PSYCHOLOGY RESEARCH PROGRESS

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CONSCIOUSNESS, ATTENTION AND MEANING

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INTRODUCTION

Consciousness, attention, and meaning: thousands of articles and books have been written on these subjects. Usually, they deal with just one of the subjects, or at best try to relate one subject with another (for example, attention with consciousness, or attention with meanings). This work represents one of the very rare attempts to systematically relate the three subjects to each other. I tried to achieve this objective by putting forward a comprehensive theoretical framework, constrained as much as possible by empirical evidence and supported by logical argumentations, that explains the existence of both consciousness and meanings through the working of attention.

My attempt has a long history: it dates back some twenty years, when I started to develop an interest in how our mind works. Much time has passed since then, filled with study, fundamental readings and suggestions by other authoritative and influential scholars and researchers, stimulating discussions, painstaking work, more or less successful attempts at formulating hypotheses and theories, and a continuous effort to see and consider things from various and different viewpoints in order to find plausible solutions and explanations. All this made me gradually develop and extend my original interest in the human mind to include what I consider to be two of its main and distinguishing features, that is, the possibility it gives us of being conscious, and of producing meanings. At the same time, my original interest in the human mind unavoidably facilitated my assumption of a unifying approach, in the sense that it led me to look for a common principle underlying both consciousness and meanings: which I found in attention.

Due to its intrinsic interdisciplinary nature, this work can be of interest to all those who carry out research and studies in psychology, linguistics, semantics, psycholinguistics, neuroscience, cognitive science, artificial consciousness, and artificial intelligence.

Many applications can derive from the theories I have put forward here. Just a few of these are: the development of conscious machines, mind-reading, mechanical translation, the direct translation of linguistic thought into electronic signals, the development of a new way of browsing the internet (an idea recently suggested to me by Alexander and Andrew Fingelkurts).

The book is divided into three chapters.

In the first chapter I try to provide an answer to a fundamental question concerning human consciousness: how can we explain the phenomenal quality of our conscious experiences? I argue that the most suitable perspective to deal with conscious experience is the first-person rather than the third-person perspective. A first-person perspective approaches

a person's conscious state not from the point of view of an external observer but of the person who is experiencing that conscious state. As such, it tries to understand how phenomenal experiences are generated by a person who creates them, and to analyze the person's conscious state in relation to the emergence, formation and development of the person.

Accordingly, I develop a model of consciousness (and self-consciousness) based on the idea that the person emerges as an entity from the organism's continuous application of its own nervous energy to itself. The model is composed of two main parts: the perceptual system and the schema of self. The perceptual system makes it possible for an organism to be conscious, whereas the schema of self provides the rules that make an organism perceive, move, act, behave, and live in general. The stream of consciousness arises from the uninterrupted interaction of these two systems.

The core of the model is attention. Attention, which is the activity the organism can perform thanks to the nervous energy that is supplied by the organ of attention, gives the organism the possibility of performing actions capable of directly varying the organism's state of nervous energy. It is this variation that constitutes the phenomenal aspect of consciousness. When acting, the organism can directly experience and feel its actions and the results of its actions, thus leading to the delimitation and emergence of the person.

The final section of the chapter is dedicated to the discussion of the empirical and logical plausibility of the three main assumptions on attention implied by my model of consciousness:

i) Attention is necessary for consciousness;
ii) Attentional activity can be performed because we are provided with the organ of attention that produces nervous energy;
iii) Attentional activity directly affects the organ of attention, causing a modification of the state of the nervous energy itself, which constitutes the phenomenal aspect of consciousness.

In the second chapter, I elaborate on the implications that some of the main ideas I put forward in the first chapter - namely, that the person emerges as such from the continuous use and application of his/her attention - have on the theory and analysis of meanings. In the process of emergence, the person differentiates him/herself from other entities, and gets to know them and him/herself. This differentiation makes the person continuously relate, in and by means of consciousness, to other entities. All the relations developed in this way contribute to form the meanings that other entities (and the person him/herself) have for the person.

In this context, therefore, my use of the term "meaning" identifies the knowledge built from the continuous interaction between the person and other entities: an interaction that is consciously experienced, specifies the relations existing between the person and other entities, and is guided by the hierarchy of principles, rules and goals of the person. By making the person experience directly how other entities relate to him/her, consciousness is the privileged way for the person to acquire and construct his/her knowledge of the world. In this sense, consciousness (and self-consciousness) can be defined as the organ of meaning.

The chapter is mainly devoted to linguistic meanings, given their preponderance in terms of usage over the other kinds of meanings, and the fact that the former are usually better codified in well-attested systems. In my view, linguistic meanings isolate, decontextualize,

"freeze" and classify, in the articulated system of words and grammars, the ever-changing and multiform stream of the conscious experiences that human beings have of their relations with other entities. The meanings of words are composed of the sequence of invariable elements that, independently of any individual occurrence of a given conscious experience, are responsible for the production of any instance of that conscious experience. The elements composing the meanings of words are attentional operations: each word conveys condensed instructions on the attentional operations one has to perform if one wants to consciously experience the relations that are expressed through and by it. Words are tools to pilot attention.

The chapter presents the specific kind of semantic I devised on the basis of my theoretical findings on consciousness and meanings: Attentional Semantics. Attentional Semantics aims at finding the attentional instruction conveyed by the meanings of words. To achieve this goal, it tries to:

i) Identify the sequence of the elementary conscious experiences of the relations that invariably accompany, and are prompted by, the use of the word being analyzed;
ii) Describe these conscious experiences in terms of the attentional operations that are responsible for their production; and
iii) Identify the unconscious and non-conscious operations that, directly or indirectly, serve either as the support that allows the attentional operations to take place, be completed, and occur in a certain way, or as the necessary complement that makes it possible to execute and implement the activities determined and triggered by the conscious experiences.

The chapter then presents the antecedents of Attentional Semantics, the methods and techniques of Attentional Semantics, the similarities and differences between Attentional Semantics and the other research programs that have set themselves the aim of systematically analyzing meanings in attentional terms, and the implications that Attentional Semantics has for the other kinds of semantics.

In the third chapter, I apply the theories and principles expounded in the first two chapters to the conscious experience of time. As I will try to show, the analysis of time is vitiated very often by circularity: several disciplines, such as psychology, linguistics and neurosciences, analyze time by using concepts or terms which already contain in themselves, or are based, on the experience and notion of time (such as when, for example, time is defined as "duration", or when our ability to estimate durations is explained by resorting to the notion of an internal clock). The theoretical framework I put forward for consciousness and meanings in the first two chapters, and the kind of semantics I developed within this framework - Attentional Semantics – represent a way out of this circularity because they describe and analyze the person's conscious state solely in relation to his/her activity constituting it and do not surreptitiously introduce any characteristic or element resulting from the very conscious activity that is being analyzed. The analysis I performed according to the principles and methods of Attentional Semantics reveals that time-sensation is determined by the quantity of labor performed by the portion of our attention (A_t) that is focused in a continuous and incremental way on the conscious product of the activity performed by means of another portion of one's attention (A_e). The activity performed by A_t represents the "temporal activity" (for instance, estimating duration); the activity performed by A_e represents

the "non-temporal activity" (for instance, perceiving the shape of an object). The amount of nervous energy - supplied by the organ of attention - expended to support the activity of A_t constitutes the basis on which the conscious experience of duration and more in general time-sensation are based.

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Chapter 1

CONSCIOUS EXPERIENCE

In this chapter I will try to tackle the main problem of human consciousness: how can we explain the phenomenal quality of conscious experience? Many researchers have tried to solve this problem by adopting a third-person perspective. I argue that this perspective is not the most appropriate when analyzing the phenomenal aspect of consciousness, and that a first-person perspective must be adopted instead. To support my argument, I will compare the two perspectives, and present the main drawbacks of the third-person perspective. I will then present my model of consciousness which is developed on a first-person perspective.

The model is composed of two main systems, the perceptual system and the schema of self. The perceptual system is mainly based on the organ of attention, sense-organs, somatosensory organs, and a working memory: it enables the organism to be conscious and provides the products that will be processed by the schema of self and that contribute to update and modify it. The schema of self, largely based on innate schemas of action and a long-term memory, provides the rules which make our organism perceive, move, act in general and interact with other organisms. From the uninterrupted interaction of the schema of self and the perceptual system, the stream of consciousness arises.

The schema of self - once it has learnt and embodied the notion that the organism, by means of conscious perceiving, is able to affect the course of its own actions - provides the organism with a new degree of freedom that enables it to directly control itself. This constitutes the fundamental passage from consciousness to self-consciousness.

Attention is the core part of the perceptual system: it is not only responsible for the selective aspect of consciousness, but also for its phenomenal quality. The organ of attention is the source of the organism's nervous energy; nervous energy is a kind of physical energy and allows the organism to operate attentionally; the attentional activity performed by the organism induces a variation in the state of nervous energy. This variation constitutes the phenomenal aspect of consciousness. The person emerges as an entity from the organism's continuous application of its own energy to itself: when acting, the organism can directly experience and feel its actions and the results of its actions, thus making possible the delimitation and emergence of the person.

A final section is dedicated to the discussion of the empirical and logical plausibility of the three main assumptions on attention implied by my model of consciousness: attention is necessary for consciousness; attentional activity can be performed because we are provided with the organ of attention that produces nervous energy; attentional activity directly affects the organ of attention, causing a modification of the state of nervous energy itself, which constitutes the phenomenal aspect of consciousness.

1. The Main Problem of Consciousness: Qualia

Many models of consciousness have been presented in the last decades. Even though most have tackled some important aspects of consciousness, very often offering viable solutions, practically none have successfully addressed what can be considered the main problem of consciousness: its phenomenal and qualitative aspect, or what philosophers call "qualia", that is, the fact that every time we consciously experience something - whether a color, a sound, pain, pleasure, or something else -, we have a direct experience of it, we "feel" it.

The inadequacy of current theories of consciousness and of available scientific tools to cope with the subjective and qualitative aspect of consciousness has been shown by many authors (see for example Chalmers 1996, Di Francesco 2000, Searle 1992, Zeman 2001). Theoretical positions on consciousness range from those which do not even admit the legitimacy of the concepts of consciousness and qualia - the so called eliminativist ones (Churchland 1983, Dennett 1991, Rey 1983, Wilkes 1988); to those which, even though they admit the importance of qualia, nevertheless fail to account for them – the reductionist ones (Baars 1988, Crick 1994, Edelman 1989, Edelman and Tononi 2000); to the dualist ones, which, despite taking consciousness seriously, are not able to explain its causal properties and its interactions with the physical world (Block, N. 1995, Chalmers 1996, McGinn 1991).

In my opinion, the fact that no model of consciousness has so far successfully addressed the problem of the phenomenal aspect of consciousness is due to the lack of a proper theoretical perspective that could exhaustively and coherently account for it: which I have called the "first-person perspective" (Marchetti 2001). Most of the current and dominating models of consciousness originate mainly from the long-established "third-person perspective" usually adopted in empirical sciences; only few attempts have been made at elaborating a theory based on a first-person perspective, among which Damasio's (1999), Evans' (1970) proposal of the "self-approach", Marchetti's (2001) theory of consciousness, and Varela's (1996, 1999) and Varela and Shear's (1999) proposal to reconcile the first- and the third-person approach to consciousness. The importance of the first-person perspective is also acknowledged by Vogeley and Fink (2003), even though mainly in relation to a specific, albeit fundamental, manifestation of consciousness, that is, self-consciousness.

Let us analyze the main differences between the third-person perspective and my proposal of a first-person perspective, and let us consider some examples of theories of consciousness based on a third-person perspective, so as to see the typical drawbacks it entails.

