, 1974; Ceccato, Zonta 1980). Ceccato used various names for the theories that made up his thought. The name *Operational Methodology* (OM) is the one that has prevailed in his School, the *Scuola Operativa Italiana* (SOI) [Italian Operational School].

Even though Ceccato had been well-known in Italian philosophical circles (and in European ones too) since the 40s and even though he directed important projects involving the application of his theories (one of the very few European projects of machine translation and the only one in Italy in the first phase of research in this field [funded by USA Air Force, 1959-66; described in Ceccato 1969]; the project of the so-called “mechanical reporter”, a machine that had to be able to observe and to describe a scene made up of seven objects arranged in various ways on a stage [Italy National Research Council, 1958-66; described by Ceccato 1969]), his thought has had very little diffusion. This can be due to various reasons. It is impossible to examine them in detail here, but we can mention the main ones: a) Ceccato, even if he started from the field of Philosophy, contrasted sharply with it, introducing his thought as something radically opposite to the whole philosophic tradition¹; b) he had anti-academic attitudes and did not want to form a real school; c) he maintained an excessively radical (in my opinion) constructivism and a relativism that weaken values; d) he

¹ This substantial diversity from the whole philosophical tradition is however essentially real: Ceccato’s thought presents vague analogies only with part of Kant’s philosophy and with the operationalism of H. Dingler and that of P. Bridgman.

used a language that was sometimes difficult and unclear. Nevertheless, I believe that the work of Ceccato and his School (Glaserfeld E. von 1989, 1998; Parini 1996; Vaccarino 1988, 1997, 2000; Amietta, Magnani 1998), even if it needs an in-depth critical revision, includes many original and very valuable ideas and intuitions, which deserve to be taken into consideration again and developed. This is precisely where I have focused my work ever since the second half of the 90s (Benedetti 1999, 2004, 2005a,b). In the early 90s, another researcher from the *SOI*, Giorgio Marchetti began a very remarkable critical revision and development of Ceccato's thought (Marchetti 1993, 1997, 2001, 2003). Since 2003, there has been a tight collaboration between Marchetti and myself.

In the following treatment, there is the problem of distinguishing Ceccato's original theories from those of the author. A complete and precise distinction here is not possible due to lack of space: for such a distinction, I can do nothing else but refer the reader to the bibliography (Ceccato 1964, 1966, 1968, 1969, 1970, 1972, 1974, 1996; Ceccato, Zonta 1980; Ceccato, Oliva 1988). Nevertheless, in the main text or in the notes, I shall indicate which are Ceccato's main original theses and which are the author's. When this is not provided, the thought exposed generally derives from Ceccato's, but with possible differences. The foundation of the exposition is the author's own and differs entirely from Ceccato's.

The fundamental theses of Operational Semantics

I believe that the best way to introduce OS is to take a sample of language at random and think over the meaning of the words that form it. As a sample of language, let's take the beginning of one of the most famous books in the world: Pinocchio.

Once upon a time there was...

— A king!— my small readers will say at once.

No, children, you are wrong. Once upon a time there was a piece of wood.

It was not a luxury wood, but a simple stack piece, one of those pieces we use to put in stoves and fireplaces in winter to light fire and to heat rooms.

[translation from Italian is the author's own]

Every discrete element of language, that is, every word, designates at least one meaning (in many languages however, many single words designate more than one meaning together, like, for instance: the basic meaning of a noun plus the plural; a verb and its tense, mood and person; etc.). Therefore, each word designates one or more "atoms" of thought. Let's ask ourselves what these "atoms" are, what their nature is. As far as their nature is concerned, it seems that the meanings of words can be divided into at least three main categories.

1) In the passage we have chosen, there are words that, at first sight, seem to designate something physical (or, at least, mainly physical). These words are: "children", "wood", "stack", "stoves", "fireplaces", "winter", "[to] light", "fire", "[to] heat", "rooms". It is easy to realise that there are so many of these words that they probably make up most of the lexicon of any language. Nevertheless, if we consider this class more in depth, it does not seem homogeneous. Words such as "robin", "bird" and "animal", for instance, all seem to belong to this class, but certainly express an increasing level of "abstraction" (therefore, something mental). Words such as personal pronouns ("I", "you" etc.), even if they undoubtedly designate something physical, are certainly more "abstract" than the names of the people they indicate in turn, for example "John Smith". Moreover, there are words that seem to designate something that is partly mental, but partly physical too. In the passage chosen, words of this kind are "readers" and "will say" (in fact, reading is surely a mental activity, but requires something physical to use as a symbol; in the same way, when we speak, we use sounds as symbols to express our thought). But, apart from these considerations, what I want to highlight is that there is a big class of words that make an *evident* and *important* reference to

something physical (I shall refer further to this in the conclusions of this article).

2) Another class of words indicates things we can collectively call “psychical”, that is, feelings, emotions, moods etc. (love, hate, fear, anger etc.). These words are much less numerous (there is not one of these in the passage).

3) Finally, there is a third class of words (and, in many languages, morphemes) that seem clearly different from those belonging to the first two classes: these words do not, or only minimally, seem to refer to something physical or psychical. In the passage, words of this kind are: the verbs “to be” and “to have”, the article “a”, the prepositions “upon”, “at”, “of”, “in”, “to”, the demonstrative adjective “those”, the negations “no” and “not”, the conjunctions “and” and “but”, the numerals “once” and “one”, the adverb “there” and the morpheme “-s”, which indicates the plural. In the vocabulary of a language, words of this kind are all the “grammatical” words, that is:

- *prepositions* (with, of, to, at, from, by, in, for, on, between, among etc.) and *conjunctions* (and, or, if, because, but etc.);
- *interrogative-indefinite-relative pronouns and adjectives* (who, what, which, whoever, whatever, whichever etc.);
- *demonstrative adjectives and pronouns* (this, that, other, the same etc.);
- *main adverbs* of place, time, manner etc. (here, there, where, when, how, why etc.);
- *pronouns and adjectives of quantity* (all, whole, many, some, few etc.);
- *negation* (not, no, in- or un- as a prefix);
- *numerals* (one/first/once; two/second/twice; three/third etc.);
- “*grammatical*” *verbs* like “to be”, “to have”, “can”, “must” etc.;
- most *morphemes* in the large number of languages that have a more or less rich morphology (the ones which indicate *cases*, in languages that have cases; the *number* of nouns and, in many languages, of adjectives; *tenses, moods, forms, aspects* of the verb etc.).

Besides the “grammatical” words, the vocabulary of a language contains other words that, like the former, do not, or only minimally, seem to refer to something physical or psychical. The passage contains two of these words: “small” and “piece”. Other examples of words of this kind can be: “big”, “part”, “beginning”, “end”, “to get”, “to do”, “to look for”, “to find” etc.

It is easy to realise that the number of items in the third class is quite limited (probably more than in the second class, but definitely much less than in the first class), but, *as a class*, they are used *in an extremely frequent way* (in the passage, the ratio between the words of the first class and the words/morphemes of the third class is about 1:4). If we choose samples of language at random, we can see that the third class is, in a large majority of the cases, the main component of sentences and that it is *absolutely indispensable in order to speak*, that is, to construct *any* speech. Therefore, it is logical to consider it as being the fundamental structural component of language, and then of linguistic thought (I use the expression “linguistic thought” because some authors stress the existence of kinds of thought that differ from the kind of thought that language is the expression of, the “internal” equivalent of language [see, for example, Weiskrantz 1988]). I maintain that *until we understand the nature of the meaning of these words, we shall not be able to understand the deep nature and structure of language and linguistic thought*.

Well, what do these words and morphemes indicate? In some cases, it may seem that these words, even if they do not indicate physical objects, indicate *relationships* amongst physical objects (in sentences such as “bottle of wine”, “he has a moustache” etc.) or *features* of physical objects (in sentences such as “a large table”). Nevertheless, the same identical words may be used without any problem in situations that have nothing to do with the physical world (for instance, we may say “stream of consciousness”, “to have an idea”, “a large number” etc.). Therefore, the answer to the question must be a different one.

Of course, linguistics has tried to give an answer to the aforesaid question. The solutions proposed seem unsatisfactory however. This can be seen by simply examining the definitions of these words in dictionaries, which use tautologies (for example, “not” is defined as “negation”) or false syno-

nyms (for example, “to have” would mean “to possess, to own”, “to keep”, “to get, to obtain”, etc.) or send us from one word to another and then back again (for example, the verb “to look for” is defined by means of the verb “to find” and vice versa). As regards the fundamental class of prepositions (in English, as in many other languages, one word out of about seven, on average, is a preposition), they are generally said to have a lot of meanings, that is, they would indicate many kinds of relationships (such as place, time, manner, cause, means or instrument, company or union, origin etc.). It is easy to object by saying that it seems highly unlikely that words composed of very few letters, which are extremely frequent and indispensable, have so many meanings. It is more likely that prepositions have *only one*, more general meaning (that is why it is so difficult to determine), and that the many relationships grammar speaks about are only specifications, just introduced by grammar itself, which are included in this more general meaning. For example, it is more likely that the preposition “with” does not designate relationships such as company or union (“cup with handle”), means or instrument (“to write with a pen”), manner (“with ease”), cause (“to shiver with fear”) etc., but *something more general* that includes the relationships of company or union, means or instrument, manner, cause etc.

A serious, wide and in-depth approach to Semantics such as the one by Wierzbicka (Wierzbicka 1972, 1989a,b, 1992; Goddard 2001, 2002; Goddard e Wierzbicka 1994, 2002) shows the difficulties we met in the definition of the words and morphemes belonging to the third class. The approach (called Natural Semantics Metalanguage, NSM) is based on a reductive paraphrase (that is, breaking concepts/words down into combinations of simpler concepts/words). This approach shows that most words in a language can be defined, yet there is *a core of fundamental*, “atomic” meanings (which Wierzbicka calls “semantic primitives”), which allow us to define any other meaning, but are *absolutely irreducible*, that is, *undefinable* by means of other words, as Wierzbicka explicitly states. The “semantic primitives” are believed to be present in all human languages. This assumption was tested extensively against a wide and extremely diversified range of languages, including English, Russian, French, Spanish, Polish, Italian, Ewe (African language of the Niger-Congo family), Malay, Japanese, East Cree (native North American language of the Algonquian subfamily), Chinese, Mbula (Austronesian language, spoken on an island of Papua New Guinea), Yankunytjatjara, Arrernte (Australian Aboriginal languages), and Maori (native language of New Zealand). Table 1 shows the present list of the 60 or so “semantic primitives”. The words that seem to belong to the third class are underlined. As we can see, they are the majority of the list.

Table 1: List of the semantic primitives (2002; <http://www.une.edu.au/lcl/nsm/nsm.php> - model)

substantives:

*I, you, someone, people,
something/thing, body*

determiners:

this, the same, other

quantifiers:

one, two, some, all, many/much

evaluators:

good, bad

descriptors:

big, small

intensifier:

very

mental predicates:

think, know, want, feel, see, hear

speech:

say, word, true

actions, events, movement, contact:

do, happen, move, touch

existence and possession:

there is/exist, have

life and death:

live, die

time:

*when/time, now, before, after, a long time, a short time, for some time,
moment*

space:

*where/place, here, above, below; far,
near; side, inside; touching*

“logical” concepts:

not, maybe, can, because, if

augmentor:

very, more

taxonomy, partonomy:

kind of, part of

similarity:

like

Operational Semantics is a *completely new solution* to the problem of the meaning of words and morphemes belonging to the third class. The fundamental thesis of OS is that these words designate *sequences of mental operations* (the name “Operational Semantics” derives from this), *amongst which the ones of attention play a key role*.