2. Two Approaches to Consciousness: Third-Person and First-Person Perspectives

2.1. A Comparison between the Two Approaches

The main differences between the third-person perspective and my proposal of a first-person perspective can be thus summarized (see also Table 1):

a) Third-person perspectives approach a person's conscious state by describing and analyzing it from the point of view of an external observer. A first-person perspective approaches a person's conscious state by describing and analyzing it from the point of view of the person who is experiencing that conscious state. Here it is important to highlight that by "describing and analyzing a person's conscious state from a first-person perspective" I do not mean capturing its phenomenal and qualitative aspect: actually, there is no possibility of transmitting from a person to another person the "what it's like" qualitative character of a great part of conscious states (unless, most probably, one takes a cable made of neurons from one person's area and connects it directly to the same area of another person, as suggested by Ramachandran and Hirstein 1997), in the sense that we can never know what another person really experiences when seeing "red", and whether he/she experiences "red" in the same way that we do (I say for "a great part" because there is an important exception: the meanings of words. In fact, when someone says that "he has seen red" we know perfectly well what he means by saying this, because we have the same linguistic and semantic conscious experience as he has, even though we cannot know what he really feels in seeing red, and if he feels the same thing as we feel). Rather, by "describing and analyzing a person's conscious state from a first-person perspective" I mean understanding how phenomenal experiences are generated by a person who creates them.

b) Third-person perspectives analyze the person's conscious state in relation either to some of its characteristics that can be observed by the external observer (for example: being "unique" albeit "unitary"; reflecting the binding of diverse modalities; being "serially ordered") or to some other observable event (the person's neural states, the person's external behavioral reactions, etc.). A first-person perspective describes and analyzes the person's conscious state in relation to the emergence, formation and development of the person. Here, "emerges" means "being able to exist as a person", that is, as an entity distinct and differentiated from other entities, beings, and objects. The process of differentiation from other entities implies that the person has the capacity to determine his/her own limits and boundaries, and concurrently the limits and boundaries of other entities: simply put, to determine the relation existing between him-herself and other entities.

c) In third-person perspectives, the person's conscious state, being described and analyzed from the point of view of the external observer, acquires the characteristics (whether they are its being "unique", "serially ordered", "largely widespread and broadcast", or else) assigned to it by the external observer (rather than by the person him-herself). This implies that it assumes and inherits all the functions, meanings, and values that the external observer – more or less unconsciously, unintentionally or inadvertently – introduces and brings along with him when describing and analyzing it. In a first-person perspective, the characteristics of the person's conscious state derive from the person's activity, and, conversely, the person characterizes according to, and emerges from, his/her continuously producing conscious states;

d) In third-person perspectives, the role of the person in constituting and characterizing his/her conscious states (and conversely, the role of conscious states in constituting and characterizing the person in turn) are completely overlooked by the external observer. Actually, the characteristics introduced by the external observer (for

example, the "uniqueness" of the conscious state, or its being "serially ordered", etc.) are the result of a person's (that is, the external observer's) activity. But, being surreptitiously introduced, they cannot be, and are not, analyzed as such (that is, as the result of the person's activity). Consequently, they magically appear as inherent, a-priori characteristics, as primary data of a ready-made world, whereas on the contrary they are (a-posteriori) duplications of products of the person's activity. This gives rise – among other things - to problems of circularity and endless regression: what is a result of the person's activity is taken to be a basic constituent of that very activity. In a first-person perspective, the role of the person in constituting and characterizing his/her conscious states is fully taken into account. Nothing is surreptitiously introduced, and everything is analyzed and explained as a product of the person's activity. Conscious states are not constituted by a-priori characteristics.

2.2. A Critical Review of Models of Consciousness Based on the Third-Person Perspective

As we have seen, third-person perspectives describe and analyze the person's conscious state in relation to some of the characteristics of the conscious state itself that can be observed by the external observer. This is the case, for example, of Baars' (1988, 1997a) *Global Workspace* model, and Edelman and Tononi's (2000) *Dynamic Core* hypothesis (see also Edelman 2003).

Baars' *Global Workspace* model is mainly based on the "theater" metaphor of consciousness, that is, the idea that consciousness is the "publicity" organ of the brain. Fundamentally, the "theater" metaphor tries to account for a specific characteristic of conscious experience: that is, its capacity to combine the various and different kinds of information processed by our brain (sensory signals, memories, etc.) into one single kind of "message" that, being widely broadcast, dominates, and prevails over all the others. Consciousness would be a facility for accessing, disseminating, and exchanging information in the brain, and for exercising global coordination and control. Indeed, only a fraction of the brain would seem to directly support conscious experience: Baars' (1988) proposal includes the reticular formation of the brain stem and midbrain, the outer shell of the thalamus and the set of neurons projecting upward from the thalamus to the cerebral cortex. Together they provide the stage for the unconscious audience in the rest of the brain. Baars' model is certainly highly valuable in explaining a number of cognitive processes: the subject's access to information, the influence of unconscious processors, voluntary control, the development of a self-concept, etc. But, as Chalmers (1996) observes, the question of why these processes should give rise to phenomenal experience is simply not addressed. The best that Baars' theory can do is to state that the information processed within the Global Workspace is experienced because it is globally accessible. But the question of why global accessibility should give rise to conscious experience remains unanswered. Not having directly and positively addressed the problem of the phenomenal aspect of consciousness, but rather having addressed derivative characteristics of conscious states (such as being "largely widespread and broadcast"), Baars' model can explain the latter, but not the former.

Table 1. The main differences between third-person and first-person perspectives

	Third-person perspective		**First-person perspective**
What point of view it implies	The external observer	Some kinds of external observation: Behaviorism Information-processing approach	The person who is experiencing the conscious state
How it analyzes the person's conscious state	In relation to characteristics of the conscious state or of some other events observable by an external observer	Some kinds of observable characteristics: Phenomenal characteristics of the conscious state Neurophysiological characteristics of the brain	In relation to the emergence, formation and development of the person
How it characterizes the person's conscious state	The person's conscious state acquires the characteristics assigned to it by the external observer	Some examples of characteristics assigned by the external observer: The uniqueness and unitary appearance of conscious states (Edelman and Tononi 2000); Conscious states are largely widespread and broadcast (Baars 1988); Reentry (Edelman 1989); Coherent oscillations (Singer 1993); Quantum processes in neurons microtubules (Penrose 1994); Sensorimotor contingencies (O'Regan & Noë 2001)	The characteristics of the person's conscious state derive from the person's activity
The role it assigns to the person in constituting his/her conscious states	Completely overlooked	Main drawbacks of third-person perspectives: Circularity, Endless regression Representationalism	Fully taken into account

Edelman and Tononi's (2000; see also Edelman 2003) *Dynamic Core* hypothesis tries to account for the contrast between the diversity and changeability of conscious states and the unitary appearance to the conscious individual of each conscious state, that is, for the fact that any particular conscious scene is experienced at once as "integrated", "all of a piece" and as "differentiated", in the sense of being "unique". The dynamic core hypothesis proposes that the occurrence of any particular conscious state correlates with a "highly informative discrimination" in a multidimensional space of signals: in neural terms, this would mean that the neural mechanisms underlying consciousness consist of a functional cluster in the

thalamocortical system, within which re-entrant neuronal interactions yield a succession of differentiated yet unitary metastable states. The dynamic core hypothesis also proposes a quantitative way of measuring "neural complexity" (that is, the extent to which the dynamics of a neural system are both integrated and differentiated), high values of which are suggested to accompany consciousness. Edelman and Tononi, despite providing a neural explanation of qualia (in their view, qualia correspond to the higher-order discriminations entailed by the activity of the neural system), admit that a third-person description of qualia cannot presume to replicate the experience that they imply, and that only an individual can experience the qualitative properties of qualia: which is tantamount to acknowledging the impossibility for a third-person analysis to fully and properly account for any subjective phenomenal state. Moreover, having based their model of consciousness on some of the characteristics of conscious states (the "uniqueness" of each conscious state, combined with its unitary appearance), they are led to explain the phenomenal aspect of consciousness precisely in terms of those characteristics: consequently, they can only state that the specific property of each quale is determined by the distinctions among the entire set of experienced qualia. This is a typical structural description of phenomena, according to which a given phenomenon is defined on the basis of the relations it has with phenomena of the same kind or level. Such a structural description unavoidably engenders a circular explanation of qualia, which it is impossible to get out of, and which cannot provide any positive account of why a certain differentiated yet unitary metastable neural state should turn into a certain phenomenal experience, and why the phenomenal experience should possess precisely the qualitative characteristics it has.

Third-person perspectives describe and analyze the person's conscious state in relation not only to some of the characteristics of the conscious state itself, but also to some other kind of observable characteristic, such as the neurophysiological characteristics of the brain. This is precisely what Edelman does, by putting forward his model of consciousness based on the idea of "re-entry" (1989, 1992; see also Reeke and Edelman 1995). Re-entry is a form of ongoing, reciprocal exchange of signals between neuronal repertoires along parallel anatomical connections. Re-entry assures that responses are correlated across different neuronal repertoires at any one time and across similar sensory signalling patterns occurring at different times; it provides: a) pathways that allow current sensory signals to evoke memorial responses in appropriate repertoires; b) a means by which these responses can interact with current responses; c) and, through these interactions, the basis for categorization, learning, and consciousness. According to Edelman, both primary consciousness - which includes an awareness of the world, mental images, but lacks a concept of self and is restricted to the present time - and higher-order consciousness - which includes self-awareness, a sense of time, and language – would arise as a result of re-entrant connectivity and signalling between different neuronal groups of different areas of the brain.

Proposals such as those made by Edelman (1989), which correlate consciousness with some neurophysiological property, have at least two drawbacks. Firstly, they induce us to believe that they are based only on a purely neurophysiological description or analysis, and that no other analytical level is involved. This is wrong of course. If we consider Edelman's proposal, for example, we can see that his idea that consciousness arises as a result of re-entrant connectivity and signalling between different neuronal groups of different areas of the brain is inspired by one of the main features of consciousness, which is the possibility it gives us of continuously accessing, monitoring and controlling our own conscious functioning and

products: this shows that a neurophysiological description of consciousness is never pure or sufficient, and that it must always be preceded or accompanied by some kind of consideration deriving from observations that are performed at some other and different level (for example, the one characteristic of folk psychology: on this point, see Pylyshyn, 1984; see also Humphrey 2006).

Secondly, as observed by O'Regan & Noë (2001), the problem with proposals such as Edelman's is that they do little to elucidate the mystery of consciousness. The presence of some neurophysiological characteristics, such as Edelman's re-entrant signalling between cortical maps, Singer's (1993) coherent oscillations, or Penrose's (1994) quantum processes in neuron microtubules, does not in itself explain the phenomenal quality of conscious experiences. Even if one particular mechanism – for example, coherent oscillations - were proven to correlate perfectly with some behavioral measure of consciousness, the solution of the problem of consciousness would simply be postponed: indeed, why and how should coherent oscillations generate consciousness? After all, oscillations are observed in many other branches of science, where they do not generate consciousness.

As we have seen, one of the main problems with third-person approaches is the circularity brought about by the external observer who, while analyzing the mechanism of consciousness from his point of view (rather than from the person's), unavoidably tends to assign to the person's consciousness some ready-made, unanalyzed characteristics (which he himself formed and developed by means of his consciousness), considering them as its basic constituent (rather than its products). One typical example of this problem is the opinion that somewhere in our brain we have an internal representation of the outside world, and that when the representation is activated, we have the kind of vivid and rich conscious experience we all share. This opinion mistakes the result of a process (the vivid, qualitative experience of something) for the basic component of the process itself, thus bringing about circularity, along with all the drawbacks it usually entails. If the phenomenal experience of something derives from the representation we have in our brain of that something, what is the difference between the former and the latter? What are the laws connecting the two? What is the need for us to consciously experience something if we already possess its representation? If the representation already has the qualities it is supposed to account for, where do they come from, given the fact that "experiencing" them cannot account for them? The hypothesis of the existence of internal representation generates more questions and problems than it is supposed to solve. O'Regan & Noë (2001) also show, as far as vision is concerned, the ineffectiveness of the representationalist view: indeed, in order to assure the visual stability and congruity of what is seen, it makes whoever adopts it postulate additional and uneconomical mechanisms that have to compensate for phenomena such as the blind spot, retinal non-homogeneities, the smear that is created by eye saccades. Moreover, as observed by Morris (2004), the representationalist view begs the question of how a brain-state becomes a representation, that is, becomes something different and more than firings of neurons. Appealing to activation levels in a neural network is not enough if we cannot say how they come to be representations: how are we to locate the difference by virtue of which they represent *all and only* those things that they are supposed to represent? We beg the question if we answer by referring to what counts as different for us: while they do indeed represent something for us, are they representations for the brain? What is it that makes the representations represent what they are supposed to represent, and not, instead, the level of glutamate in the brain?

O'Regan & Noë's (2001) proposal to overcome the problems raised by the representationalist view consists in considering conscious perception as something we do, as a mode of exploring the environment in ways mediated by the knowledge of what they call "sensorimotor contingencies". In their view, the qualitative experience we have when we see an object would consist in the knowledge of the relevant sensorimotor contingencies, that is, in knowing that if we make a certain eye movement, the object will change in the particular way typical of what happens when we move our eyes. The differences in the qualitative character of perceptual experiences would correspond to differences in the character of the relevant sensorimotor contingencies.

In my opinion, O'Regan & Noë's (2001) account of conscious experience suffers from the kind of circularity I have described above. If seeing involves testing and mastering the changes that occur through eye, body and attention movements, then the question would now become: How are these "changes" perceived? Who perceives the "changes"? Who is doing the testing? Is there some agent or homunculus perceiving them? Who possesses the knowledge of the sensorimotor contingencies? O'Regan & Noë seem to overlook the fact that their account of conscious experience presupposes, but does not explain, the existence of a person who detects and tests the changes, who knows what will happen when his/her eye will move in a certain direction, and so on: indeed, in order to detect a certain change, there must be someone who detects it, and for whom the change has certain implications, a certain meaning or value. Moreover, as Manzotti and Sandini (2001) observe, O'Regan & Noë's proposal raises the question of why sensorimotor contingencies should explain subjective experience, given the fact that it seems perfectly conceivable that sensorimotor contingencies can exist without any visual qualities or phenomenal experience at all.