Ceccato called these sequences of mental operations “mental categories” (because they have some analogies with the categories of Kant’s philosophy). OS has adopted this name as well. We must point out that the meaning OS gives to the term “category” is *completely different* from the meaning that Cognitive Psychology and Linguistics give to the same term. Typically, Cognitive Psychology and Linguistics use the term “category” to highlight the fact that, since many objects of the physical world share common features, but are not identical, we create *classes* (that is, *categories*) by means of a mental process of abstraction (Barsalou, 1999; Lakoff, 1987; Rosch, 1973, 1978). On the contrary, OS calls “mental categories” the meanings of the words such as those listed in point 3.

Ceccato called the mental operations that make up the mental categories *elemental mental operations*. Once again, we must point out that the use OS makes of the expression “elemental mental operations” differs completely from the use that cognitive sciences make of the same expression: while for OS the expression denotes only the elemental operations that make up mental categories, for cognitive sciences it has a wider meaning, denoting various kinds of operations that may be considered “elemental”, such as, for example, basic operations of perception. In this paper we shall therefore use, as much as possible, the more specific expression “elemental operations that make up mental categories”, or its acronym EOMC.

Therefore, defining the meaning of a word that designates a mental category means, according to OS, identifying the structure of that mental category, that is, the sequence of elemental mental operations that make it up. We call this task “analysis of a mental category”.

If we tackle the task of analysing the mental categories, the things that we have to understand are essentially the following:

- 1) what are, from a *general* point of view, the elemental mental operations which make up mental categories;
- 2) in *particular*, what combination of these elemental operations makes up every single mental category considered (that is, it is necessary to have a method by which we can carry out the analyses and it is also very desirable to be in some way able to verify the analyses we obtain).

All of this is extremely difficult. We make up mental categories continuously, because they are a fundamental component of linguistic thought. Nevertheless, even if we know very well how to carry out the operations that make up mental categories, we carry them out in a completely unconscious, and moreover in an extremely fast way and without any effort, so that discovering them is really a very difficult task.

The elemental or basic mental operations

Ceccato hypothesized that attention can only be in two states (attention waiting for something to focus on and attention focusing on something) and that the structure of mental categories is made up of the various possible combinations of a progressively increasing number (2, 3, 4 etc) of these two states. Since this hypothesis gave poor and controversial results in the analysis of mental categories,

I believe it is completely wrong (Benedetti 2004). Nevertheless, Ceccato also gave some other sketched descriptions of the structure of several mental categories. I used these descriptions as a starting point to identify the elemental mental operations that make up the mental categories. I proposed (Benedetti 2005b, 2006) a more complex set of EOMC, and consequently presented new analyses of the fundamental mental categories. Most of the operations that are considered EOMC have been repeatedly described in Cognitive Psychology (as regards attention, see for example James, 1890; Jonides, 1983; La Berge, 1983, 1995; Pashler, 1998; Posner, 1980, 1994; Posner, Cohen, 1984; as to representation, see Braga-Illa, 1997, 2006; Denis, 1989; as to memory, see Baddeley, 2000; Baddeley and Hitch, 1974; Cowan 2001, 2005; Miller, 1956; Oberauer, 2002; Oberauer et al. 2000). *The new idea we are proposing is that by means of these operations we can account for the meaning of the words listed in point 3, hence for the nature and structure of linguistic thought* (this idea is Ceccato's own).

I wish to underline that my list is by no means definitive, and that it is open and can be modified, in the sense that the description of some operations or group of operations could be improved, should there be a need to add some new operations, modify the classification that I have used etc. The list of the EOMC I propose at present is the following.

1) **Operation of attentional focalisation (AF)** – This operation has the fundamental property of producing the “selection”, or “highlighting”, of its object with respect to all the rest (James 1890). Inside AF we can distinguish at least three sub-operations.

- a) AF can widely *vary in extension (AFext)*: it may concern an object, or a part of it, or several objects.
- b) The focus of attention can *move (AFmov)* from one object to another, or from a part of the field to which it is applied to another.
- c) Moreover, AF can be *maintained for variable, though limited, amounts of time (AF-maint)*.

2) **Presence keeping (PK)** – Let's consider Picture 1. In this picture, let's look at the bottle and say “bottle”; then, let's look at the glass and say “glass”. Let's try to say, “there are a bottle and a glass”. Obviously, the physical situation has not changed, but it is our mind that has done something different. In the first case, when we passed to the glass, the bottle was mentally discarded. In the second case, instead, we keep the bottle present while our attention passes to the glass. I call this fundamental operation “presence keeping”.



Picture 1

The operation of presence keeping is surely strictly related to the well-known concept, developed by Cognitive Psychology, of “working (or active) memory”, whether in the classic Baddeley-Hitch's model or in more recent models, such as Cowan's or Oberauer's models (Baddeley, Hitch 1974; Baddeley 2000; Cowan 2001, 2005; Oberauer, Süß, Schulze, Wilhelm, Wittmann 2000; Oberauer 2002). The operation of presence keeping requires the interaction of a short-term memory having a limited capacity and attention (the interaction of a short-term memory and attention is especially highlighted in Cowan's and Oberauer's models).

3) **Operation of attentional discarding (AD)** – Considering Picture 1 once again, let’s try to say “glass or bottle”. In this case, we can easily sense that both objects are focused on by attention and kept present, but when our attention focuses on the glass, we must *exclude, discard* the bottle (this operation is different from simply stopping to focus our attention on an object in order to pass on to focus it on another one, because in our case we bear in mind the fact that we considered the object we are now discarding). I call this operation the operation of “attentional discarding”.

4) **Operation of representation (R)** – The operation of representation is the act of focusing attention on something that is not present at the moment, but is retrieved from memory. This is what we do when, for example, hearing a word, we pass to its meaning, which was previously memorised. Sometimes the formation of a mental image of the object follows the understanding of the meaning. In some cases, this operation is not simply a retrieval of something memorised, but has a clearly creative character, such as when we imagine or think up something that does not exist.

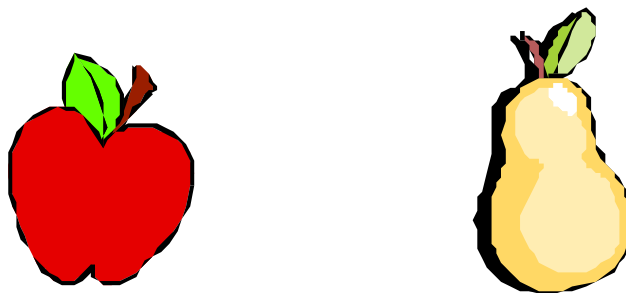
5) **Operation of comparison (C)** – Our mind performs comparisons very frequently. Every time we use typically relative words, which concern properties of an object (like “high/low”, “big/little”, “long/short”, “strong/weak”, “heavy/light” etc) or express a judgment (like “good/bad”, “normal/abnormal”, “legal/not legal” etc), we make comparisons. Obviously, when we perform this operation, we focus our attention on the objects compared and we bear them in mind. Even though comparison implies operations of attentional focalization and presence keeping, I believe that it has to be considered a separate function. This is why I call it “extra-attentional” operation.

6) **Operations of memory (MO)** – Memory surely plays a key role in our mental life: by means of it, we fix and recall both brief and long-term memories continuously. Apart from all of this, I think that memory operations are part of the structure of some mental categories (Benedetti, 2005b, 2006). Therefore, I list memory operations amongst the basic mental operations that make up mental categories. Also these memory operations are distinct from the ones of attention.

Examples of analysis of mental categories

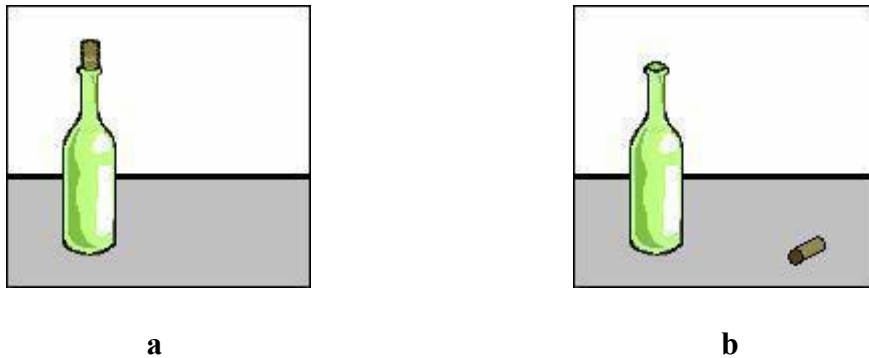
As we said, our hypothesis is that the meanings of the “grammatical” words, which represent the majority of mental categories, are sequences of EOMC. Let’s briefly consider some examples. As examples of analysis of mental categories, I have chosen some of the simplest and some of the ones that need no quotation or little quotation of linguistic data. On the contrary, in order to analyse a mental category and verify the analysis, several linguistic data concerning the word that designates it are often necessary (this is often due to the linguistic evolution of the word).

I use Picture 2 to show the analyses of the conjunctions “and” and “or” (these analyses are substantially Ceccato’s own). In the case of the conjunction **and**, we focus our attention (AF) on something (say *A*; the apple, in our example) and we keep it present (PK) while focusing our attention on something else, *B* (the pear). In this way *B* is “tied” to *A*. In the case of the conjunction **or**, firstly we focus our attention (AF) on an object *A* (the apple, in our example) and then we discard (AD) it in order to focus our attention (AF) on another one, *B* (the pear). Therefore, *A* is excluded when *B* is taken into consideration: an alternative between the two objects is thus created.



Picture 2

The preposition **with** means that, firstly, we focus our attention (AF) on an object *A*, then, keeping it present (PK), our attentional focalisation (AF) also extends (AFext) to another object *B*, because *B* is in such a relationship with *A* that it leads us to focus our attention on *A* and *B* as a single unit, together². For example, we say “bottle with cork” if the cork is in the neck of the bottle (Picture 3a), while we do not use this expression if the cork is far from the bottle (Picture 3b).



Picture 3

A noteworthy fact is that this analysis clearly explains that in many languages this preposition is used to express both the relationship of company or union between two things and the relationship of means or instrument between an activity and an object. Whether we say, for example, “cup with handle” or “to write with a pen”, what appears to our attention is an object which is in such a relationship with the other that it leads us to focus our attention on both objects together, as a single unit. In fact, the handle is joined to the cup and therefore as long as we look at the cup we also see the handle; and as long as we watch the action of writing we see the pen (Picture 4).



Picture 4

The analysis also clearly explains that the preposition “with” can be used when relationships such as opposition (“to fight with”), manner (“with ease”), time (“swallows migrate with the cold season”), cause (“to shiver with fear”), concern (“no concern with”) are involved, and in comparisons (“to compare with”). In all these cases the attention, while focusing on something, is also extended to something else (from the act of fighting to the enemy, from an activity to the way it is performed, from an event to another one that happens at the same time, etc).

The preposition **without** indicates that first we represent the relationship referred to by “with”, and then we discard its second object, because it is missing. What induces us to represent such a relationship may be the situation or a specific question (for example, when looking at a window without panes, we are led to say “window without panes”, because we are used to see windows with panes; or we can answer that we are “without money”, if asked to say “how much money” we have).

² This analysis is my (substantial, from a certain point of view) modification of the original Ceccato’s analysis (which is: “two things are focused together by attention and then they are divided by it”).

Also with the case of the meaning of the **genitive case** (expressed in English with the preposition “of”, the possessive case or word order) we refer to a situation in which an object is in such a relationship with another object that it leads us to focus our attention on the latter as well. However, when using the genitive case, we keep this relationship between the two objects mentally present (PK), but then we focus attention (AF) only on the second object (the analysis is my own). For example, if, looking at a man with a black hat on his head, we say “there is a man with a hat” and then add “the man’s hat is black”, in both cases we bear in mind the fact that the hat is in such a relationship with the man that it leads us to focus our attention on both objects (the hat touches the man), but when using the genitive case the attention is then focused only on the hat (in order to talk about the hat and say that it is black). This analysis clearly explains the fact that the genitive case is used when there is a relationship between two objects such as: possession (“John’s car”), work/author (“picture of Raphael”), part/whole (“the branches of the tree”), belonging to a group (“a friend of mine”), feature/object (“the colour of the dress”) etc. The fact that, in the relationship expressed by the genitive case, “A of B” (for example, “bottle of wine”), attention focuses, according to our analysis, *first on B* (together with A), *then only on A*, can also explain why some languages (such as English, for instance) can express this meaning by means of the word order *B-A* (“wine bottle”). The category of **negation** (“not”, “no”, “in-” or “un-” as a prefix) indicates the discarding (AD) of the representation (R) of a meaning (the analysis is my own). If, for example, we say, “John’s car is not red”, we mean that the representation of the meaning “red”, concerning John’s car (a representation that was prompted by something previous, such as for example the question: “Does John have a red car?”) is discarded.

The categories **who**, **what** and **which** indicate that the attention is firstly focused (AF) on a group of two or more items (human beings in the case of the pronoun “who”, anything that is not a human being in the case of the pronoun “what”; “which” is the derived adjective), which are considered equal (C), and then focused on one of them while discarding (AD) the remaining items, bearing in mind (PK) the origin of the first. If, for example, we are looking at some books (Picture 5), and someone asks us “Which book do you want?”, we will realize that after having focused our attention on the group of books, we focus it on one of them while discarding the others, but bearing in mind the fact that the book chosen comes from a group of similar items (that is, a group of books).



Picture 5

Focusing our attention on an element of a group, while discarding the others, is obviously an operation of fundamental importance. In fact, linguistic research has shown that the two pronouns “who” and “what” are among the first in the list of the most stable words in the linguistic evolution of the languages of the world (Dolgopolsky, in Lehmann, 1992, p 217 It. ed.).

The category **how much** is produced by means of the operation of **counting**, that is, by means of a series of operations of focalization of attention (AF), one after the other, on each item of a group of items considered equal (C), bearing in mind (PK) the preceding items each time we add a new one. Each subsequent repetition is called by a different name (these are the **single numbers**: “one”, “two”, “three” etc.). The word **number** indicates indistinctly one of these repetitions without speci-

fying which one, while the word **how much** indicates that attention must be focused on the final result of counting. The category of **plural** indicates that we have simply carried out subsequent attentional focalizations on things considered equal, but without associating a conventional name of a progressive series (that is, a number) to each of them³. For example, if, when looking at a scene with an apple, a pear, a plum and a peach (Picture 6), we say “there are four fruits”, this happens because, first, we have considered the apple, the pear, the plum and the peach as items that are equal (that is, “fruits”); second, we have focused our attention on one of them associating a conventional name (“one”) to it; third, while bearing this in mind, we have focused our attention on a new item associating another conventional name (“two”) to it; and so on. If instead we say “there are some fruits”, we have carried out the same operations, but without the association of a progressive series of conventional names.

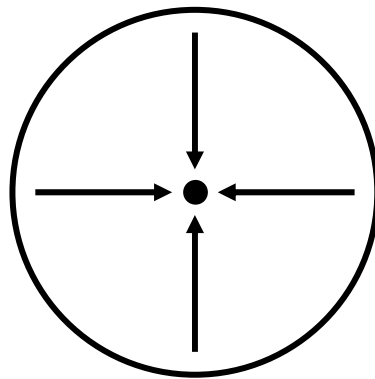


Picture 6

Besides the definition of “number” (that is, the fundamental entity of Mathematics), I would like to mention the definition of a fundamental entity of Geometry, that is, “point”. Ever since the origin of Geometry, point has been considered one of the so-called “*primitive concepts*” (Euclid), that is, the fundamental concepts that we acknowledge *without a definition*. According to OS, the **point** designates an attentional focalization on the spatial “map” (see further on) which is so restricted that attention cannot move inside it anymore⁴. If we wish to illustrate this operation with a scheme, we may use a picture like Picture 7, where we suppose that, as often happens, there is a restriction in the extension of the attentional focalization, as happens when we pass from any object (in the picture, it is symbolised by the circle) to a single point of it.

³ The analysis of the category of “plural” is my own. The other analyses of this group are developments or modifications or explanations of analyses sketched by Ceccato.

⁴ This analysis is completely my own, that of Ceccato being completely different. The fact that Ceccato did not sense that the movements of attention are fundamental attentional operations makes his analyses of the mental categories that have something to do with space some of the least convincing of his work, in my opinion (it is not by chance that they also are very few).



Picture 7

We have stated that, according to OS, memory operations are part of the structure of some mental categories. An example is given by the categories “the same” and “other/else”. Let’s take a quick look at their analyses. There are a lot of objects of which many specimens exist, which are thus designated with the same word. For example, the word “dog” indicates each specimen of the class of “dogs”. If, in a speech, after having found the word “dog” we find it once again, we remember that the word has been already used, so we have to know whether the latter word refers to the aforementioned dog (let’s call it dog *A*) or not. The mental category **the same** indicates that we have to focus our attention on dog *A* retrieved from memory, while the category **other/else** indicates that we have to discard dog *A* retrieved from memory and represent a new specimen of the class of dogs, let’s say *B*.

The meanings of the two verbs “to have” and “to get” are so general that dictionaries usually try to capture them by defining each entry with a long list of verbs: for example, “to get” would mean “to obtain”, “to receive”, “to understand”, “to become”, etc. However, these lists are nothing else but collections of more “specialised” verbs, whose meanings are included in the more general meanings of “to have” and “to get”. The meanings of “to have” and “to get” are so general because both these verbs designate the same relationship as the one designated by the preposition “with”⁵ (first, attention focuses on an object *A*, then attentional focalization is extended to another object *B* because the latter is in such a relationship with *A* that it leads our attention to focus on *A* and *B* as a single unit, together). The difference with the preposition “with” is that, in the case of these two verbs, as in all verbs, we see the situation from the temporal point of view⁶, which entails that we focus our attention in a continuative way or repeatedly on the *same* situation (see further on). In the case of the verb **to have**, the result is something static. For example, “that man has a moustache” means that when we focus our attention on his face we also see a moustache and this remains constant throughout time. On the contrary, in the case of the verb **to get**, the result is something dynamic. For example, “to get the pen” means that our hand comes in such a relationship with the pen that, if

⁵ This basic idea, and the difference between “to have” and “to get” described below, are Ceccato’s own; as regards the analysis of the proposition “with”, see note 2.

⁶ For an in-depth discussion of the psychological sensation of time, starting from the presuppositions of OS, see Marchetti 2007. The basic thesis of this article is that such a sensation is a subjective construction, and that such a construction is based on the perception of the effort made by the organ of attention in performing a given activity, generically called “temporal activity” (for example, evaluating how long an event lasts). According to Marchetti, in order to perform a temporal activity we have to focus, in a continuous and incremental way, a portion of our attention (A_t) on the conscious product of the non-temporal activity (the event) of which we have to evaluate the duration. The non-temporal activity in its turn is the product of the use of another portion of our attention (A_e). The continuous and incremental focalization of A_t involves a continuous and cumulative working of the organ of attention: it is just the perception of the effort made by the organ of attention in performing this continuous and incremental work which makes up the basis of the psychological sensation of time. We have to notice that Marchetti’s thesis is a development of the thesis that Ernst Mach exposed in his *Beiträge zur Analyse der Empfindungen*.

we look at the hand, we also see the pen (the pen is *in* the hand), while before there was not such a relationship⁷.

A very important group of mental categories is the one designated by the words and morphemes related (some of them not exclusively) with space or time (for example: “place”, “where”, “here”, “there”, “high”, “short”, “wide”, “narrow”, “left”, “right”, “now”, “before”, “after”, “during”, “when” etc). In order to analyse the meaning of these linguistic elements we have to introduce some concepts.

In my opinion, the attentional operations and the other EOMC can be applied not only to objects, but also to what I call “maps” (Benedetti, forthcoming). I call “*map*” an ordered mental representation of an ordered set of elements or of an ordered *continuum* (since here I use the word “map” in a new meaning, I shall always put it between quotation marks). Examples of “maps” are the representation of the series of numbers, of the words of a speech, of the items of a list, etc. Nevertheless, the main maps are the spatial map and the temporal map, that is, our mental representations of space and time.

How we build these representations and what supports them is a problem that we can address only very briefly here. Let’s consider the *temporal* “*map*” first. As everyone can easily sense, when we have focused our attention on an object, we can continue keeping it on that object. If the situation is static, we can keep our attention on the same object for rather brief periods, a few seconds. Think, for example, about when we look at a red traffic light waiting for the green one: after a very few seconds of gazing at the red disk, our sight is inevitably pushed, even against our will, to look away from it at least for a moment. In the case of dynamic situations (for example, when our eyes track a moving object), we can keep our attention focused on the same object for longer periods. Nevertheless, we have to note that even in situations of this kind rarely do we keep our attention exactly on the same object. That is, attention is extremely “mobile”, that is, it tends to move continuously in the attentional field (the reason for this is easily understandable: only with a continuous exploration of the attentional field it is possible to perceive all the stimuli that could be important for the subject). Anyway, even if we can keep our attention focused on the same object for limited periods only, it is possible, once we have left the object, to focus it on again. This is what we do for example in the aforesaid case of waiting for the traffic light to become green, when the waiting is rather long: we keep our attention on the red disk for some seconds, then we divert it for a moment, then we gaze again at the red disk, etc, till it goes out and the green disk appears. This kind of operating can cover even long or very long periods. In fact, we can focus our attention again on the same object even after many years (for example, when we knew a man when he was a boy and we meet him again when he is an adult). Whatever the distance of time between the two (or more) attentional focalizations, all that is necessary is that their results are remembered and that there is some way of ascertaining without any doubt that the object of the attentional focalizations that follow the first one is always the same as that of the first focalization, even if the object has not been continuously followed. Furthermore, we usually integrate what we perceived during the phases of the attentional focalization, representing, that is, imagining, what happened during the phases when our attention was elsewhere directed, so as to build a *continuum* where the object has a stable existence (for example, when we are waiting in front of a traffic light, we assume that the red disk still exists also when we divert our attention away from it; as in the case of the man met after many years, we assume that he gradually changed from a boy into an adult ; etc). As we can see, this way of operating is a rather complex one, where there can be several operations of attentional focalization, operations of memory and of representation. Because of this, I call it temporal “operational scheme” (**TOS**).