3. A New Model of Consciousness Based on the First-Person Perspective

All the examples we have seen in the previous section show that the third-person perspective is not suitable to tackle the phenomenal aspect of consciousness, because of the incompatibilities between its "objective" methods of investigation and the specific characteristics of the subjective sphere. In order to properly account for it, a different kind of perspective must be adopted: the first-person perspective. The first-person perspective overcomes the drawbacks of the third-person perspective by fully taking into account the role of the person in constituting and characterizing his/her conscious states, and avoiding to surreptitiously introduce external, ready-made characteristics into its analyses and descriptions of the person's conscious state.

In the following paragraphs, I will present my model of human consciousness which was developed using a first-person perspective. Essentially, this model is based on the continuous interaction of two systems:

1. the perceptual system and
2. the schema of self.

The perceptual system, principally based on the organ of attention, sense-organs, somatosensory organs, and a working memory (in which the products of the attentional activity previously performed - such as memories, concepts, meanings of words, thoughts - can be processed), enables the organism to be conscious and provides the products that will be processed by the schema of self and contribute to update and modify it. These products derive from the operations performed by the perceptual system either on the organism or on the environment.

Conversely, the schema of self, largely based on innate schemas of action and a long-term memory, provides the rules which make our organism perceive, move, act in general and interact with other organisms. As a consequence, it provides not only the instructions for the perceptual system but also the raw material it has to work out: in fact, the actions performed by the organism can be perceived by the perceptual system (even the very action of perceiving) and become available under the form of conscious perceptions for the schema of self. The latter in turn works on the basis of these perceptions to issue a new instruction for the perpetual system and for the organism.

The uninterrupted interaction of the two systems generates the stream of consciousness (James 1890); each interaction between the two systems generates a specific and unique perception. The uniqueness of each "pulse of consciousness" (James 1890) is determined by the particular instructions that the schema of self gives each time to the perceptual system. These instructions in turn vary each time because of the modification of the schema of self by the conscious perceptions. The consistency and coherence of the stream is ensured by the presence of the schema of self, which tends to run the perceptual system and the organism in general according to a hierarchy of principles, goals and rules at the top of which there is one fundamental principle: the principle of survival, which can operationally be translated into the following imperative "operate in order to continue to operate".

The perceptual system acts as a monitor that continuously checks what is going on inside and outside the organism, and informs the schema of self. Without this kind of information, the schema of self would be kept in the dark about what has happened or is happening within itself and in the environment. As we will see, what counts more is that the perceptual system provides the schema of self with the necessary information for the definition and development of a self, that is, for its differentiation from the environment.

The fact that the perceptual system monitors the organism implies that the operations and activities of the organism are consciously perceived only after they have been performed. We become aware of what we do only after we have done it (see for example, Libet 2004: but on the limits of Libet's theory about voluntary acts, see Marchetti 2005). Evidence of this is given by our daily experience: sometimes, we become aware of what we wanted to say only after having said it.

The fact that the schema of self is updated and fed by the perceptual system implies that conscious products play a causal role in human behavior. They not only contribute to modify the schema of self, but provide the organism with the capacity to act autonomously and voluntarily. According to some authors, the only condition necessary for this to happen is that the organism has a language. For example, Cimatti (2000) points out that, if an organism uses language not only to communicate its own intentions or the events happening in the environments to other organisms, as animals do, but also to communicate with itself, directing its own attention to itself and to its attentional system (and, consequently, to someone else's attentional system), the organism can control its own attention and actions,

and act intentionally. This is what happens when someone says to oneself that it is time to stand up, and then one stands up. This is also what happens when someone tells someone else to control him/herself, and the latter acts accordingly. In my view, by repeating these kinds of operations, the schema of self assimilates the notions of autonomy and self-regulation, thus giving the organism the ability to control and plan its own activities.

Now let us see in detail how the perceptual system and the schema of self work.

3.1. The Perceptual System

As we have seen in the previous section, the most suitable perspective to analyze a sentient person is the first-person perspective, because it centers on the process by means of which a person emerges as such and comes into existence. Such a person can be said to exist and be so when he/she can delimit and control him-herself, his/her operations, movements and intentions, according to the impact his/her actions have on him-herself. This implies that he/she is able to perform a kind of activity that gives him/her the possibility of *directly* knowing him-herself and defining his/her limits. The direct experiences he/she has of him-herself contribute to form and constitute him/her. For instance, the activity he/she performs when trying to reach something unsuccessfully has a direct effect on him-herself, in the sense of modulating his/her own pool of nervous energy by either blocking the nervous energy flow, re-directing its course, or further stimulating it in the same direction (what I mean here by "nervous energy" will become clearer in the following paragraphs: a detailed description is given in sections 4.2 and 4.3). This effect, which constitutes the "feeling" the person has, immediately gives the person the dimension of his/her effort, and the boundaries of his/her body. We could say that the form the person assumes is the outcome of the activity that produces his/her experiences: the person is the result of this activity. It is this activity that gives the person the possibility of existing as such, because only by performing it can the person take a form and differentiate him/herself from other beings and objects. Therefore, describing what a person feels and experiences is describing this activity and its course.

How can this activity make a person have experiences and feelings? I think that an explanation can be found if we conceive:

a) The person as the outcome of a special kind of activity (let us call it "attentional activity") performed by an organism thanks to a special kind of energy (let us call it "nervous energy") that is supplied by one of its organs (let us call it the "organ of attention"). By means of this energy, the organism can pilot itself by controlling and running some of its organs (the motor organs, the sense-organs, the organ of attention itself, the somatosensory organs, working memory, and the schema of self). This energy is physical and most probably not of a simple kind, but a combination of different kinds: chemical, electrical, etc. The "organ of attention" is the physical substrate or the nervous structure that is responsible for the production of nervous energy.
b) The attentional activity the person performs as what makes his/her state of nervous energy change. This can happen indirectly, through the action of the person on the world, and the subsequent re-action of the world on the person, or directly, through the action of the person on him-herself;

c) The conscious experience the person has as the change of the state of nervous energy resulting from performing the attentional activity.

As one can see, this proposal implies three strong assumptions on attention, namely: attention is necessary for consciousness; attentional activity can be performed because we are provided with the organ of attention that produces nervous energy; attentional activity directly affects the organ of attention, causing a modification of the state of nervous energy itself, which constitutes the phenomenal aspect of consciousness. Since the analysis of the empirical and logical plausibility of these assumptions deserves a specific and detailed discussion, I will dedicate the last section of this chapter to it, preferring to first present my model of consciousness.

It should be noted that some other authors also highlight the fact that conscious experiences are the product of the person's activity, even though they do not identify this activity with attention. For example, Humphrey (2006, p. 14) claims that sensations are something that the person *creates*: "Something that does not exist before he looks at the screen, and will vanish when he closes his eyes. Some *thing* indeed, a new fact of his own making". Humphrey, however, adopting a typically third-person perspective, and more precisely a behaviorist one, can only conceive sensation as a response to the sensory stimulus (2006, p. 54), and "feeling sensation" as the self-monitoring by the person of his/her own response (2006, p. 90). Consequently, he cannot explain the qualitative aspect of qualia, nor can he avoid falling into the circularity implied by the third-person approach: in fact, how can one explain the "self-monitoring" by the person of his/her own response? Is this self-monitoring still a kind of response? But if it is still a kind of response, there must be someone else who monitors this further response, and so on, in an endless regression.

In my opinion, we can satisfactorily account for the way the person's activity gives origin to consciousness only if we identify this activity with attention, and if we suppose that we can perform attentional activity thanks to the nervous energy supplied by the organ of attention.

In this view, attention has a central and active role. Every time we direct our attention towards an object, we spend our nervous energy on it. At this point, a change in the state of nervous energy may occur, thus making us perceive or feel the object. Clear evidence of this can be found in very common situations. When having certain "negative" sensations, our activity tends to be slowed down or blocked: sensations of sorrow, pain, tiredness, depression, and so on, *consist* precisely in a reduction or block of our energy flow, as if an obstacle was put in the way of our operating (as a consequence of either a full consumption of our nervous energy or a block of the input flow of energy). Conversely, "positive" sensations, such as happiness, wellness, freshness, and so on, *consist in* a beneficial restoration, facilitation or stimulation of our energy flow.

Even sensations that are not as strong give us evidence of the change that our state of nervous energy undergoes because of the working of attention. When we intend to perceive the surface of an object by touching it, we focus our attention on our fingertips: if a limitation is imposed on us, and we cannot further expand our movements and nervous energy in that direction or dimension, then we have a sensation of "hard". On the contrary, a sensation of "soft" arises when we can further expand our nervous energy, as if we have not yet reached a limit.

Therefore, a person's feelings and conscious experiences are the direct result of his/her applying and using his/her attention (whether on the sense-organs, the somatosensory organs,

working memory, or attention itself). What he/she does changes his/her state of nervous energy, thus immediately affecting it, and his/her following actions and behavior: that is, the attentional activity performed by the person involves a temporary variation or disequilibrium in the state of his/her nervous energy. This variation or disequilibrium constitutes the phenomenal aspect of consciousness. The amount of nervous energy necessary for the organism to reestablish the equilibrium represents the *quantitative* aspect of the sensation.

The person as such emerges from his/her continuously performing the attentional activity, that is, from his/her continuously using and applying his/her nervous energy. Every time the person uses his/her nervous energy, the action performed affects his/her source of nervous energy (either blocking the nervous energy flow, or stimulating it, or in some other way), thus resulting in a possible change of the state of nervous energy. These changes of the state of nervous energy constitute the temporary boundaries and limits of the person's activity: as such, they give form to and characterize the person's activity, while also giving form to and characterizing the person him-herself. Therefore, the form the person takes is a result of the way the person applies his/her nervous energy, that is, of the amount of nervous energy used and of the specific dimension (whether physical - visual, tactile, muscular, etc. -, psychological, social, or else) to which the person applies it.

In my model of consciousness, attention no longer plays a purely passive and subsidiary role – with respect to consciousness – that is usually assigned to it by a typically third-person perspective: the information-processing approach. The information-processing approach describes attention as something passive. The metaphors used to describe it, whether a filter (Broadbent 1958), a zoom lens (Eriksen & St. James 1986), a spotlight that moves (Tsal 1983), a gate (Reeves and Sperling 1986), or a selective, amplifying channel (La Berge 1995), all imply all that it is seen as a privileged route for events to enter our mind or consciousness, that is, as a kind of mechanism which, letting information come in and be processed by some other device, plays a marginal, passive role. In such a way, the core problem of consciousness - how can we explain the fact that we have subjective, direct experiences of objects? - is devolved to another organ, for example an operating system (Johnson-Laird 1983, 1988), a central processor (Umiltà 1988) or a supervisory system (Shallice 1988). In so doing, however, the information-processing approach does not provide an answer to the problem of consciousness, but simply pushes it back into a deeper hiding place: if we accept the idea of a final device towards which information flows, we should be willing to consider the final device as a conscious agent itself, or a homunculus, thus entering a vicious circle. The information-processing conception of mind presents the same problems that all third-person perspectives present when studying consciousness. It can certainly explain how information is processed, the changes it undergoes, the time needed to process it, and so on. However, it does not and cannot explain what a person feels as he/she processes information, that is, how his/her conscious states start forming, develop, and change as a consequence of what he/she does. This is because information is made up of ready-made symbols representing the external world, whose meaning derives not so much from the importance they have for the person's formation and development, but from the importance they have for the researcher's investigations. The information-processing approach, in fact, is based on the assumption that the mind processes representations that already have their own meaning, independently from the history of the person, and does not investigate how they acquire a meaning for the person, and how the person builds meaning (Cisek 1999, Edelman 1989, Freeman 1999 and Searle 1980, 1984, 1992 raise a similar critique to the conception of the mind as a computer and of

mental processes as computational). The information-processing level of analysis examines how some parts of a person's organism - sense organs, attention, memory, central processor, and so on - transform information, but does not examine how a sentient person transforms him-herself as he/she processes information. This is also plainly visible from the way the information-processing approach usually represents the process flow, which can be so schematized:

input > processing unit > output

where: the input is usually a stimulus coming from outside the organism; the processing unit represents some kind of module or unit capable of elaborating and transforming the input; the output is the product of the elaboration performed by the processing unit. This way of representing the process flow leaves some fundamental problems completely unresolved, such as how a certain thing came to be an input for the organism; where the output goes and how it is in turn transformed; why the transformation occurs; how something – for example, a bunch of cells - can turn into an independent entity; etc. Moreover, it says nothing about: the active role that an organism usually plays in its environment; the importance of the exploratory activity of the organism in delimiting and constituting itself and delimiting its own boundaries; how and why something becomes an "input" for the organism; etc.

In my perspective, on the contrary, attention *is* the fundamental element of conscious processing, a processing which is characterized by two main phases.