When we perform this fundamental operational modality, we use a **verb**. This fact may be not immediately evident. This depends on the fact that we *already know* the meanings of the various verbs and this may make us think that these meanings can be understood in an instantaneous way, without

⁷ The restricted space of an article do not allow us to show other examples in order to verify these two analyses and the other analyses that I have proposed. Nevertheless, the reader can easily verify them himself or herself by finding other examples.

necessarily following the situation during time. But imagine you want to teach the meaning of a verb, for example “to burn”, to a very little child who does not know it: to do this, there is no other way but to make the child keep his or her attention on something that is burning, for example some wood, and see it changing into something else (the ashes) during time, while producing heat and fire.

The result of TOS is a temporal representation or “map” relevant to a process (or state). By capturing the relationships among the various phases of many processes (or states) and by using some cyclic processes (the alternation of day and night, the lunar phases, the seasons etc) as a privileged reference, we build a temporal “super-map” where all other temporal “maps” are included, that is, the general representation of time (the complexity of such a process is evident and accounts for the fact that children come to possess a representation of this kind late).

A *spatial “map”* is what allows us to consider an object or an environment from the spatial point of view, that is, in its extension. We can become aware of the activation of a representation of this kind if we make the two following simple experiments:

- 1) considering any physical object (for example, this page) in two different ways:
 - a) first, we simply recognise it (in this case, only its distinctive features, that is, its whiteness, its rectangular shape, etc will be evident);
 - b) then, we consider some positions on it (for example, the centre, the upper half, etc);
- 2) considering a part of the environment (for example, the room where we are) in two different ways:
 - a) first, once again we simply recognise it (also in this case, only its distinctive features will be evident);
 - b) then, we consider it as a “place” (in the latter case, the room will become a part of a wider spatial representation that includes it, for example the one of the house).

As regards the neurophysiological basis of the “maps”, perhaps ordered sets of neurons are involved (structures of this kind, where single cells fire according to the position of the animal in the environment have been shown; generally speaking, wide areas of the cerebral cortex, which are clearly distinct from the ones involved in the recognition of the objects, seem specialised in the visual spatial representation of the environment and in the localization of an object inside it [Kandel, Schwartz, Jessel, 2000]).

However we build our spatial and temporal representations, we clearly have the ability to do this. Substantially the same operations that are at the basis of the mental categories “who/what/which” may be performed on a spatial “map”. That is, attention may be firstly focused on the “map”, and then focused on a part (say *A*) of it, while discarding the rest *B*, but bearing in mind the origin of *A* and its relationship with *B*. So we obtain the mental category **place**, or **where** as an interrogative or relative⁸ adverb. If we perform the same operations on a temporal “map”, we obtain the mental category **moment/time** (“time” in the sense of “portion of time”), or **when** as an interrogative or relative adverb).

Therefore, I have hypothesised that there are groups of mental categories based on the same mental operations. The groups we have seen are

- 1) the one comprising the verbs “to have”, “to get” and the preposition “with”;
- 2) the one comprising the categories “who”, “what”, “which”, “where”/“place” and “when”/“moment”.

However, other groups exist (I shall not introduce them here). If my hypothesis is correct, it is possible to consider the problem of linguistic universals in a new way and to propose a new direction for the research in this field. My hypothesis is that the meanings of the words that make up these groups are given by a central core (I call it *categorical core*) plus another component (I call it *secondary component*). For example, in the case of the second group, the one consisting of the mental

⁸ Given the propedeutical nature of this paper, I have not introduced the analysis of the mental categories “interrogative” and “relative” adverb or pronoun here.

categories “who”, “what”, “where/place” and “when/moment”, the same operations, which I have just described (for the sake of shortness, I call them “operations of the 2nd core”), are performed on four different “substrates”, which make up the secondary component (Table 2).

Table 2

	category core	secondary component
who	operations of the 2nd core	human beings
what	operations of the 2nd core	things
where/place	operations of the 2nd core	spatial “map”
when/moment	operations of the 2nd core	temporal “map”

The categorial cores are made up of sequences of EOMC (which all human beings can perform) and their practical usefulness is universal. Therefore, they are very probably linguistic universals. The secondary components, on the contrary, may vary across languages. This can very well explain the differences across languages because of which the identification of a large core of linguistic universals has always been problematic. For example, a language may make a different distinction from the “human beings/things” distinction that makes up the secondary component of the pronouns “who/what”, but it is highly improbable that a language will lack their categorial core, that is, the possibility of indicating the attentional selection of an item from a group, while discarding the others. Similarly, in cases where a language has the preposition “with”, another language may have the present participle of the verb “to have”; instead of the verb “to have” there may be the verb “to be” (whose analysis is not introduced here) together with the preposition “with”, or a particular construction formed by the object possessed as the subject + the verb “to be” + the owner in the dative case; or, instead of the present of the verb “to have” some voice of the past of the verb “to get”. We understand in an intuitive way that, for example, “man with stick” is equivalent to “man having a stick”, “to have a temperature” is equivalent to “to be with a temperature”, “I have a book” is equivalent to “a book is to me”, “I have” is equivalent to “I have got”, but the fact that the verbs “to have”, “to get” and the preposition “with” are based on the same categorial core is a much more consistent justification.

Therefore, the concepts “category core” and “secondary core” can steer research in the field of the linguistic universals in a very different direction. At present, I have identified about 20 categorial cores that should be linguistic universals.

General remark — As the reader probably noticed, attention is regarded as operating serially when used to make up mental categories. Although according to some theories in Cognitive Psychology (Duncan and Humphreys’s theory, Bundesen’s TVA theory) attention is also regarded as operating in parallel on multiple objects (Duncan, Humphreys 1989; Bundesen 1990), at present I believe that attention operates essentially in a serial way when it is used to make up mental categories. My belief results from the empirical observations I performed when analysing the structure of mental categories by using, as we shall see, the method of slowing down our mental operations: in those occasions, the essentially serial nature of the attentional operating becomes rather evident. This does not rule out of course that a sequence of attentional operations can be integrated into a “chunk” and carried out so quickly as to appear instantaneous. Nevertheless, the production of mental categories requires, as mentioned, a strict interaction between attention and working memory. The latter holds and processes multiple items at the same time: that is, it works in a parallel way. So we may say that the processing required to make up mental categories (as well as the whole process of thought, as we shall soon see) is both serial and parallel (for a similar idea, see Fingelkurts and Fingelkurts, 2006).

The correlational theory of thought

Now that we have introduced some analyses of mental categories, we can explain how, according to OS, mental categories allow us to produce linguistic thought. Let's consider the following words: "apple", "pear", "red", "and", "or", "with". Let's try to represent each of the meanings of these words in an isolated way. This is easy for the first three words, while for the other three we have a clear sense of "incompleteness". We sense very well that the last three words require something that precedes them and something else that follows them. In other words, their function is to "tie" two other elements to each other. According to OS, linguistic thought is made up of two fundamental kinds of elements:

- 1) correlators;
- 2) correlata.

Correlators are the elements that have the specific function of tying the other elements of thought. They are the mental categories designated by prepositions, conjunctions and some of the so-called cases (genitive, dative, etc.), in languages that have cases (in languages that have no cases their meaning is expressed by means of prepositions). *Correlata* are the elements that are "tied" by a correlator. According to OS, even though the meanings of isolated words (such as "apple") are a kind of thought, there is actual linguistic thought only when we "tie" or "correlate" more than one meaning to each other, that is, when we say, for example, "apple and pear", "red apple", etc. The two correlata that are tied by a correlator are called "first correlatum" and "second correlatum", respectively, according to the order in which attention focuses on them. We call the whole structure thus formed *correlation* or *correlational triad* and we represent it graphically in the following way:

correlator	
first correlatum	second correlatum

In the case of the example "pear and apple", we shall have this correlation:

and	
pear	apple

Besides prepositions, conjunctions and some cases (in languages that have cases), there is another correlator, which is extremely important. Its structure is the same as for the conjunction "and" (attention focuses on *A* and *A* is borne in mind while attention focuses on *B*), but in this case *A* and *B* do not remain separate, but they "combine" together. This happens because *A* and *B* are in some way complementary. For example, *A* is an object that can exist on its own and *B* a possible feature of it (correlation substantive-adjective); or *B* is what may happen to *A* in time (correlation subject-verb); or *A* is an activity and *B* something the activity can be performed on (correlation verb-object); etc. We call this correlator *presence keeping* and we represent it graphically by means of a horizontal bar:

—	
green	leaf

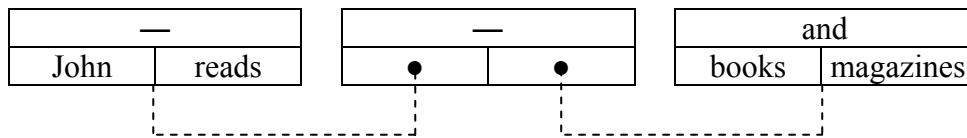
—	
John	runs

—	
reading	books

Since this correlator is, as we can easily understand, the most used of correlators, it is convenient not to express it with a word and to indicate its presence either by simply putting the two words that it correlates one after the other (when this is possible) or using marks of the words (English has very few marks of this kind, but many languages have several of them: for instance, in the Italian sentence "bottiglia di vino nuova", which means "new bottle of wine", the two "a" that are underlined are marks of the feminine genus, which indicate that the adjective *nuova*, "new", has to be related to *bottiglia*, "bottle", not to *vino*, "wine"). Because of this, this correlator has also been called *implicit*

correlator. Nevertheless, it is really implicit only when no linguistic element (whether word order or word marks) expresses it, that is, only when we can understand which words it links only by the general sense of the sentence. For example, in the two expressions “empty whisky bottle” and “Scotch whisky bottle” only the sense of the expression tells us which noun the two adjectives “empty” and “Scotch” refer to.

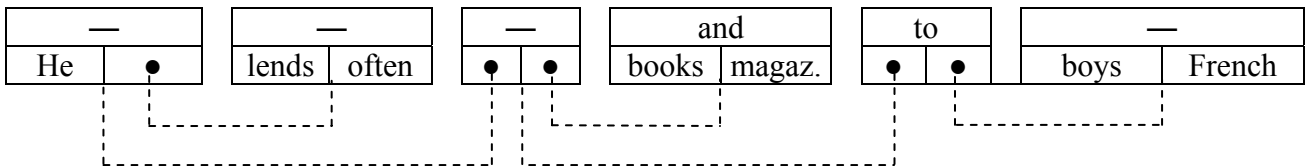
According to OS, correlation is the basic unit of thought. Thought is, in fact, a “network” formed by correlations (*correlational network*) in which a correlation acts as a correlatum of another correlation. Therefore, the sentence “John reads books and magazines”, for instance, has the following structure of thought:



(the dotted line that starts from the line that separates the two lower boxes of a correlation and that ends with the symbol “•” placed in one of the two lower boxes of another correlation indicates that the first correlation is one of the correlata of the second correlation). Another, more complex, example can be the sentence

He often lends books and magazines to French boys

which, from a certain point of view, can be considered a typical sentence (there is a subject, a verb, an adverb, a direct object, an indirect object, a conjunction and a preposition).

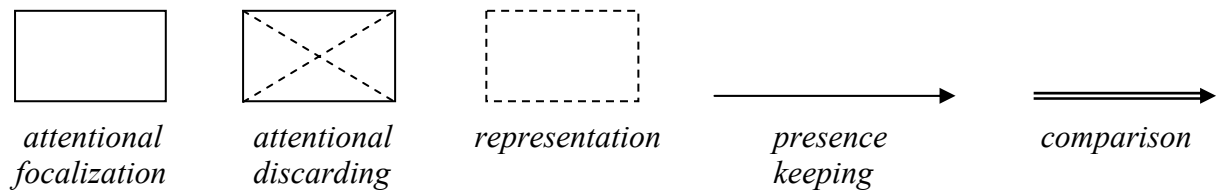


We call this theory *correlational theory of thought*. Obviously, it is also a linguistic theory but *deeply different from all other linguistic theories* because: a) it is above all a theory about the nature and structure of thought; b) it makes a clear-cut distinction between correlators and correlata; c) it considers linguistic thought a non-linear “network”, based on units necessarily composed of three elements, that is, one element that ties and two elements that are tied (even if sometimes the former is not expressed).

In my description of mental categories and thought, the procedural and architectural character of them is implicit. Let’s examine the level of mental categories and that of thought separately (even if the use of a correlator is already an instance, albeit minimal, of thought).

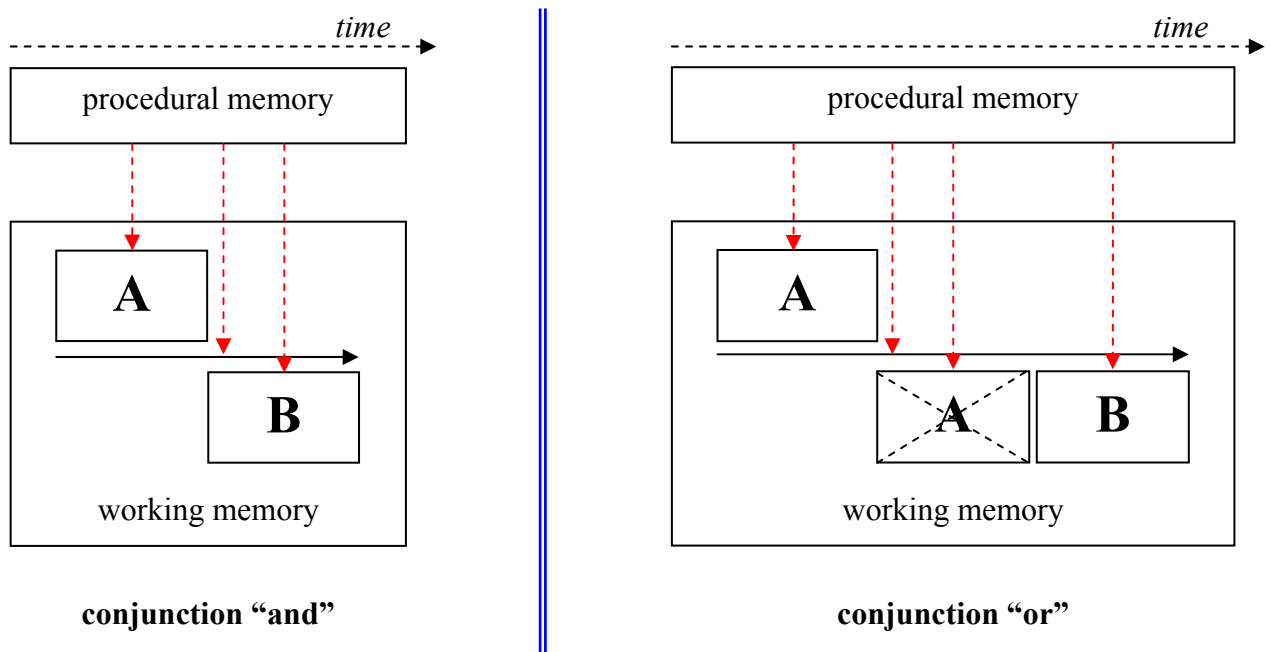
We said that, according to OS, the mental categories are sequences of elemental mental operations. Nevertheless, we also saw that, in order to make up a mental category, a simple sequence of mental operations is not enough. Working memory is also required to keep present a certain mental operation and its results while the successive operation is carried out. However, also this is not enough. The set of combined mental operations has to be memorised, so that it can be recognised and repeated, which requires a procedural memory too. We can illustrate all of this with some simple schemes (even if the production of mental categories and thought cannot be easily represented graphically, because it is a process that is carried out not only serially but also in parallel, as we said).

Picture 8 shows the possible symbols for some elemental mental operations.



Picture 8

Picture 9 shows the production of a mental category, exemplified by means of the conjunctions "and" and "or".



Picture 9

In the case of the conjunction “and”, procedural memory “loads” in working memory (or, rather, in a part of working memory) something that has been focused on by attention. That is, procedural memory chooses the operation of attentional focalization, and applies it to something, say *A*. After having done this, procedural memory chooses another elemental mental operation, presence keeping, and applies it to *A*. While *A* is kept present, procedural memory “loads” something else, say *B*. *A* is therefore joined to *B* (“*A* and *B*”). In the case of the conjunction “or”, procedural memory “loads” in working memory something that attention has focused on, *A*. *A*, even if is kept present in working memory, is then discarded, while procedural memory “loads” something else that attention has focused on, *B*. That is, *A* is excluded when *B* is taken into consideration: an alternative between the two objects is thus created.

Everything that has been thus “loaded” and processed in working memory in the two examples is a whole, which, using a term of Cognitive Psychology, may be called a “chunk”. This “chunk” is a mental category, more exactly an *applied mental category*⁹. Picture 10 shows the structures of two other mental categories (as they were described above in the text) by means of the symbols in Picture 8.

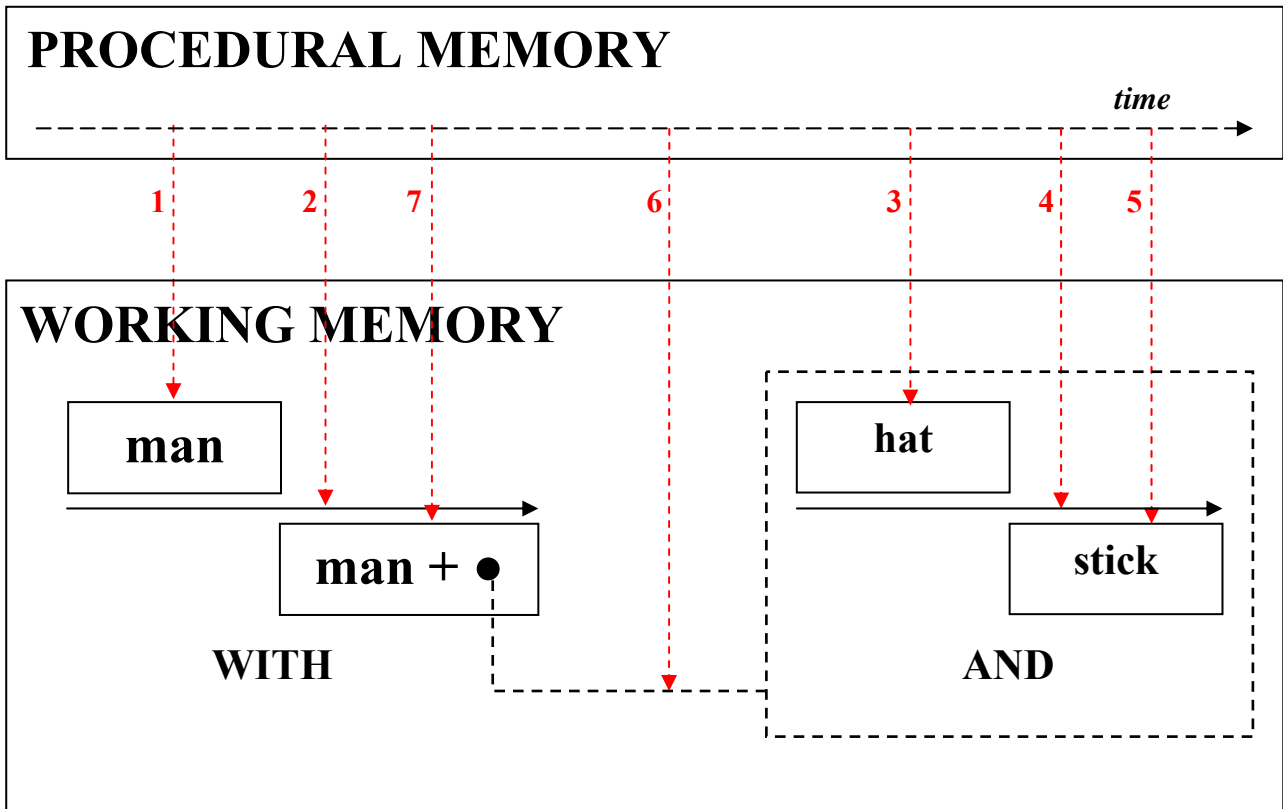


Picture 10

Now, let's consider the level of thought. At this level, it is again a procedural memory that is responsible for producing correlations and relating them to each other (a correlational network is thus produced)¹⁰. The correlations and the network are produced in working memory. A very simple example of such a process is shown in Picture 11.

⁹ The whole process can be elicited by either a linguistic input, that is, by hearing the corresponding words, or some other kind of factors (here, we are not concerned with the generative aspects of thought).

¹⁰ As regards the input of this activity, see the previous note.



Picture 11

The picture shows the construction of the correlational network designed by the expression “man with hat and stick”, which may be used to describe a situation like the one in Picture 12. The operations shown in Picture 11 mean that in such a situation: 1) we first see a man, then a hat and a stick; 2) because both the hat and the stick are in the same relationship with the man (that is, they both touch him), when our attention focuses on the man, it is also led to focus on the man and both (“and”) the objects as a whole (“with”).



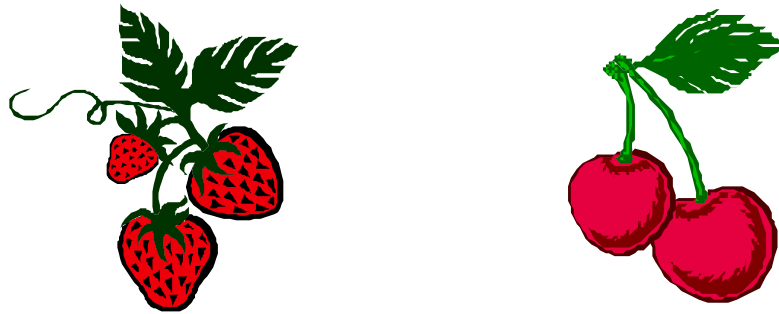
Picture 12

Theoretically, the process of production of thought can go on without limits. Practically, its limit is

the capacity of working memory. This corresponds to the well-known fact that sentences have a limited length (even if they can be very long) and are separated by full stops in writing and by pauses in speech. A **full stop** and the corresponding pause exactly indicate that working memory has stopped being loaded. What has been present in it up to that moment has to be in some way stored in a short-term memory. An item or a part of a correlational network or even a whole correlational network is often taken from short-term memory and loaded again in working memory in order to begin a new correlational network. This function, which we may call *recall function*, is very important, because it allows us to build even very complex thoughts. It is mainly carried out by pronouns. In the following two examples, the pronoun and the preceding part of the correlational network that it recalls are underlined:

- a) “This morning I saw Bob. But he didn’t see me.”;
- b) “This morning I saw the German boy I knew at the seaside last summer. He told me...”.