Firstly, the continuous application of attention to the other organs (sense organs, the proprioceptive system, the interoceptive, system, the musculoskeletal system, and working memory) or to attention itself. This "continuous" working of attention can best be conceived as cyclical, a repetition of successive acts of focalizations each of which has a certain minimal and maximal duration. The hypothesis of the cyclical dynamics of attention, which has been put forward and tested by several researchers (see for example, Large and Jones, 1999, or Ward 2003 who states that attention seems closely associated with alpha and gamma rhythms), can also be inferred from the observation that no one can possibly attend continuously to an object that does not change (James, 1890), or from the close correlation between the perception of apparent simultaneity and the alpha phase at which stimuli are presented (Varela et al. 1981). The cyclical nature of the working of attention also accounts for the temporal limit of perception known as "phenomenal present" (Vicario 2005), that is, the interval of physical time which, despite being composed of non-contemporaneous parts, is perceived as a unitary and unique act of consciousness, and in which separate events are not differentiated and discriminated, and undergo some process of restructuring and grouping, according to non-temporal principles of organization, such as the Gestalt principles (on the temporal limits of conscious experiences, see also Cabanac 1992, 2002).

Secondly, the modulation of the state of the organ of attention resulting from the application of attention to the other organs or to attention itself. Accordingly, the process flow should be represented as starting not so much from an input coming from outside the organism, as from the actions generated and performed by the organism itself.

As we have seen, in my model of consciousness the *quantitative* aspect of the conscious sensation can be defined as the amount of nervous energy necessary for the organism to reestablish the equilibrium in the state of its nervous energy. The *qualitative* aspect of consciousness, that is, the fact that sensations originating from different perceptual modalities

differ qualitatively from each other (a sensation of "hard" is qualitatively different from a sensation of "red"), can be accounted for by the hypothesis that the organ of attention is composed of different parts, each of which is dedicated to processing only a specific kind of information. According to this hypothesis, conscious experiences of different qualities are processed by different, dedicated parts of the organ of attention: when paying attention to a specific perceptual or mental modality, a specific area of the organ of attention is stimulated, and a specific sensation arises. The specificity of each area represents the qualitative aspect of sensation. Indeed, it would not be possible to explain the qualitative aspect of conscious experiences if we considered the organ of attention as an undifferentiated unit, not divided into sub-specialized units: signals coming, for instance, from different sense-organs would produce qualitatively undifferentiated variations in the state of the nervous energy. The organism would be able to feel only quantitative differences. To explain qualitatively different variations we have then to resort to the concept of an organ of attention subdivided into or composed of different parts.

Such a concept of a segmented organ of attention seems to be well supported by empirical evidence (Pashler 1998). As far as the *perceptual processing stage* is concerned, there is evidence:

- supporting the hypothesis of the existence of modality-specific perceptual attentional systems (that is, separate perceptual attention systems associated with different sensory modalities), instead of a unified polymodal attention system. In fact, people appear capable of selecting visual stimuli in one part of space and auditory stimuli in another part, even if there is a decrement of performance in comparison with selecting visual and auditory stimuli coming from the same side (Driver and Spence 1994); moreover, capacity limits in recognition appear to be more severe when processing multiple stimuli presented through a single modality compared with multiple modalities (Treisman A. and Davies 1973);
- from divided-attention studies showing that, when the total load of stimulus processing does not exceed a certain threshold, subjects are able to process information arriving on more than one channel at a time. In fact, when targets differ from non targets along a simple featural dimension, many elements can be processed in parallel without evident capacity limits (Shiffrin and Gardner 1972); moreover, parallel, unlimited-capacity searching is possible when targets are defined by membership in a well-learned symbolic category;

As far as more *central processing stages* (response, selection and more generally thinking) are concerned, there is clear evidence from PRP (Psychological Refractory Period) studies of the existence of dissociations between the central processing stage and the perceptual processing stage. Perceptual analysis, whether overloaded or not, occurs without interference from ongoing central operations (Pashler 1989); there is obligatory queuing of cognitive operations such as response selection and associative retrieval that is independent of sensory modality; certain variables that mitigate perceptual overload do not affect central interference: whereas detecting two attributes of a single object circumvents the perceptual capacity limits (Duncan 1984) that are usually involved whenever two perceptual detections occur at the same time, it does not attenuate the magnitude of central, bottleneck-based interference (PRP effect) (Fagot and Pashler 1992).

The segmentation of the organ of attention into sub-specialized units accounts for the non-parametric, discrete nature of the qualitative dimension of conscious experiences (Cabanac 2002): visual sensations differ from auditory ones, which in turn differ from memories, thoughts, etc. An interesting question related to the qualitative dimension of conscious experiences is whether a hypothetical artificial conscious machine will have the same kinds of conscious experiences that we have or not. In my opinion, such a machine could theoretically have the same kinds of conscious experiences as we have insofar as it is provided with: (a) an artificial organ of attention, devoted to the supply of nervous energy, segmented in sub-specialized units, and (b) sense organs and somatosensory organs working on the same principles as those governing our sense organs and somatosensory organs. However, if the machine was provided with artificial organs working on different principles, its conscious experiences would differ from ours. I have used the term "theoretically", because one should take into account what Negrotti's (1997, 1999) work clearly shows: the very use of artificial organs implies unavoidable and unforeseen side effects that tend to differentiate and separate the reproduced object (the artificial conscious machine) from the original exemplar (the human being). Moreover, the use of new materials and processes entails that some performances of the original exemplar cannot be reproduced. On the whole, this would seem to make artificial consciousness really and unavoidably different from human consciousness.

Further to the foregoing description of the perceptual system, I have proposed the block diagram of Figure 1 as the circuit that is responsible for conscious perception. The figure shows a case of voluntary or endogenous attention. The organism issues instructions to itself to direct its attention toward one or more organs: sense organs, the proprioceptive system, the interoceptive, system, the musculoskeletal system, working memory, or the organ of attention itself. The results of the activity performed by these organs (here labeled as "output") act directly on the relevant area of the organ of attention, making the person have conscious sensations. This is obviously a very schematic representation: for the sake of simplicity, I have represented only some organs and connections; I have also omitted all those circuits – such as the "efferent copy mechanism" (Berthoz 1997, Taylor 2007a) - that, combining sensory information with the person's expectation and contextual knowledge, help perception resolve ambiguities, and speed up and correct the processing of data (see also Haikonen 2003, Leonardi 2008).

There can also be, of course, cases of captured or exogenous attention, in which some objects, such as one's own name (Moray, 1959), capture a person's attention even though he/she does not expect them or have any intention toward them. In these cases, it seems reasonable to think that a signal coming from the somatosensory system or from some other organ has the power to autonomously capture attention and become conscious, independently of the person's intention.

As Figure 1 shows, attention can be directed not only toward the other organs, but also toward itself. Among other things, this possibility explains, as I will try to show later in this book, the way we human beings have conscious experience of time. In fact, in my view, time-sensation is determined by the quantity of labor performed by that portion of our attention (let's call it A_t) that is focused in a continuous and incremental way on the conscious product of the activity performed by means of another portion of one's attention (let's call it A_e). The activity performed by A_t represents "temporal activity" (for instance, estimating duration); the activity performed by A_e represents "non-temporal activity" (for instance, perceiving the

shape of an object). The amount of nervous energy - supplied by the organ of attention - expended to support the activity of A_t constitutes the basis on which the conscious experience of duration and more in general time-sensation are based.

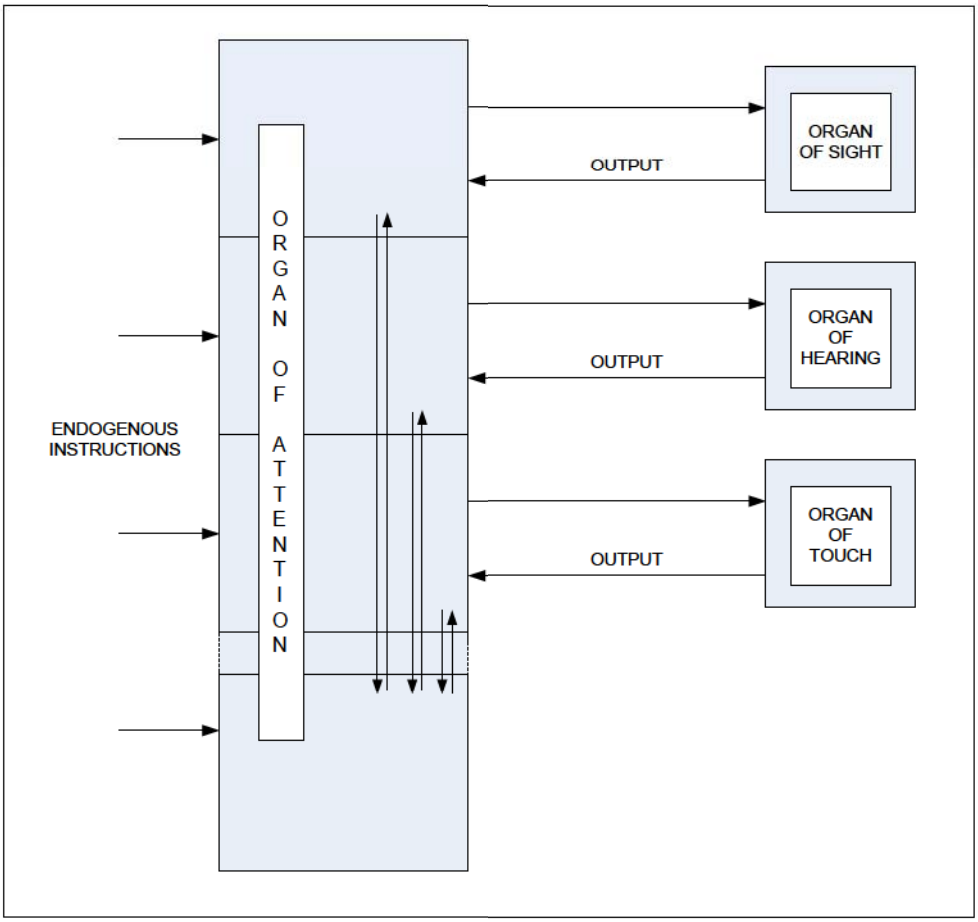


Figure 1. Conscious perception.

3.2. The Schema of Self

The perceptual system provides the necessary raw material for the person to emerge and form. But this is not sufficient. There must also be a device that guides and controls the formation of the person. This device is represented by what I call the schema of self. The schema of self runs the perceptual system and the organism in general according to a hierarchy of principles, goals and rules at the top of which there is one fundamental principle: the principle of survival. Operationally, the principle of survival can be expressed as follows: "operate in order to continue to operate". This is the vital instinct, the algorithm of life, or more precisely the algorithm of being (as pointed out by Peter Jakubik, personal communication), which regulates all the other instincts of the organism and its actions. This algorithm makes the organism continue to act and operate, and can only exceptionally be

stopped: most probably, it was initially coded in the DNA of the human species as an instruction to maintain the organism's energetic homeostasis (on how it is possible to maintain the energetic homeostasis, see for example Cabanac and Russek's model [2000]), and has subsequently evolved into more sophisticated cultural and social forms (which explains exceptional and counter-intuitive human behaviors such as martyrdom, suicide, heroic sacrifice, etc.)

The schema of self not only incorporates and coordinates all the innate or learned schemata that are necessary to keep the organism alive, but also provides all the rules necessary to guarantee the existence, formation and preservation of the person. To this end, one of the main activities it ensures is defining the person's boundaries, and consequently the differentiation of the person from other organisms, beings, and from his/her environment. The organism defines its boundaries by continuously monitoring its activity and consciously perceiving its own movements, operations, gestures, and so on. The conscious perception of its activity informs it immediately about the dimension, limits and possibilities of its body, and adjusts the rules and components of the schema of self.

To better understand how the interaction between the schema of self and the perceptual system works, we can try to imagine how the interaction could be achieved, for example, in a specifically dedicated electronic unit (let's call it *X*), and determine how *X* differs from a standard electronic unit (let's call it *Y*), such as those that can be found in a computer. Obviously, when doing this exercise, we have to consider some important things about our model of consciousness, that is: the main component of the perceptual system is the organ of attention; the organ of attention supplies nervous energy (in this sense, the organ of attention can be assimilated to a kind of power supply unit: but on this issue, see the discussion on the three main assumptions on attention in the last section of this chapter); nervous energy makes it possible to perform attentional activity; attentional activity directly affects the organ of attention, causing a variation in the state of nervous energy; it is this variation that constitutes the phenomenal aspect of consciousness. With these things in mind, we can now try to determine the difference between *X* and *Y*. While in *Y* the energy supplied by the power supply unit (whether it is a battery or a generator) depends on, and varies according to, the needs of the circuits it feeds and the operations that the circuits are processing (in the sense that the power supply unit supplies as much energy as the circuits require, at least to a certain extent), in *X* it is the operations of the circuit that depends on the variations of the energetic state of the power supply unit, in the sense that the operations of the circuits are modified according to such variations.

The definition of the person's boundaries is made possible by the sensations and feelings the organism has. As long as its action can flow undisturbed and is not hindered by anything, the organism feels free, well, pleasure, positively stimulated, etc. Whenever something hinders or blocks its activity, it has to make efforts to overcome the difficulty. These efforts cost it nervous energy, time, pain, frustration, and so on. It is precisely the threshold of effort and pain that sets the limits of the person, and differentiates him/her from its environment. The boundaries of its body are determined by the feelings of pain or frustration it has when acting. The person coincides with his/her action: the person is his/her action.

Any conscious perception of the organism helps to form and mold the person. The person is the outcome of the uninterrupted conscious perceptions of the organism. The process that leads to the emergence of the person can be divided into three main components, and can be represented as in Figure 2.

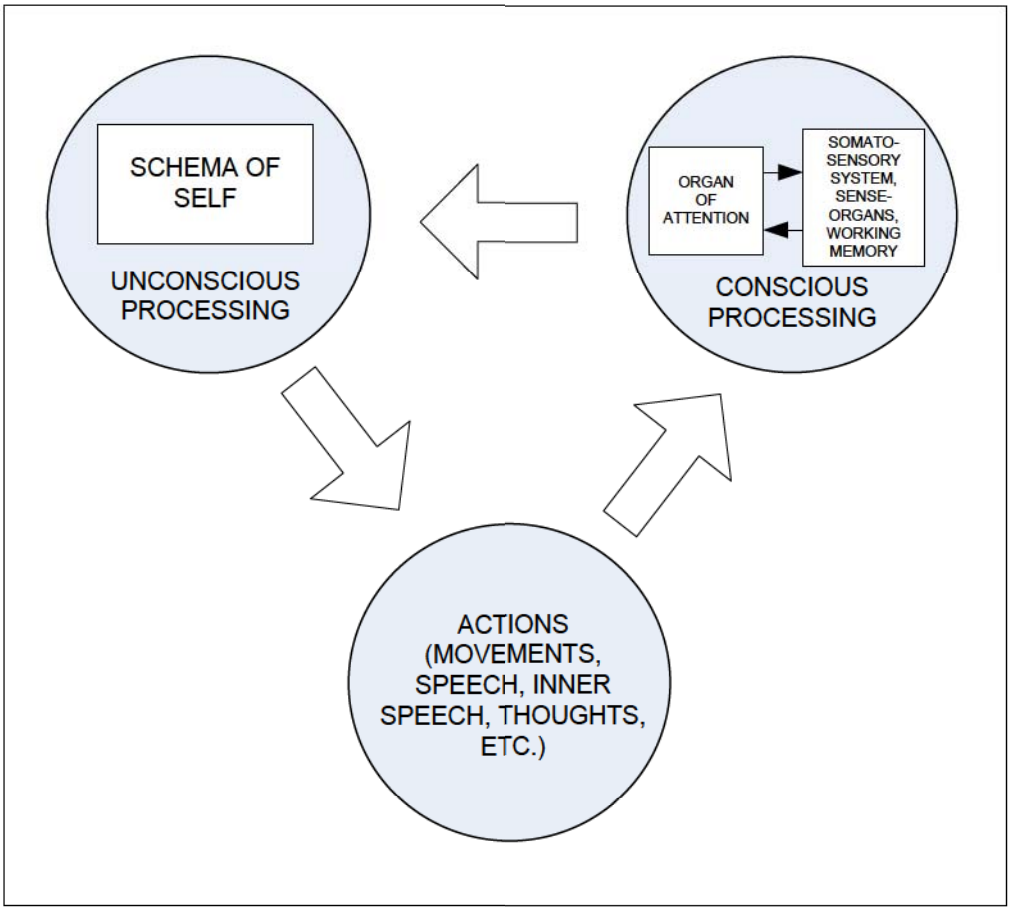


Figure 2. The process that leads to the emergence of the person.

The schema of self, and all the other schemata it incorporates and coordinates, embody all the competences and abilities - linguistic, social, physical, and so on - the organism innately possesses or has acquired during its life up to that time. It regulates the activities of the organism according to the hierarchy of principles and goals it incorporates, and the rules specific to each kind of competence. Every action the organism performs is caused by the goals of the schema of self - at the top of which there is the principle of survival - and generated and structured by the rules expressed by each kind of competence.

The organism's actions - whether they are represented by a single movement, a coordinated sequence of movements, the production of a sound or a word, inner silent speech, or else - as well as the consequences of the action, can be perceived by the organism. They become the raw material that the perceptual system works out. Since every action unavoidably entails sensations concerning the body and the environment, and the body related to the environment, the organism is able, through them, to understand and define its limits and the limits of the objects of the environment.

Once the organism has consciously perceived its action or the consequence of its action, the information concerning its body, the objects of the environment or the relation between its

body and the objects, becomes available for the schema of self, and can be appropriately used to update it and adjust the rules of the relevant competence. This process is variously and differently termed and described by some other authors: for instance, Damasio (1999) describes it in terms of the formation in the brain of *first-* and *second-order maps* representing both the organism, the object perceived, and the relationship of object and organism, while Edelman (1989) speaks of the *reentrant mechanisms* allowing categorization and learning.

Incidentally, it should be noted that it has been proposed (for example, Baars 1988) that the language of consciousness is preeminently based on a perceptive, imaginal, spatio-temporal *lingua franca*, and that this is probably due to the fact that the consciousness system is overlaid on an earlier function that is primarily sensory. This implies that whenever we think about, or form a conscious idea of something, we can do this only through images, sounds, colors, sensations. We always think by means of perceptible objects and things. What cannot be perceived or felt through sense-organs or the somatosensory system cannot be thought about or thought of either. In my view, this is only partially true. It is certainly true that most of our conscious experiences have a perceptive, imaginal aspect, and also that inner speech is made of words that have a sound and a form; however, as it will become more apparent in the next chapter, it is equally undeniable that we do have conscious experiences, such as the meanings of words and sentences, beliefs, intentions, that do not have the qualitative and phenomenal properties belonging to images and perceptions originated by our sense-organs or somatosensory system (on this topic, see also Ramachandran & Hirstein 1997, who distinguish between strong, vivid qualia, such as percepts, and not fully laden qualia, such as beliefs and internally generated images).

Once a thing or object is perceived, it becomes available for the schema of self, which processes it. What takes place inside the schema of self is unconscious. When we hear a certain word, or see a certain scene, it is unknown to us how these facts affect our subsequent behavior, thoughts and attitudes, in the sense that we are not aware of what is happening inside us. It simply happens. After having heard a sentence, some thoughts or images appear unexpectedly, but we do not know where they have come from and why only they have appeared, instead of something else. We can suppose this job is done by some mechanism, such as the collections of specialized unconscious processors described by Baars (1988), and following a certain sequence of steps, such as that described by Piaget (1967), but we are conscious neither of the mechanism, nor of its job.

The fact that the schema of self is updated and fed by the perceptual system implies that what the organism consciously perceives plays a causal role in its behavior. *This is one of the most important features of consciousness: it gives the organism the possibility of setting its own aims and objectives, and modifying autonomously its own schema of self.* The schema of self - once it has learnt and embodied the notion that the organism, by means of conscious perceiving, is able to affect the course of its own actions - provides the organism with a new degree of freedom that gives it the possibility of directly controlling itself. Without this further degree of freedom, the updating of the schema of self would take place only in consequence of the actions that the organism performs because of its innate instincts (and the limited set of rules that it could have learnt on the basis of these instincts). Thanks to this new degree of freedom, the schema of self is updated by the actions that the organism voluntarily and autonomously takes. This means that the schema of self, whose main goal is to keep the organism operating, succeeds in equipping the organism with the capacity to self-regulate itself, and consequently find on its own the best ways and means of assuring its survival and

of creating new strategies and aims. This constitutes the fundamental passage from consciousness to self-consciousness. The organism's attitude can then change from a purely reactive to a proactive one.

From that moment on, the schema of self runs the organism in such a way that its actions are primarily and directly governed not so much by its innate instincts as by what happens in its consciousness, even though the latter can be occasioned by the former. Every action the organism performs is a direct consequence of its previous conscious experience. The existence of an uninterrupted and consistent sequence of single units of conscious perception, the Jamesian stream of consciousness (James 1890), is secured precisely by the fact that the previous units play a direct, causal role in the production of the following ones. An interesting neurobiological hypothesis on the brain processes which would instantiate discrete conscious experiences without fundamentally violating the demand for continuity of consciousness is put forward by Fingelkurts and Fingelkurts (2001, 2006). Their key idea is that the temporal synchronization of different brain operations simultaneously executed by different local neuronal assemblies gives rise to a new level of brain abstractness: metastable brain states or "operational modules" (OM). These short-term metastable states change rapidly during transitive fringes or "rapid transitional periods" (RTP). The succession of discrete and relatively stable periods (OMs) separated by abrupt changes (RTP) represents the stream of consciousness.

One of the easiest ways an organism has to control itself and autonomously modify its own schema of self, or at least the easiest way from a human being's point of view, is by using language. Language can be considered as the most effective and economic way of exploiting the opportunities offered by self-consciousness. Some authors think that self-consciousness could not even be attained without language. According to Cimatti (2000), for instance, what differentiates animals from human beings is precisely the fact that the latter use language not only to communicate their own intentions or the events happening in the environments to other organism, as the former do, but also to communicate with themselves, directing their own attention to themselves and to their attentional system. Neuman and Nave (2010) give a physical reason why language plays a central role in self-consciousness: the brain as a physical system is limited in observing itself and consequently must rely on the mediation of language for the reconstruction of its phase space trajectory (however, not all authors agree on the fact that language is the major cause of self-consciousness: see for example Zlatev 2002, according to whom its acquisition presupposes at least a degree of intersubjectivity).

In my view, by speaking to itself, the organism can "listen" directly to itself, in the sense of listening to its body, mind, intentions, aims, and eventually to its schema of self, without having to wait for the usual physical manifestations - such as coordinated movements of arms, legs, body, and so on - that the schema of self can occasion. Therefore, within certain limits, the organism need not perform actual physical actions in order to perceive itself, its body, the environment, the relations between itself and the environments. Inner speech functions as an artificial behavior that allows the organism to consciously perceive itself. In turn, these perceptions continuously modify the schema of self.

Language is not the only way the organism has to exploit the possibilities offered by self-consciousness. Other perceptive modalities can be used as well. Images, sounds, and smells all represent alternative means that the organism has to artificially represent itself. However, due to its form and structure, language is no doubt the most common and exploited one. As

Vygotskij (1973) pointed out following N. Ach, the original function of words is to direct attention toward something. They serve to isolate certain aspects of objects, and attract attention towards them: as Logan (1995) puts it, semantics specify the computational goals that the attention system must satisfy (on the idea that the meanings of words are based on attentional operations, see the pioneering work of Ceccato, for example, Ceccato 1969, and Ceccato and Zonta 1980. His work has been further developed by Benedetti 2006, 2008, and Marchetti 2006. This idea will be further developed and analyzed in the following chapters of this book). Through language, adults can guide and influence children's attention, thus getting them to learn how to autonomously master their own attention. But if, as we have seen, attention is the mechanism responsible for consciousness, then learning how to master one's own attention is tantamount to learning how to master one's own consciousness.

Languages have many expressions that serve to address the person's attention not only towards something in general, such as "Look at it", "Watch me carefully", "Try to do so and so", but also towards the very mechanism of the person's attention or consciousness, such as "Pay attention to what you are saying", "Are you aware of what you have done?", "Try to remember what you have done". By means of these expressions, the person can control him-herself and his/her attention, and consequently modify his/her own schema of self. The person can then assume new attitudes and view things under a different light. In turn, the modification of the schema of self entails a new course of actions, thoughts and speeches which, being consciously perceived, can further modify the schema of self, and so on. The uninterrupted interplay between the schema of self and what is consciously perceived constitutes the stream of consciousness: the person's schema of self is continuously modified according to what the he/she consciously perceives, and, conversely, he/she consciously perceives what his/her schema of self occasions.

The block diagram of Figure 3 represents the circuit responsible for the stream of consciousness. The schema of self makes the organism act according to the fundamental principle of survival "operate in order to continue to operate". The organism can consciously perceive the activity so occasioned, whether it is a movement, a speech, or other, through its various organs: attention, sense-organs and somatosensory system, working memory. The result of the conscious perception updates the schema of self, which in turn issues new instructions to act and perceive.

In Figure 3, for the sake of simplicity, I have not represented the internal connections between the various parts of the organ of attention that allow the organism to focus its attention not only toward the other organs, but also toward the organ of attention itself. Nor have I represented all those connections that allow a person to have subliminal perceptions, such as when a stimulus, which has exogenously captured a person's attention, is unconsciously processed and perceived (McCormick 1997, Merikle et al. 2001): most probably these connections directly link the somatosensory system and the sense-organs to the schema of self, and prevail when there is not sufficient time for the stimuli to be processed to the point of awareness (Libet 2004, McCormick 1997).

Thanks to self-consciousness, the person is able to exert voluntary attention, analyze his/her own responses and acts, find alternative ways of solving problems, that is, autonomously and voluntarily learn. Automatic, "reflexive" attention can involve learning only as long as innate programs afford it, and animals certainly give evidence of this fact. However, an organism provided only with consciousness cannot learn to learn. Only self-consciousness gives this possibility to the organism. Self-consciousness implies that the

organism is conscious of its own operative limits, understands its own boundaries, becomes an autonomous and responsible person, reflects on its own past, decides how and what to learn, and determines its own future.