Given the level of complexity that the correlations of thought can reach, the aforesaid process requires a huge capacity of working memory. The task of procedural memory may also be very difficult. All of this could be one of the main reasons for the huge differences between human thought/language and animal thought/communication. In order to deal with this subject, I use a very simple example. Let’s imagine that we have two objects, like the ones in Picture 13.



Picture 13

It is very likely that a lot of animals can perceive a red cherry or a red strawberry. Amongst the motor activities that the animal can perform, there is the activity of producing sounds when a certain object appears in its visual field (or other perceptual field). These sounds can be recognised by some other animals of the same species making them direct their attention so that they too can perceive the object. All of this is surely a form of communication. Yet research in Linguistics and Psycholinguistics has repeatedly stressed that this form of communication is different from human language in some fundamental features, one of which is that in animal communication the number of objects that can be indicated is very limited and fixed and the relationship between a certain sound and a certain object is fixed too (Yule 1996).

According to OS, a *fundamental difference between human mind and animal mind* could be the fact that the former has:

- 1) an *attentional activity* that is *much more sophisticated* than the latter;
- 2) an activity that is probably absent or almost absent (at least spontaneously) in animals: the *production of mental categories and correlational network*.

The very sophisticated human attentional activity allows humans to *fragment* their experience in a far richer way than animals. In the aforesaid example, humans can isolate the perceptions “strawberry” and “cherry” (that is, two specific shapes, which are different from the shapes of any other object) from another perception, the colour “red”. Humans can do the same in innumerable other situations: they can isolate the action of “flying” from the object “bird”, the meaning of the adjective “hard” from the object “stone”, etc. As a result of this process of fragmentation, many single different meanings are created.

Then, at the level of thought, correlators allow humans to perform a *recombination* of these many

single different meanings, thus generating sequences (that is, sentences) that can be made up of many of them. In this way humans can produce an *unlimited* number of utterances, that is, they can describe any experience. In our simple example, we may say that the strawberry or the cherry or *innumerable* other things are “red”; we may simply say that there are “a strawberry and a cherry”, leaving out their colour; we may say that they are “not green, but red”, etc. *The aforesaid two processes, the one of fragmentation and the one of recombination, are, according to OS, the essence of human language.*

All of this implies a huge advantage from an evolutionistic point of view. In this way, human beings have acquired the ability to tell each other any experience they have. Therefore, a huge accumulation of notions becomes possible for every human being, with the only limit of the long-term memory capacity.

The grammatical terms according to Operational Semantics

The correlational theory of thought allows us to give an easy definition of some grammatical terms that have always been considered necessary, but have always been very difficult to define. For example, the grammatical category of **noun** (in the widest sense that this term has in linguistics: this sense also includes the nominal forms of the verb, adjectives, other parts of speech when they have the function of a noun, as well as pronouns of course, which are nothing else but substitutes of a noun). According to OS, the grammatical category of noun indicates the class of the simple correlata (the meaning of the expression “simple correlatum” shall be clarified below), in opposition to the class of correlators (therefore, the thesis of OS in regard to the grammatical category of “noun” is that it can be defined only by using the position the word has in the correlational network as a criterion of classification, not by basing ourselves on a semantic criterion, that is, for some characteristic of its meaning). In fact, for example, the words “John”, “piece”, “glass”, “doors” and “windows”, which are correlata in the following correlations:

—	
John	reads

of	
piece	glass

and	
doors	windows

are nouns. The adjective also indicates a correlatum, as we can see in this example:

—	
red	book

In fact, adjectives are commonly considered “nominal forms” in linguistics, like nouns (Robins 1997). This theory easily explains why certain words, which are normally classified as parts of speech that differ from the “noun”, in some cases are instead sensed as nouns. This happens for the infinitive forms of the verb. In fact, in examples like “to be strong” and “to read books”, the verb is nothing else but a simple correlatum:

—	
to be	strong

—	
to read	books

Instead, the **verb in the personal form** is never a “noun”, because it does not simply indicate a correlatum (thus it is not a “*simple* correlatum”), but it designates a good four things:

- a correlatum;
- a particular correlator, the presence keeping;
- the position of the correlatum, which is the one of a second correlatum;
- that the first correlatum is what grammar calls a “person”, and the kind of this person (first,

second, third, singular, plural, etc).

That is, for example, the personal form of the verb “to laugh” in the sentence “John laughs” indicates that the corresponding correlation of thought is the following:

—	
John	laughs

The adverb is generally not a noun either because, like the verb in the personal form, it normally indicates four things (a correlatum; the position of this correlatum, which is the one of a second correlatum; a particular correlator, the presence keeping; that the first correlatum is a verb). Nevertheless, it can also be a simple correlatum, like, for example, in the sentence “tomorrow is another day”. In fact, in this case, grammar books and dictionaries agree in considering it a noun (as we can see, this is another confirmation of the validity of the definition of “noun” that we have proposed).

Another concept that is considered fundamental in grammar, but whose definition has always been problematic, is that of “subject”. Indeed, while everyone knows very well how to identify the subject of a sentence, all the traditional definitions in some cases fail to identify it. For example, the semantic definition (“subject is who/what performs the action or is in the state expressed by the predicate”) fails in identifying the subject in the passive sentences (for example, “Tom was arrested by the police”); the morphosyntactic definition (“subject is what triggers agreement morphology on the verb”) does not work in languages where this morphological agreement is (partially or totally) missing (however, as regards this definition we might also object that this agreement, when it exists, presupposes that the speaker *knows* which is the subject); the definition of subject as “what is being talked about” (or “topic”) fails in sentences such as “The little girl, someone hit her”, where the topic is not so much “someone” (that is, the subject) as “the little girl”.

On the contrary, thanks to the correlational theory of thought, OS offers an easy definition of “subject” and “object”. According to OS, **subject** is what is focused on by attention, and kept present, *before* the verb; **object** is what is focused on by attention *after* the verb, which is kept present. We can easily see this different temporal setting in a couple of expressions such as, for example, “the wheel rotates” and “rotating the wheel”: in the former expression, what we see before is the wheel, while in the latter it is the act of rotating. In other words, “subject” is the first correlatum of a correlation whose correlator is presence keeping and whose second correlatum is a verb; “object” is the second correlatum of a correlation whose correlator is presence keeping once again, and the first correlatum is a verb. Therefore, in our examples, we have the following structures:

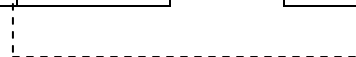
—	
(the) wheel	rotates

—	
rotating	(the) wheel

In the case of a sentence made up of a subject, a verb and an object, such as, for example, “John loves Mary”, the structure is the following:

—	
John	loves

—	
●	Mary



These definitions work perfectly in the aforesaid examples where traditional definitions fail. Moreover, they agree perfectly with the fact that languages where the order of subject, verb and object is either SVO or SOV or VSO (that is, where the subject *precedes* the object, like in the correlational network of thought) are almost the totality of languages of the world, while the ones that have one of the other three possible orders (where the subject *follows* the object, contrary to what happens, in

our opinion, at the level of thought) are extremely few (Graffi, Scalise 2002, p 68)¹¹.

Notes about the methodology of analysis of the structure of mental categories

The methodology of analysis of the structure of mental categories (which has been mainly formulated by the author; the most important exceptions are indicated in notes 14 and 15) is a rather wide and complex subject. An in-depth presentation requires much more space than an article, also because of the numerous examples that are worth quoting in order to make it more concrete and more easily understandable. In this section, I shall only try to give a general idea of the subject.

The most difficult problem is surely the identification of the elemental mental operations. Here I can only say that the list I have proposed (however, as I stressed, it has no pretension of being definitive) has originated from:

- 1) an in-depth critical revision of what Ceccato and the *SOI* have proposed in this regard;
- 2) a review of the literature, in the field of Cognitive Psychology, concerning attention and other mental activities that might be considered basic mental operations (Benjafeld 1997; Reed 1992; Pashler 1998; Posner 1980, 1994);
- 3) a series of “empirical”, that is trial-and-error, attempts of analysis, starting from some “sketches” of analysis (that is, first suppositions about the structure of some categories and descriptions given in rough and metaphorical terms).

That is, the two phases, the identification of the elemental mental operations and the analysis of the single mental categories, were not two clearly distinct phases, with the second phase following the first (this would have been logical in theory, but probably impossible in practice), but there has been a continual exchange, that is, the second phase contributed to the progress of the first one and vice versa.

Then, in order to analyse each mental category, first of all it is necessary to identify, amongst the great many words of the lexicon of a language, the words that designate mental categories. Naturally, we are mainly interested in the *fundamental* mental categories, that is, the ones that are not compound, nor do they derive from other mental categories. Identifying them is not a simple task. As sources, we can take the following into consideration.

1) Obviously, we cannot use the dictionary as a source, because it includes a great many words that designate physical things, besides a great many compound words. We must surely always use grammar as a source, because grammar contains all the “grammatical” words and morphemes, which are the majority of the mental categories. Nevertheless, grammar generally makes no distinction between fundamental terms and compound/derived terms. Moreover, the words and morphemes that grammar is concerned with are not the only mental categories. Indeed, the grammar books deal, for example, with the verbs “to be” and “to have”, but not with verbs like “to get”, “to become”, “to look for”, “to find”, etc, which are fundamental mental categories as well.

2) The aforesaid “semantic primitives” of Wierzbicka. In Wierzbicka’s work there is no concept that is similar to OS’s concept of “mental category”, but most of the about 60 “semantic primitives” that she lists at present are mental categories, as we pointed out. From our point of view (that is, identifying the most important mental categories to analyse), it does not matter whether there are really about 60 “semantic primitives” or more (the list has been expanded over time). It is instead important: 1) from the practical point of view, to have a list of words that probably designate fundamental mental categories, from which we may start the research; 2) from the theoretical point of view, the existence of a *core of meanings*, which allow us to define all other meanings of a language, but which appear *impossible to define by means of other words* (therefore, it is evident

¹¹ The correlational theory of thought, with its implications, as it has been exposed in the two last sections, is essentially Ceccato’s own. Only some modifications and additions are my own.

that, since the “semantic primitives”, which cannot be defined by means of Wierzbicka’s approach, can be defined starting from OS’s presuppositions, the two approaches are complementary).

3) Another source that we may take into consideration is the Swadesh list. The Swadesh list is a list of about 200 words that are considered fundamental, and which is used in so-called “glottochronology” to determine the closeness of the relationship of languages and the approximate date of their separation. From our point of view, the criticisms to this approach do not matter: what is important is that the Swadesh list is a set of words that are fundamental and present in most languages at least. This is probably true. Table 3 shows the words of the Swadesh list that are mental categories.