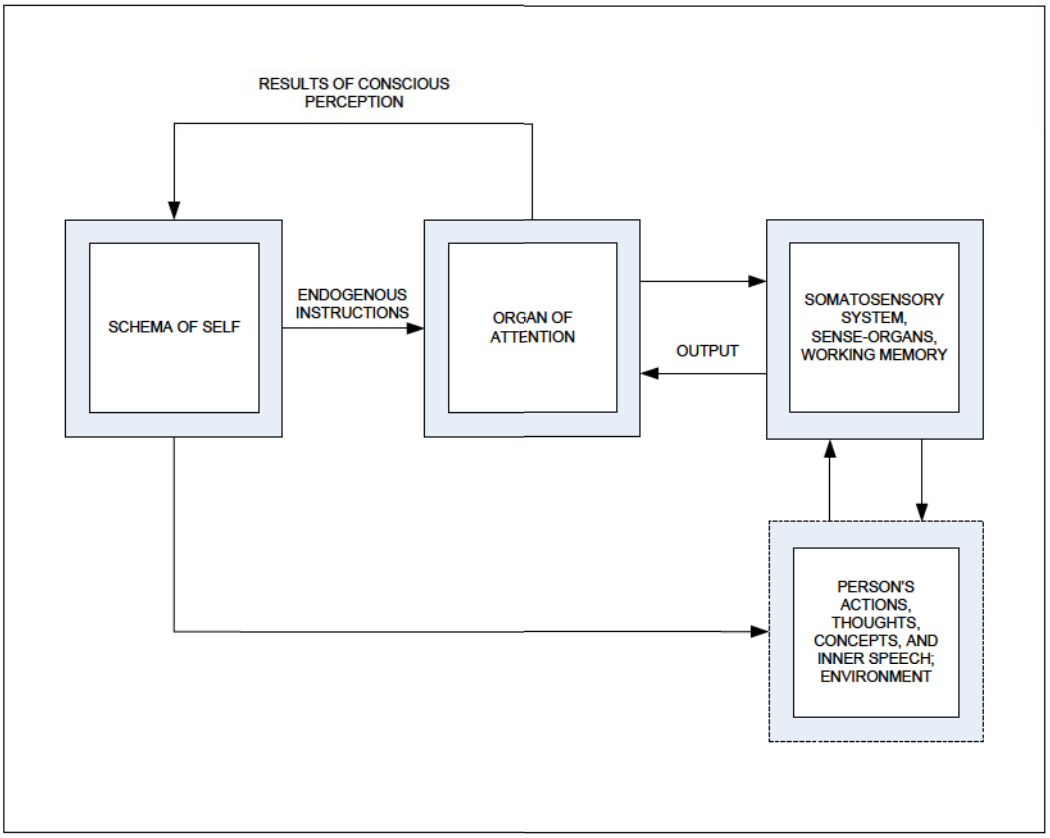


Figure 3. The circuit that generates the stream of consciousness.

If consciousness gives the organism the possibility of producing certain results and attaining certain goals that are usually genetically determined, self-consciousness gives it the possibility of autonomously and rationally determining what goals to attain and what results to produce. This is the fundamental difference between consciousness and self-consciousness: while the former lets the organism produce some results, the latter lets it control the operations necessary to produce results.

The difference between consciousness and self-consciousness could be also highlighted in terms of means and ends. As we have seen, studying consciousness means taking a new perspective that considers how a person emerges from an organism's continuous use and application of its nervous energy. This perspective implies seeing the person as an active agent personally and directly involved in constructing not only him-herself but also his/her own knowledge. The organism becomes a person because it acts, and, by acting, it differentiates itself from the environment and the other beings, thus getting to know them. An

object becomes an object and acquires a meaning for the person only as long as the person can relate the object to him-herself in some way. Therefore, every object can be defined in terms of the person's activity, where "person's activity" means the activity a person has to perform in order to emerge as such. An object exists and has a meaning because a person exists who gives it a meaning, and a person exists because by acting he/she has been able to differentiate him-herself from that object. It is precisely through this activity of differentiation that objects come into existence and acquire a meaning for the person: they become objects and acquire a meaning because through them a person can take shape. Defining an object in this way is viewing it instrumentally, as something that takes part in the construction and definition of the person. In this view, an object is a means a person has of coming into existence. Every object serves the purpose of forming the person, or is somehow associated with this process.

Consciousness, making the person experience directly what he/she is doing and the results of his/her activity, is the privileged way a person has of constructing him-herself, his/her knowledge, objects, and the relation between him-herself and objects. It is through consciousness that a person understands how an object relates to him-herself, learns how to use it, and gets to know it. Consciousness gives the person an immediate understanding of the object and of its meaning. The meaning of the object emerges when the person becomes conscious of it. At that moment, the person understands what relation exists between him-herself and the object, and gives a meaning to the object. At the same time, understanding this implies - for the person - taking a particular shape, namely the shape that the relation makes possible. Therefore, consciousness is the fundamental device by which objects, becoming the means that makes the person take shape, acquire a meaning.

If consciousness gives the person the possibility of assigning a meaning to objects, self-consciousness gives the person the possibility of assigning a meaning to him-herself. Self-consciousness makes it possible for a person to see him-herself as an object, and consequently to become a means to an end. By seeing him-herself as an object, a person can set an end for him-herself, and consider him-herself as an instrument for achieving it. The person then acquires a meaning: the meaning determined by the end he/she has set for him-herself.

4. The Empirical and Logical Plausibility of the Three Main Assumptions Implied by This Model of Consciousness

As we have seen, the central role played by attention in my model of consciousness implies three main assumptions on attention:

i) Attention is necessary for consciousness;
ii) Attention is a kind of activity that can be performed because we are provided with a form of energy, namely the nervous energy that is supplied to our organism (this energy is physical and most likely not of a simple kind, but rather a combination of different kinds: chemical, electrical, etc.); this form of energy is produced and supplied by a physical organ, which I call "the organ of attention". By the expression "organ of attention", I mean the physical substrate or the nervous structure that is responsible for the production of nervous energy. We use our nervous energy to pilot

our organ of attention and some other organs (the motor organs, the sense-organs, the somatosensory organs, working memory, and the schema of self);

iii) Attentional activity directly affects the organ of attention, causing a modification of the state of the nervous energy itself. It is precisely this modification that constitutes the phenomenal aspect of consciousness.

Let's consider these assumptions in detail.

4.1. Attention Is Necessary for Consciousness

The idea presupposed by my model that attention is so strictly linked to, and necessary for, consciousness, is not new (James 1890, O'Regan & Noë 2001, Posner 1994a). Indeed, the idea is quite intuitive, if we consider what is thought to be one of the main characteristics of attention: its selective power. When we attend to a certain object or part of an object, we are able to isolate it from the other objects or parts, so that our conscious mind is completely and exclusively possessed and "filled" by it (La Berge, 1995). This shows that there is a direct connection between attention and consciousness: how we pay attention to the world is highly correlated with how the world appears to us. Moreover, well-known psychological phenomena demonstrate that attention modulates perception, directly influencing the way we consciously experience the world. Let's consider some evidence from psychological studies.

4.1.1. Some Positive Evidence of the Close Correlation between Attention and Consciousness

4.1.1.1. Psyhological Studies of Visual Perception

Carrasco et al.'s experiments (2004) show that attention alters phenomenal appearance: it boosts the apparent stimulus contrast. When observers' transient covert attention (which is the stimulus-driven, exogenous, involuntary capture of attention by an abrupt, salient peripheral cue) is drawn to a stimulus via a peripheral cue, observers report this stimulus as being higher in contrast than it really is, thus indicating a change in appearance with attention. In Carrasco et al.'s experiments (2004), subjects were presented with two gratings (tilted at either +45° or -45° from vertical) that appeared briefly and simultaneously on opposite sides of a central fixation point on a monitor. They were instructed to report the orientation of the stimulus that appeared higher in contrast: "Is the stimulus that looks higher in contrast tilted to the left or the right?" (the emphasis on the orientation judgement served to rule out the possibility of response bias). Before the appearance of the gratings, a small dot (the cue) appeared and disappeared, either at the fixation point or at one of the sites of the upcoming gratings. Subjects were informed that the peripheral cue was not informative either in terms of contrast or orientation and that it had equal probability of appearing on either the higher or lower contrast stimulus (which ruled out a decisional explanation for an attentional effect). Unbeknown to the subjects, this cue provided the crucial manipulation to assess the influence of attention on stimulus appearance. In experiment 1, the contrast of one of the two gratings (the standard patch) was kept fixed at a near-threshold level of 6%, whereas the contrast of the other grating (the test patch) was varied from trial to trial from 2.5% to 16%. In the

neutral condition, which served to provide the baseline measure of the subject's contrast discrimination performance, the cue appeared at the fixation point. In the cued condition, which served to exogenously, reflexively draw the subjects' spatial attention towards the cued grating, the cue appeared peripherally. In the neutral condition, subjective equality (that is, when subjects reported each grating's orientation in exactly half of the trials) was expected to occur at physical equality. In the cued condition, subjective equality was expected to occur at lower test contrasts when the test patch was cued, and at higher test contrasts when the standard patch was cued. This is exactly what Carrasco and her colleagues found. When the subjects' transient attention was drawn to a stimulus location, they reported that stimulus as being higher in contrast than it really was: for example, a 3.5% contrast, cued test stimulus appeared to the subjects to be 6% contrast; likewise, a cued stimulus at 6% contrast appeared as if it were 8.5% contrast. Figure 4 illustrates the effect of attention on apparent contrast: when the low-contrast grating on the left side is attended, it is perceived as having the same contrast as the unattended right stimulus.

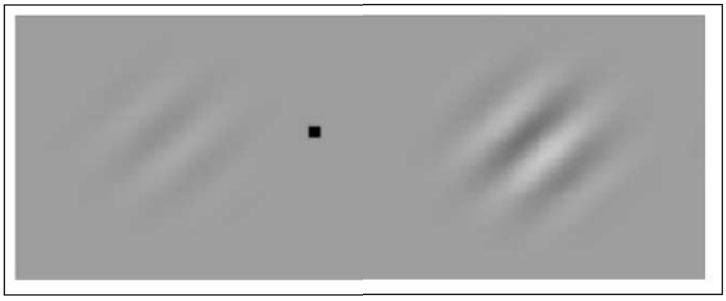


Figure 4. The effect of attention on apparent contrast.

Commenting on Carrasco et al.'s experiments (2004), Treue (2004, p. 436) observes that this study "completes a triangle of converging evidence from electrophysiology, functional brain imaging and now psychophysical findings, which argues that attention not only enhances the processing of attended sensory information but manipulates its very appearance".

The effect of attention on apparent contrast is further supported by Liu et al.'s study (2009), which shows that voluntary (endogenous, sustained) covert spatial attention also alters the appearance of objects. In this study, which provides a phenomenological correlate of the effect of voluntary attention on perception, voluntary attention increases the perceived contrast of suprathreshold stimuli: attending to a peripheral location makes a cued 29%-contrast stimulus and an uncued 36%-contrast stimulus both subjectively equivalent to a 32%-contrast stimulus.

4.1.1.2. Psychological Studies of the Perception of Time

Important evidence that attention modulates perception also comes from the domain of the studies of time perception. The phenomenon of prior-entry, for example, shows that when a person attends to a stimulus, he or she perceives it as having occurred earlier in time than it would if he or she was not attending to it (Shore et al. 2001). Experiments on duration judgments in which subjects are asked to prospectively judge the duration of the time period they have to perform a certain task, reveal that judged time decreases linearly with the

increased processing demands of non-durational information, and that experienced duration increases to the extent that subjects can allocate more attentional resources to the flow of time itself (Brown 1985, Hicks et al. 1976, 1977, Coull et al. 2004). In short, a higher amount of attention allocated to the passage of time itself produces a lengthening of the experienced duration. A similar attentional effect results when attention is directed in advance to one of two possible stimulus sources: Mattes and Ulrich (1998) show that subjects judge a stimulus as being longer when it appears at the precued stimulus source than when it appears at the uncued one; that is, directed attention prolongs the perceived duration of a stimulus.

4.1.1.3. Inattentional Blindness and Change Blindness

The idea that attention is necessary for consciousness has received strong support from the work of Mack and Rock (1998) and Rensink et al. (1997). In Mack and Rock's (1998) experiments, the subject's attention was engaged in a task (for instance, to report the longer arm of a cross briefly presented on the screen and centered at about 2 degrees from fixation). After some trials, an unexpected, unsearched critical stimulus (for example, a black circle) was presented at fixation, and subjects were asked whether they had seen anything that had not been on the screen in the earlier trials. Between 60% and 80% of the subjects failed to detect the critical stimulus. A comparison between reports of the critical stimulus in the inattention, critical trials (where subjects were told to pay attention to the cross, but were not told that a critical stimulus would appear) and those in full attention control trials (where subjects were told to ignore the cross, and to report only what else they saw on the screen when the cross was present), confirmed that focal attention is clearly implicated in conscious perception. More in general, Mack and Rock's experiments show that subjects tend to be blind to a critical stimulus that appears either at, or close to, fixation when they are not searching for it, when they are occupied with a task that engages their attention, and when it is located outside the boundaries of the area on which attention is directed. These findings do not imply that there is no implicit, unconscious perception, but only that there is no explicit, conscious perception prior to the engagement of focal attention. Stimuli to which subjects are inattentionally blind, can be implicitly, unconsciously perceived. In order to bring them into consciousness, they must be attentionally processed.

Inattentional blindness results, however, could be subject to alternative interpretations involving processes other than attention, such as expectation and memory (Lavie 2006a). Firstly, the critical stimulus is expected in the control trials, and subjects are likely to look for it intentionally: therefore, the comparison of control and critical trials may confound effects of attention with effects of expectations. Secondly, while in control trials awareness reports are made immediately following display presentation, in critical trials they are made after a task response and a surprise awareness question in critical trials: therefore, reduced rates of awareness in critical vs. control trials may reflect higher rates of forgetting during the longer delay from display presentation until the awareness question in the critical trials.

The alternative explanation based on expectation was ruled out by Cartwright-Finch and Lavie's (2007) study, which, manipulating perceptual load within Mack and Rock's inattentional blindness paradigm, compared the rates of inattentional blindness not so much between the critical trials and the control trials, as between critical trials of different levels of load (that is, the critical stimulus was equally task-irrelevant and equally unexpected across the varying levels of perceptual load). Cartwright-Finch and Lavie found that the level of perceptual load in the task determined the rates of inattentional blindness: whereas subjects

were often aware of the irrelevant stimuli in situations of low load, they failed to notice the irrelevant stimulus in situations of high load. This result shows that it is the level of attention available for the processing of the task-irrelevant stimulus that determines whether the stimulus can be consciously perceived.

The alternative explanation based on memory is ruled out by Rensink et al.'s (1997) study, which, unlike the inattentional blindness paradigm, does not rely on a retrospective question about an unexpected stimulus: indeed, subjects are instructed in advance that their task is to detect whether a change occurred between two successive images and report about it immediately following the images. Rensink et al. (1997) developed the "change detection flicker task" paradigm (which is a variant of the change blindness paradigm: see for example Simons and Levin 1997, 1998): an original image *A* repeatedly alternates with a modified image *A'*, with brief blank fields placed between successive images; differences between original and modified images are highly visible; subjects freely view the flickering display and hit a key when they perceive the change. In order to prevent guessing, subjects are asked to correctly report the type of change and describe the part of the scene that was changing. Because the stimuli are available for long stretches of time and no eye movements are required, the flicker paradigm provides the best opportunity possible for an observer to build a representation conducive to perceiving changes in a scene. The change blindness found with the brief-display techniques adopted by previous experimental paradigms might have been caused by insufficient time to build an adequate representation of the scene; saccade-contingent change blindness might have been caused by disruptions due to eye movements. Both of these factors are eliminated in the flicker paradigm, so that if they are indeed the cause of the difficulties, perception of change should now become easy. But if attention is the key factor, a different outcome would be expected. And it is precisely this different outcome that Rensink et al.'s study reveals. Their experiments show that identification of changes becomes extremely difficult, even when changes are large and made repeatedly: under flicker conditions subjects take a surprisingly long time to perceive large changes in images of real-world scenes. This difficulty is due neither to a disruption of the information received nor to a disruption of its storage: it does however depend greatly on attention. The role of attention is further confirmed by the findings that: cueing the object that changes removes any difficulty in detecting change (Rensink et al. 1997); objects that capture attention, either by virtue of containing a singleton feature, or by virtue of their significant socio-biological meaning, do not suffer from change blindness (Ro, Russel, and Lavie 2001); the rate of change detection critically depends on the level of load in the search task, that is, subjects fail to detect the change far more often in the condition of high vs. low load in the search task (Lavie 2006a and 2006b).

Rensink et al.'s (1997) experiments also answer most of the criticisms raised by Mole (2008). Mole argues that what Mack and Rock's work shows is only that there are some circumstances in which attention is necessary for consciousness: that is, cases in which the stimulus is presented unexpectedly, for a fifth of a second, concurrently with something else that one is attending to, in an unfamiliar experimental paradigm, and followed by a pattern mask. As Rensink et al.'s (1997) experiments show, attention *is also* necessary with expected, familiar, and available for long stretches of time stimuli.

Mole's (2008) criticisms, however, seems to imply a more general kind of criticism based on "some relatively uncontroversial features of the epistemology of perception". According to these considerations from the epistemology of perception, Mack and Rock's (1998) and

Rensink et al.'s (1997) experiments would show not so much that attention is necessary for consciousness *in general*, but only that attention is necessary when one's experience is to provide one with knowledge of the sort probed by the experimenter's questions in a change-blindness or inattentional blindness experiment. In other words, change-blindness and inattentional blindness experiments suffer from the defect of not giving the possibility of independently ascertaining whether attention is necessary for consciousness in general: as they are designed, these experiments would only reveal that attention is necessary for consciously detecting changes or unexpected stimuli but not, *in general*, for being conscious. According to this view, a subject who has not attended to the changing item in the change-blindness pictures or to the unexpected stimuli in the inattentional blindness experiment, could theoretically have some kind of conscious experience, but the experience does not have the "structured content" needed to provide the subject with knowledge of the fact that the thing is changing or unexpectedly appearing.

I think that Mole's epistemological considerations are legitimate and that they deserve to be properly addressed. In order to do so, I will analyze some experiments that either have been explicitly conceived and designed to prove that there can be consciousness in the absence of attention or have been interpreted as evidence that attention is not necessary for consciousness. The analysis will show that even such experiments substantially fail to prove the thesis of the unnecessity of attention for consciousness, and consequently that an answer can also be provided to Mole's epistemological considerations (at least until contrary evidence is offered).

4.1.2. Experiments Aimed at Demonstrating Consciousness in the Absence of Attention

The idea that attention is necessary for consciousness is not universally accepted (Baars 1997b, Hardcastle 1997, Koch and Tsuchiya 2006, Lamme 2003, Umiltà, 1994). A very strong and paradigmatic version of the view that attention and consciousness are dissociated phenomena is that held by Koch and Tsuchiya (2006): more precisely, they maintain that *top-down* attention and consciousness are distinct phenomena that need not occur together. Table 2 shows their four-fold classification of percepts and behaviors, made depending on whether top-down attention is necessary or not and whether such percepts and behaviors necessarily give rise to phenomenal consciousness.

Given the strong position held by Koch and Tsuchiya, I will start the analysis of the evidence that there can be consciousness in the near absence of attention by considering the examples and arguments that they put forward in favor of their hypothesis. To do so, I will proceed by separately considering some of the perceptual phenomena and behaviors that they have listed in the upper-right quadrant of Table 2 as evidence of the dissociation between attention and consciousness. Additionally, I will also consider some complementary examples and arguments proposed by other researchers in support of the view that attention is not necessary for consciousness.

As my analysis will show, the view that there can be consciousness without attention originates primarily from a failure to notice the varieties of forms that attention and consciousness can assume. As many authors have highlighted (Bartolomeo 2008, De Brigard & Prinz forthcoming, Posner 2008, Srinivasan 2008), in order to correctly understand the relationship between attention and consciousness, it is essential to duly take into account the varieties and complexity of forms of attention and consciousness: overlooking this factor may lead to the wrong view that there can be consciousness without attention.

Indeed, attention can, up to a certain extent, be split between different perceptual and processing modalities (Pashler 1998); it can be either exogenously or endogenously elicited; it can be both widely distributed for relatively long time periods in a certain location (preparatory attention) and narrowly distributed in another location for shorter periods (selective attention) at the same time (La Berge 1995); it varies according to the perceptual load (Lavie 1995); it has one transient component and one sustained component (Nakayama & Mackeben 1989); and so on.

Likewise, a general awareness of our environment (ambient awareness) can be distinguished from a more detailed focal awareness of a scene (focal awareness) (Iwasaki 1993); a form of primary consciousness, including an awareness of the world and mental images, but not a concept of self, can be distinguished from a form of higher-order consciousness, including self-awareness, a sense of time, and language (Edelman 1989); forms of spatial awareness can be distinguished from more reflective forms of consciousness based on intellectual acknowledgment (Bartolomeo 2008); consciousness of sensory qualities differs from volition, which in turn differs from the simple conscious state, which neurology associates with the concept of arousal and the diurnal cycle of sleep and wake (Posner 2008).

My analysis will also show that there is a second, but not less important, reason explaining the origin of the view that there can be consciousness without attention: this reason can be found in the scholars' attitude of adopting a third-person instead of a first-person approach when analyzing conscious phenomena.

Table 2. Koch and Tsuchiya's (2006) four-fold classification of the relationship between top-down attention and consciousness

No top-down attention, no consciousness	**Consciousness in the near absence of top-down attention**
• Formation of afterimages • Rapid vision (< 120 msec) • Accommodation reflex • Zombie behaviors	• Pop-out • Iconic memory • Gist • Animal & gender detection in dual-tasks • Partial reportability
Top-down attention without consciousness	**Top-down attention with consciousness**
• Priming • Adaptation • Visual search • Thoughts	• Working memory • Detection and discrimination of unexpected & unfamiliar stimuli • Full reportability

According to Koch and Tsuchiya, all four cases are possible:

(1) no attention-no consciousness (upper-left quadrant of Table 2);
(2) attention with consciousness (lower-right quadrant of Table 2);
(3) attention without consciousness (lower-left quadrant of Table 2);
(4) consciousness without attention (upper-right quadrant of Table 2).

4.1.2.1. Animal and Gender Detection in Dual-Task

Koch and Tsuchiya (2006) quote Li et al.'s (2002) work, which shows that subjects can rapidly detect animals or vehicles in briefly presented novel natural scenes while

simultaneously performing another attentionally demanding task, and Reddy et al.'s (2004) work, which, comparing how subjects perform on a face-gender discrimination task carried out in the single-task condition with the same task carried out in the dual-task condition with a known attentional demanding task (5-letter T/L discrimination), shows that the face-gender discrimination task can be performed equally well under the two conditions. According to Koch and Tsuchiya, this kind of evidence shows that there can be consciousness without focal, top-down attention. However, as observed by Taylor and Fragopanagos (2007), in these experiments the subjects underwent up to ten hours of prior training on the stimuli, which makes it highly plausible that the subjects learnt to develop an automatic route to respond to the peripheral stimuli to which they were exposed. Moreover, as observed by Srinivasan (2008), there are studies (for example Yeshurun and Carrasco, 1998) demonstrating that performance in certain tasks can actually be better under conditions of less attention: therefore, what these experiments would show is not so much a dissociation between attention and consciousness, as a dissociation between attention and performance. Finally, it is also possible that the subjects were able to use multiple foci of attention to detect the presence of both the peripheral target as well as the main central one (McMains & Somers 2004).

4.1.2.2. Attentional Blink

Koch and Tsuchiya (2006) also quote Olivers and Nieuwenhuis' (2005) study on the Attentional Blink. The Attentional Blink (Shapiro et al. 1994) occurs when subjects view rapid serial visual presentations of a series of stimuli presented in the same location, usually at rates of approximately 100 msec per item. Subjects have to detect two target stimuli, T1 and T2; T1 appears first and is followed by T2, which may appear immediately after T1 or at some other point in the sequence after T1, with distractors presented between T1 and T2 (that is, the temporal lag between T1 and T2 can be varied). The blink effect refers to a decrement in detection of T2: the basic finding is that the decrement is often greatest when T2 occurs not immediately after T1 (position n+1), but rather somewhere around positions n+2 through n+5 (that is, when there are one or more distractors between T1 and T2). The performance improves with higher lag and reaches asymptote around n+6 or n+7. A possible explanation of the Attentional Blink is that processing of T1 takes up limited Attentional resources: as a result, either access to these resources is denied for T2 or the representation of T2 is so vulnerable that it easily suffers from interference from temporally surrounding distractors (but alternative explanations are also possible: see Pashler 1998).

Olivers and Nieuwenhuis' (2005) study, which was motivated by the observation that participants in previous experiments reported rather counterintuitively improved T2 performance when being somewhat unfocused on the task, shows that the Attentional Blink is significantly ameliorated when observers are concurrently engaged in distracting mental activity, such as free-associating on a task-irrelevant theme or listening to music. The experiment suggests that under conditions of rapid visual presentation, target detection may benefit from a diffusion of attention.