Table 3

at, in, with, and, if, because, this, that, here, there, who, what, where, when, how, not, all, many, some, few, other, count, one, two, three, four, five, big, small, long, short, wide, narrow, thick, thin, near, far, right, left, straight, round, new, old

As we can see, most of these are the same as the ones included in the “semantic primitives” of NSM (or are very similar: for example, “in” is very similar to “inside”, “who/what” is not so different from “someone/something/thing”). Nevertheless, there are also a few meanings that are not included in the “semantic primitives”. Here we have to note that, even if we must surely analyse *all* the mental categories included in the “semantic primitives” of NSM, this does not mean that we have to analyse these mental categories *exclusively*. Indeed, the fact that a meaning is paraphrasable does not imply that we learned and understand this meaning by means of such a paraphrase, or that the corresponding word was introduced instead of a longer expression, which can be its paraphrase. This probably happens only in some cases. For example, the word “bachelor” was probably introduced to substitute, more briefly, the equivalent expression “man who is not married”, and we learned and understand this word by means of this paraphrase. But meanings such as, for example, the conjunction “and” and the preposition “with” (which are included in the Swadesh list, but are missing among the “semantic primitives”) surely were not introduced to substitute expressions that can paraphrase them, and they are learnt and understood *directly*. Moreover, a paraphrase, which is considered satisfactory at present, might be considered unsatisfactory in the future (as we said, the list of the “semantic primitives” has been expanded over time). For these reasons, I have considered fundamental some meanings that seem very important, even if they are not included among the “semantic primitives” of NSM (therefore, I have analysed them).

As regards the Swadesh list, we have to note that it is a list of *words* (since it was conceived to compare languages), not of *meanings*. Because of this, meanings that are probably very important, but in many languages are expressed by means of morphemes or word order, may be missing (this is probably the case, for example, of the meaning of the genitive case).

Once we have thus established which are the fundamental mental categories (those to be analysed first), the analysis of the single category always starts from a careful study of the linguistic contexts where the corresponding word is used. That is, we examine all the examples that are quoted by a good dictionary (or more dictionaries), taking into consideration all the “meanings” listed and the corresponding definitions (even though these definitions generally are, as we saw, completely inadequate, sometimes they give us some useful suggestions; the whole of the “meanings” is always a matter that must always be carefully considered). A second step is a careful study of the data of historical comparative linguistics that concern the word under examination. Historical comparative linguistics often gives us precious indications (it shows if the word is stable and widespread, which suggests that it designates a fundamental mental category, generally having a simple structure; it highlights the words that do not appear to be, but are compound; it shows affinities and contrasts

amongst words that can be very useful for the analysis; it shows aspects of the linguistic evolution of which knowledge is indispensable, as for example the unapparent double meaning, without the knowledge of which we would search in vain for a single meaning¹²; it can exclude apparent affinities amongst categories; etc).

Once we have gathered all these data (which sometimes already give us some idea), we proceed with the real analysis, concentrating on few linguistic expressions with the word that designates the category under examination. They must be as brief as possible and they must concern only physical situations. This is because there must be only one unknown factor, that is, the structure of the category under examination. In fact, expressions that are long or that include other mental categories would introduce other unknown factors (for example, if we are trying to analyse the category designated by the conjunction “and”, an example like “pear and apple” includes this unknown factor only, while the expression “beginning and end” also includes two other unknown factors, that is, the categories of “beginning” and “end”). The main analytical techniques that we can use are the following.

1) To slow down our mental operations excluding the use of sight and using touch. In order to realize to what extent this technique makes the identification of our mental operations easier, apply it to a particularly simple case, the one of the words that designate the dimensions of objects, as for example “high” (that is, imagine having to estimate the height of an object keeping our eyes not open but closed); or, possibly, to a slightly more complex case, the one of the mental category of “end” (the analysis of it that I propose is quoted in note¹³).

2) To examine, together with the category to be analysed, the categories that seem similar and the ones that instead are the opposite (for example, if we are trying to analyse the meaning of the verb “to be”, it is useful to compare it with verbs that seem to have a similar meaning from some point of view (for example, “to stay”) and with other verbs that instead seem to have a meaning that is opposite in some sense (for example, “to become”).

3) To take into consideration expressions where everything remains identical, except the mental category at stake (for example, expressions like “to go in the water”, “to go to the water”, “to go for the water”, “to go on the water” etc), in order to try to understand what it is that makes the difference between these expressions¹⁴.

4) To consider the gesture that sometimes accompanies the verbal designation of a mental category. For example, the gesture that we sometimes make while we pronounce the conjunction “or” is made up of a swinging rotation of wrist, with thumb and forefinger completely stretched and the other fingers bended on palm. This means that the first two fingers are alternately presented to the attention of our listener, and this perfectly agrees with the structure I proposed for this mental category (p. 8)¹⁵. We should note that the fact that the gesture that possibly accompanies the verbal designation of a certain mental category agrees with the structure hypothesized for it, is a verification by means of something *objective* of the hypothesis formulated.

¹² For example, the Italian preposition *di* takes the meaning of the genitive case, which disappears in the passage from Latin to Italian, but preserves the meaning of the original Latin preposition *de*, and this explains some uses of the Italian preposition *di* that would be otherwise unexplainable.

¹³ In my opinion, the category of **end** indicates that attention moves on an object in a linear way until it meets with something different (operation of comparison) from this object; then, it gets back on its way and focus on the point of separation between the two things or the last part of the object first focused on.

¹⁴ The techniques in 2) and 3) have been proposed by Ceccato, even if in a form of hints (in his work there is no systemised treatment of the methodology of analysis of mental categories); the same can be said of the technique in 1), but in this case we should note that the “slowing down” which Ceccato refers to is something very different from what I propose here, fundamentally because the attentional “states” that he tries to identify by means of this technique are something completely different from the mental operations that I have proposed. The technique of “slowing down” as proposed by Ceccato has been largely criticised within the *SOI*.

¹⁵ The idea of using the study of gestures as an instrument for verifying the analyses can be found in Amietta & Magnani (1998), from which this comparison between the structure of the conjunction “or” and the corresponding gesture has been taken (pp 50-52). The same idea was independently formulated again in Benedetti 1999, p. 7 and Benedetti 2004, p.110.

Once we have carried out the analysis of a mental category, it is strongly desirable to have a method to verify if it is right. The main methods that we may apply are the following.

1) As we said, the analysis of a mental category is generally carried out by concentrating on a few linguistic expressions where there is the word that designates the category under examination. The first verification that must be done is controlling if also in other linguistic contexts (the other examples quoted by the dictionary) the mental operations that we carry out seem to be the same.

2) Because we are often successful in formulating a hypothesis about the structure of the category under examination by applying only one of the aforesaid methods, the remaining methods can be used as methods of verification. That is, one or more of these must confirm the hypothesis formulated (see the example that has just been provided for the conjunction “or”). Note that the aforesaid methods are very different. Therefore, if very different methods confirm an analysis, it is very probable that this analysis is, at least substantially, right.

3) In my opinion, the most important mental categories are very general “schemes” made up by man, which are: a) fundamental mental operations that man carries out on objects (to select an object from a group of objects, adding an object to another, discarding an object if another one is selected etc, as happens, for example, in the cases, which we saw, of the categories “who/what/which”, “and” and “or”, respectively); b) instruments for describing the relationships that objects have with each other (we saw the example of the preposition “with” and of the verb “to have”). Especially in case b), the possibility of using a certain mental category is influenced by the situation at stake. Therefore, in order to describe a certain situation, some expressions or sentences will be adequate, others will not. For example, if we have a situation with a bottle and a cork placed far from each other on a table, the expression “bottle with cork” is inadequate, while the expression “bottle and cork” can be used. The structure we have hypothesized for a certain mental category must explain the possibility or impossibility of using that mental category in a certain situation: if it does so, this is a verification of the hypothesis formulated. This methodology can be widely used, in various ways:

- a) we may substitute one correlator with another, as we have done in this case;
- b) we may invert the two correlata tied by a correlator (for example, if we invert the two correlata of the preposition “of” we achieve either nonsense or a completely different sense, like, for example, “wheel of a bicycle/bicycle of a wheel”; “bottle of glass/glass of a bottle”);
- c) we may make some substitutions (for example, if, in the expression “right after”, we substitute “after” with “then” we achieve an expression, “right then”, which sounds contradictory); etc.

All the phenomena that follow these manipulations must be explained by the structure we have hypothesized for the category under examination.

As the reader can see, the methods used to verify the analysis of a mental category, which I have just proposed, are essentially linguistic. Nevertheless, we may hypothesize that the methods of experimental Cognitive Psychology and Cognitive Neuroscience could also be used to verify the hypotheses about the mental categories formulated in this article. For instance, it can be hypothesized that during the production of the mental categories considered in this article, brain areas involved in selective attention, divided attention or memory (shown by means of techniques such as fMRI, PET, EEG etc.) are differently involved somehow according to the analyses proposed here.

Recently, An. and Al. Fingelkurts have put forward the hypothesis that there can be a correspondence between the theory of brain-mind functioning they propose, called *Operational Architectonics* (OA; Fingelkurts & Fingelkurts, 2001, 2003, 2004, 2005, 2006), and OS. OA, which was developed starting from Kaplan’s work (Kaplan et al., 1995; Kaplan, 1998, 1999), is an innovative neurobiological theory founded on the joint analysis of cognitive and electromagnetic data (EEG and MEG) and based, similarly to OS, on the central notion of “operation”. According to OA, every conscious phenomenon is brought to existence by the joint operations of functional transient (synchronised) assemblies of neurons, called Operational Modules (OM). Experiments have been sug-

gested to verify the putative correspondence between the theoretical frameworks of OA and OS (Benedetti, Marchetti, Fingelkurts, and Fingelkurts, forthcoming).

Relationships between OS and other approaches to the study of cognitive activity

As we can understand very well from what has been said up to now, OS is a set of *theories* that lies somewhere between Cognitive Psychology and Linguistics. Actual or possible relationships between OS and Psycholinguistics (and the related Neurolinguistics) can surely be found (even if OS has an independent origin, as we said). We cannot deal in depth with this subject in this article, which aims to provide a general introduction. Here, we can only mention very briefly the main actual or possible relationships.

1) A central question in Psycholinguistics is how human beings manage to create syntactic sentences, that is, whether syntax is an evolutionary product of increased human intelligence over time and social factors that encouraged the development of spoken language, or language exists because humans possess an innate ability, an access to what has been called a “universal grammar” (the first view is well represented by the mentalistic theories of J. Piaget, the empiricism of R. Carnap etc; the second point of view can be said to have begun with N. Chomsky [Chomsky 1959]). With regard to this, OS’s position is an intermediate one. In fact, in my opinion, it is *only the ability of carrying out the elemental mental operations that is innate*. On the contrary, *the ability of making up mental categories by means of these operations*, and of building the structure of thought by means of the mental categories, *is acquired* and culturally transferred, from generation to generation. The fact that in the various languages most of the mental categories are common (so that translation is always substantially possible) derives from the fact that humans live in physical environments that have a lot of similarities and have more or less the same necessities in communication. These necessities can nevertheless be satisfied in different ways, with the result that in the various languages there can be some differences both amongst the various mental categories and the structures of thought that are used. For example, in English there is no word with the same meaning as the Italian demonstrative pronoun (or adjective) “*codesto*”, which designates a distance from the one who speaks and a closeness to the one who listens (in English, we can only indicate either a distance from, or a closeness to, the one who speaks). All of this is in agreement with both the fact that the so-called “linguistic universals” (Lehmann 1992; Comrie 1989) are really very few and with the well-known fact that the so-called “feral children” lack language. We can clarify the position of OS about the innate component of thought/language and the cultural one by means of a simple comparison between language and the way of eating. There are some peoples who use knife, fork and spoon in order to eat, some who use sticks, and others who use (or used) their hands. These customs are acquired and culturally transferred, and differ from each other (in the same way as the syntax and some mental categories of the various languages can differ from each other). Nevertheless the gesture of using your hand to put food into your mouth is common to all humans (in the same way as most of the syntax and mental categories are common to the various languages), because the fact that humans have arms, hands and a mouth, which are in a certain reciprocal position, is genetically determined (in the same way as the ability of carrying out the elemental mental operation is genetically determined) and the fact that we have to put food into our mouth is a common necessity (in the same way as what humans have to communicate is largely common).

2) Psycholinguistics also deals with the comparison between human language and animal communication and with research into the possibility of a partial learning of human language by animals. *S.O.I.*’s theoretical approach has been applied to the latter problem. In fact, within the Lana Project (USA, 70’s), research into the possibility of linguistic communication between man and animal (the animal was a female chimpanzee, named Lana), a *S.O.I.* member, E. von Glasers-

feld, created an artificial language based on Ceccato's theories. This language (which comprised some mental categories) allowed the chimpanzee to show her having acquired such mental abilities to produce sentences, which were grammatically correct and had a sense, even if they were very simple (Glaserfeld 1989).

3) As regards the application of psycholinguistic methods to OS, the eye tracking method, used in Psycholinguistics to study the cognitive processes related to spoken language (Tanenhaus, Spivey-Knowlton, Eberhard, Sedivy 1995), was also used by Ceccato as early as the 60's. The possibility of verification of OS's theories by means of techniques such as fMRI, PET, EEG etc. has been mentioned above.

As a conclusion, we may say that OS is a general theory concerning thought and language, and here it is introduced as such. The methods used by Psycholinguistics could also be applied to OS. Relationships can be found and comparisons can be made between OS and Psycholinguistics (and other approaches). However, the complexity of the subject cannot be adequately dealt with in such a propedeutical article as this.

The limits of Operational Semantics

Even if the theories and the methodologies I have introduced are, at least as outlined in general, correct, we should nevertheless note that OS allows us to understand the nature and structure of the processes of thought and language¹⁶ *only partially and only up to a certain level of "depth"*. In fact, OS allows us to identify the meanings of the linguistic elements of the third class (page 4), because we have defined their meanings in terms of *operations*, that is, something *extra-linguistic* (in other words, in this way the meanings of these linguistic elements are no longer defined *with, in terms of, other words*, that is, we solved the problem of "going out of language", avoiding the vicious circle of words that send us to other words and so on¹⁷).

Nevertheless, even if it is possible to identify the elemental mental operations that make up the mental categories, and the structure of every single category, it is instead impossible to go *beyond* this level. In fact, OS defines, or describes, the meanings of the aforesaid linguistic elements in terms of operations of attention, of memory etc, but it cannot tell us what supports these functions. Moreover, OS allows us only to "see" what we may call, to use a metaphor, the "bare skeleton" of thought and language, that is, the mental operations we perform on, and that are elicited by, *our subjective phenomenal experience*. We have said that the words with an evident and important reference to something physical (or psychical) are one of the two fundamental components of human language. In my opinion, we should rather say that this component is given by words that designate *our subjective phenomenal experiences* (the so-called "qualia", or components of "phenomenal consciousness"), *which the physical world somehow elicits inside us, and which we "project" outside our mind, identifying them exactly with the physical world*. Apart from the inferences of science, our subjective phenomenal experience is *the only thing* that puts us into relationship with the physical world. Therefore, our subjective phenomenal experience is so usual for us that we are led to identify it with the physical world. That is, we are led to believe that "there, outside us" there are light, colours, sounds, etc. In my opinion, it is absolutely not so. "There, outside us" are electromagnetic waves, mechanical vibrations, etc, which *invariably make us feel* the sensations of light, colour, sound, etc, but which *are not* these sensations. The sensations *exist only inside us* (for similar view, see Revonsuo, 2006). This is not evident because, as we have said, our phenomenal ex-

¹⁶ As we said, this article deals with the descriptive aspects of thought and language, rather than with their generative or creative aspects, which are surely a crucial aspect of human cognition. Actually, my research has not been focused on them, at least up to now. In our research group, some reference to the topic can be found in Marchetti 2003, pp 22-30.

¹⁷ Obviously, these descriptions of operations are made up of *words*, because words are, even if not exactly the only, certainly by far the main way of making a description. But in this case words *do not send*, in order to define, *to other words*, in a circular way. In this case, words are only a means of describing *something different from words* (that is, mental operations). Therefore, there is no circularity.

perience is the only, therefore usual, direct intermediary with the physical world; and because, for each of most of the various kinds of sensations, there is only one external stimulus that can produce it (that is, only electromagnetic radiation gives us the sensation of light and colour, mechanical vibrations give us the sensation of sound, etc). But for some kind of sensations it is not so. For instance, there is no specific external stimulus for the sensation of pain. In other words, “there, outside us”, there is no “pain”: there are only various physical events that, by means of the physical mechanism of cell lesion with the emission of potassium ions, etc, *make us feel* the sensation of “pain” (in a completely unknown way), but that *are absolutely not* “pain” (nor is cell lesion “pain”). It is the same for any other sensation. The only difference is that for most kinds of sensations there is, almost always, stimulus specificity (the few exceptions are the well-known phenomena such as the strong compression of the eyeball, which elicits a sensation of light, etc).

Thus, *a fundamental part of our thought*, which is designated by language (that is, a fundamental part of the general problem of Semantics, i.e., “what does language designate?”) *is exactly our subjective phenomenal experience*. OS cannot tell us anything about this (for a different opinion, starting from the presuppositions of OS, see Marchetti 2006).

Possible practical applications of OS: implementation of a machine translation program of a new kind

The correlational theory of thought has allowed the conception of a device for the implementation of a machine translation¹⁸ program, which should allow us to achieve a noticeably better translation quality than that of the programs available today, especially when the source language is a language with very little morphology and a lot of ambiguities, such as English, and the target language is a language with rich or very rich morphology (such as French, Spanish, Italian, German, Russian, etc). This device is described in detail in Benedetti 2005d¹⁹. What the program should allow us to achieve is not a *perfect* translation, but what the programs available today do not guarantee, that is, an output text which is always or almost always *understandable and without distortions*, so that the user who does not understand a certain language at all or understands it very little can understand a text written in that language. The characteristics, which make this program different from all others, are the following.

- 1) The device is based on the correlational theory of thought, which is, as we saw, a radically new and deeply different linguistic theory from the other linguistic theories.
- 2) Basing itself on this theory, the program simulates, even if does not reproduce, a part of what the human beings actually do by using their intelligence when they translate, that is, rebuilding the structure of thought that corresponds to speech and choosing the meaning of a word (when a word may have more than one meaning) according to the sense of the sentence. In this way, the main problem that machine translation has always had, that is, the fact that the programs do not understand what they have to translate, is tackled and, in a wide part, solved at its root (even if thanks to an artifice).
- 3) The device is probably the only one that is completely and exclusively based on a single linguistic theory.
- 4) The device is probably the only one that is conceived by the persons who proposed the linguistic theory which the device itself is based on.
- 5) The number of ways in which the words making up a sentence can combine according to the correlational theory of thought is a finite number and not particularly high (it can be mathematically calculated starting from the number of words in the sentence and the number of the explicit correla-

¹⁸ The references for the history and the state-of-the-art of machine translation are: Hutchins 1986, 1992, 1999, 2001a,b, 2002, 2003.

¹⁹ This device was conceived by Ceccato and his collaborators in this project (Ceccato 1969; Glasersfeld, Pisani 1970). Only minor modifications and the description, which is rather different from the original one, are my own.

tors present in it). The program generates all the possible combinations (in order to examine them later), therefore the right combination is also surely produced.

The program is not difficult to implement from the theoretical point of view and does not require any special hardware or software technology. Therefore, this program could be implemented even now. The only problem that the implementation of this program presents is the fact that the human work needed to construct the extremely complex “notional spheres” the program is provided with (these notional spheres allows us to simulate the translation of the human being as described in 2) increases exponentially as the number of dictionary entries increases. Therefore, this is not a theoretical but a practical problem. Nevertheless, a first level experimentation in order to verify the validity of the program is, on the contrary, rather simple. We can start by providing the program with a very small dictionary, a dictionary of a few dozen words. Even with so few words we can build a large number of sentences and can check that the program does not make the kind of errors that are commonly found with current programs.

Conclusions

In this article, the author has stressed the fact that words and morphemes seem divisible, as far as the nature of their meaning is concerned, in at least three main classes: elements that seem to have an evident and important reference to something 1) physical or 2) psychical; 3) elements that do not, or only minimally, seem to refer to something physical or psychical. The third class consists mainly of the words that we may call “grammatical” (prepositions, conjunctions, interrogative-indefinite-relative pronouns or adjectives, demonstrative adjectives and pronouns, main adverbs of place, time, manner etc., pronouns/adjectives of quantity, numerals, negation, fundamental verbs like “to be”, “to have”, etc.) and of most morphemes of the large number of languages that have a more or less rich morphology. It has been stressed that the elements of the third class, even if they are much less numerous than those of the first class, are almost always, as a class, the main component of any speech and seem absolutely indispensable in order to speak. Therefore, it seems possible to affirm that until we have understood the *nature of the meaning* of these words and morphemes we shall not understand the nature of a fundamental component of thought and language. In this article the author has tackled the problem of the semantics of these linguistic elements. He has introduced a radically new theory (Operational Semantics) about the nature of the meanings of these linguistic elements and of thought-language in general. This theory is based on the fundamental assumption that these meanings are sequences of mental operations (“mental categories”), among which the ones of attention play a key role. A methodology for the analysis of these meanings and for the verification of the analyses carried out has also been provided. This methodology is partly based on introspection, partly on the study of linguistic data. The limits of OS have also been stressed. In fact, OS offers (if its theses are, at least substantially, correct) a solution to the problem of the meaning of the linguistic expression: 1) only up to a certain level of “depth”, because OS defines, or describes, one of the two fundamental components of what language designates in terms of certain mental functions (attention, memory, etc), without yet being able to explain how these functions take place; 2) only partially, because OS does not throw any light on the other fundamental component of what language designates, that is, the contents of phenomenal consciousness. Nevertheless, OS allows us to achieve a level of comprehension of the nature and structure of thought and language that, at present, is far beyond the reach of Neurobiology. Obviously, there is no opposition at all with Neurobiology, but, on the contrary, the greatest possible synergy is to be hoped for.

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