Koch and Tsuchiya (2006) have interpreted Olivers and Nieuwenhuis' (2005) findings as indicating that top-down attention and consciousness can oppose each other. However, as Srinivasan (2008) shows, there is an alternative interpretation of Olivers and Nieuwenhuis' (2005) findings. The alternative interpretation is based on the concept of differential attentional strategy, and is more economical than Koch and Tsuchiya's because it does not require two different processes (one for attention and another for consciousness) to explain

the same phenomenon, but only one process (attention). According to Srinivasan (2008), Olivers and Nieuwenhuis' (2005) findings would imply not so much that there can be consciousness in the absence of top-down attention, as that some *other form* of attention is necessary for consciousness when stimuli are expected to occur under the specific conditions implied by the Attentional Blink paradigm. Indeed, top-down attention is not a unitary phenomenon; instead it can imply at least two different attentional strategies: focused attention and diffused attention (Demeyere and Humphreys 2007). As Srinivasan suggests, these two different attentional strategies can be conceived as two ends of a continuum in which the focus varies. Under certain conditions, such as when subjects know that they need to consider a large number of items in order to report the second target stimulus in an experiment on attentional blink, diffused attention may turn out to be a better strategy than focused attention. Indeed, this also corresponds to one of the three explanations that Olivers and Nieuwenhuis put forward to account for the phenomenon they found: it may have actually been the additional task itself that induced a more distributed state of attention. As attention widened to incorporate the extra task, it may have also widened temporally and thus included T2 in the series of stimul (in Olivers and Nieuwenhuis' view, there are two other possible explanations. First, the effects may be related to arousal: decreased or increased arousal - as may have occurred in the free-association and music conditions - may have made the attentional system more susceptible to other input, including T2. Second, thinking about one's holiday or listening to music may have induced a positive affective state, which has shown to improve performance on several cognitive tasks).

A further alternative explanation of Olivers and Nieuwenhuis' (2005) findings, which however lead to a conclusion similar to Srinivasan's (2008), is provided by Posner (2008). According to Posner, the blink effect may arise because there is a specific inhibition to processing a second target when it is similar to a first target which is still being attended. Olivers and Nieuwenhuis' (2005) study would show that when concentration on the first target is reduced by a second task the inhibition may be released. Therefore, the phenomenon may not indicate that attention is distinct from awareness, but instead that attention may be distinct from performance.

4.1.2.3. Gist

Koch and Tsuchiya (2006) observe that we are aware of the gist of a scene or of our surrounding environment even when we are not paying attention to it: "In a mere 30 ms presentation time, the gist of a scene can be apprehended. This is insufficient time for top-down attention to play much of a role. Furthermore, because gist is a property associated with the entire image, any process that locally enhances features, such as focal attention, will be of limited use" (p. 18).

In my view, the fact that top-down attention is absent or nearly absent does not entail that there is no attention at all: some form of limited attention may be involved, such as for example what Velmans (1991) defines "preliminary attention", which allows us to capture the gist of a scene. This is also De Brigard & Prinz's (forthcoming) view, who observe that there is no reason to think that attention is absent, but rather that it is more plausible to think that attention is only diminished. Indeed, the view that attention is necessary for consciousness predicts such findings very well: when attention is nearly absent, we are aware of far less than when it is fully deployed. This is why the gist is perceived and no more.

Alternatively, it is also possible to conceive the phenomenon of gist reported by Koch and Tsuchiya as evidence of the existence of a specific form of consciousness: what Bartolomeo (2008) calls "primary consciousness". Primary consciousness refers to the basic condition of being aware of something: as such, it must be distinguished from a higher-order, reflective form of consciousness, which can involve linguistic abilities and allows subjects to perceive and describe their own actions and thoughts. Not always what enters primary consciousness also enters the higher-order form of reflective consciousness: overlooking this fact may sometimes lead to the wrong observation that the absence of a verbal report means the absence of consciousness tout court. Bartolomeo (2008, p. 17) illustrates the difference between the two forms of consciousness by quoting an example given by Merleau-Ponty "of someone who enters a room and feels an impression of disorder, only to later discover that this impression came from a crooked picture on the wall. Before discovering that, this person's consciousness was □ living things that it could not spell out□ . This would by no means imply that the first impression on entering the room was unconscious. Rather, the crooked picture generated a form of consciousness whose source was not immediately amenable to verbal description".

Indeed, as shown by Bartolomeo et al. (2007), subjects can use endogenous strategies of attentional orienting - which are traditionally maintained to be voluntary and require conscious awareness - without being able to subsequently describe them. In Bartolomeo et al.'s (2007) study, subjects performed cue-target detection tasks in various conditions (5 experiments). They were presented with three horizontally arranged boxes; the central box contained the fixation point, on which subjects were instructed to maintain fixation during the experiment; 500 ms after the appearance of the boxes, a cue, which was clearly perceptible, was presented for 300 ms; for the majority of the experiments (1 to 4), the cue consisted of a 300-ms thickening of the contour of one of the two lateral boxes; at variable time intervals from cue onset, a target appeared, either at the same location as the cue or at the opposite location; the cue could be valid, that is, correctly predicting that the impending target would occur at the cued box, or invalid, that is, indicating that the impending target would occur at the opposite, uncued box; subjects were instructed to respond to the target as quickly as possible; moreover, they were told that targets would be preceded by cues, but they were invited to concentrate exclusively on targets and to pay no attention to cues. Unknown to the participants, in each experiment two blocks of trials followed one another without interruption: in the first block, cues were non-informative, that is, valid and invalid cues were presented in equal proportion; in the second block, the level of informativeness of the cues varied according to the experiment (for example in experiment 1, cues were informative, because targets appeared in the cued box 80% of the time). In all experiments, there was nothing to alert participants that they were passing from block 1 to block 2; moreover in the majority of experiments (1 to 3 and 5), participants were not informed of the level of informativeness of the cues, that is, of the cue-target relationship. After the experiments, participants filled out a questionnaire that asked whether there had been any cue-target relationship, and whether the cues had predicted the target location or the wrong location most frequently. On the basis of the responses to the questionnaire, participants were classified either as "verbalizers" if they answered correctly to both questions, or as "non-verbalizers" if their answer to the former question was incorrect.

Bartolomeo et al. (2007) found that: (a) most participants were able to build endogenous, strategy-based expectations about the side of occurrence of the target preceded by informative

cues in block 2 (in experiment 1, for example, there was late facilitation for cued targets with 80% valid cues), despite the absence of previous knowledge about the cue-target relationships (experiments 1 to 3) and the presence of the non-informative cues of block 1: which indicate that the informativeness of the cues in block 2 influenced performance, and that participants could adapt their response strategies even in the absence of explicit instructions to do so; (b) half of the participants were "non-verbalizers", being unable to verbally describe the relationships between cues and targets; (c) even "non-verbalizers" showed endogenous orienting, being able to use the relationships between cues and targets of block 2. Bartolomeo et al. (2007) concluded that endogenous orienting can occur independently of verbal reportability; moreover, Bartolomeo (2008, p. 18) adds: "Presumably, all the participants had primary consciousness of cues and targets, and developed accurate knowledge about their relationships, but not all of them could develop the reflective consciousness necessary to verbally describe this knowledge. Thus, this evidence appears to support the phenomenological distinction between primary and reflective consciousness."

4.1.2.4. Pop-Out and the Cocktail Party Effect

Treisman A. and Gelade (1980) showed that when subjects search for a target defined by a conjunction of properties (say a red T) amongst a number of non-target items or distractors (say, red Xs and green Ts), search time increases linearly with the number of distractors. On the contrary, when subjects search for a target defined by a unique feature (say a red letter among green and red letters), search time is independent of the number of distractors. In this case, the unique feature is said to "pop-out". The pop-out effect is sometimes interpreted as evidence of the fact that the unique feature "automatically" captures attention, in the sense that subjects can become aware of the target prior to and independently of the focusing their attention to it. This interpretation is patently wrong because in visual search experiments subjects are actively looking for the target: that is, their attention is broadly and purposefully distributed through the display or the scene (see Most et. 2005). Therefore, the pop-out effect cannot be considered as evidence of consciousness in the absence of focal attention.

A related but slightly different phenomenon is the cocktail party effect. Using a dichotic listening task, where subjects who were presented with two simultaneous messages to the two ears via headphones were asked to attend to the message presented to one ear and to ignore the other message presented to the other ear, Moray (1959) found that subjects still recognized their name when it was presented in the unattended ear (the cocktail party effect). Cases such as this, where the subject's name or some other meaningful stimuli can exogenously capture a subject's attention even though the subject does not expect them or have any intention toward them, involve not so much focal attention (subjects are asked to focus on one message and ignore the other message) as a form of peripheral, exogenous attention. Indeed, it does not seem so implausible to think that: (a) evolution has endowed us with some mechanism that allows us to quickly orient to salient features of our environment; (b) this mechanism is (at least partly) based on the working of some form of peripheral, exogenous attention, which, being constantly applied and distributed, albeit at low levels of intensity, can be captured when salient stimuli occur.

Umiltà (1994) interprets the cocktail party effect and similar effects as evidence that attention does not coincide with consciousness and that they must be considered as independent systems. In these cases, he argues, the object is perceived consciously in a direct manner, without the intervention of attention.

Umiltà's argument contrasts with what Mack and Rock (1998) have found. They show that by decreasing the probability that attention is paid to an object, the probability of perceiving its presence is reduced. This also applies to cases of captured or exogenous attention: when the difficulty of capture is increased by reducing the attentional zone or increasing the inhibition of attention, the probability that one's own name is reliably perceived decreases (even if it continues to be seen significantly more often than other stimuli). Moreover, as McCormick (1997) has shown, exogenous cues presented below a subjective threshold of awareness capture attention without awareness.

These facts indicate that, contrary to Umiltà's opinion, attention is always involved in conscious perception. Even objects such as one's own name cannot be perceived without the intervention of some form of attention: they must capture attention to become conscious. There cannot be conscious perception without attention.

In my opinion, Umiltà's way of wrongly interpreting the findings on exogenous attention derives from considering consciousness from a purely third-person approach, namely the information-processing one. Like many other authors, he considers mental activity as a particular way of processing information. In this view, consciousness is conceived as a central processor (for a similar view, see Johnson-Laird, 1983, 1988), and attention is a privileged route for events to enter the central processor and become conscious, even though not the only one available (Umiltà, 1988). As a consequence, attention is assigned a passive, subsidiary role in relation to consciousness. As we have seen, this way of considering consciousness cannot explain how it is possible for us to have subjective experiences of things. But it also has another major fault: it cannot account for the constructive role that a person plays in building his/her knowledge. This is due to the fact that its main target is to analyze how a person processes information, and not how a person constructs his/her knowledge. Knowledge construction is not so much a matter of processing information, the time needed to process it, ways of processing it, and so on, as of *why* a person has to process it. An information-processing approach neither disputes, nor addresses the question of the necessity to process information: it simply analyzes the process, taking the presence both of information, and process and person for granted. On the contrary, a knowledge-construction approach analyzes first of all the origin of information, that is, why and how a person assigns a meaning to objects, and objects acquire a meaning for the person. Only by addressing such questions, is it possible to understand the role played by the person in constructing his/her knowledge.

4.1.2.5. Iconic Memory

Lamme (2003) also proposes that there can be consciousness without attention. In his view, the attentive selection process operates at a later stage than consciousness: attention does not determine whether stimuli reach a conscious state, but determines whether a conscious report about stimuli is possible. In other words, we are conscious of many inputs, but without attention this conscious experience cannot be reported: when we view a visual scene, we experience a richness of content that goes beyond what we can report. His model - which presupposes the existence of a short-lived, vulnerable and not easily reportable form of visual experience, which contrasts with a more stable, reportable form of awareness – parallels: (a) Block, N.'s (1996) proposal of the existence of two distinct kinds of awareness: phenomenal and access awareness; and (b) the distinction made in the domain of sensory memory between "iconic memory and "working memory".

In support of his view, he quotes Becker et al.'s (2000) and Landman et al.'s (2003) change detection experiments. It is known from Change Blindness' experiments that the ability of subjects to detect a change in a visually presented array of items is greatly reduced if a blank interstimulus interval (ISI) is inserted between the original array (stimulus 1) and a subsequent array displaying the same items as stimulus 1 except for one item that has changed (stimulus 2). It is also known that change detection improves if the item to be changed is cued during the display of stimulus 1. The new and surprising phenomenon found by Becker et al. (2000) and Landman et al. (2003) is that change detection also improves when the location of the change is cued during the blank ISI. This may lead one to believe that all of the items of stimulus 1 are conscious, and remain in consciousness even after the stimulus is removed, until it is overwritten by stimulus 2.

In my opinion, Lamme approaches consciousness and attention from a typical information-processing point of view, even though the model he proposes differs from most of the models that are inspired by such a point of view. In his opinion, attention is a selection process that determines not so much whether stimuli reach consciousness, as whether stimuli can go from phenomenal awareness to access awareness. He arrives at this model on the basis of the considerations that:

i) there are different levels of processing that stimuli can reach. More specifically, there are sensory inputs that: (1) reach a conscious state via the process of attentive selection; (2) do not reach a conscious state when not attended; (3) do not reach consciousness, not even when attended;
ii) these different levels of processing can be more parsimoniously explained by a model that is based on an early distinction between conscious and unconscious stimuli than by a model that is based on an early distinction between attended and unattended stimuli. Indeed, while the early distinction between attended and unattended stimuli would lead to postulating at least three different processes (one for stimuli that are conscious because attended, one for stimuli that are unconscious because unattended and one for stimuli that are purely unconscious), the early distinction between conscious and unconscious stimuli would lead to postulating only two processes (one for stimuli that are conscious and one for stimuli that are unconscious).

There is no doubt that Lamme's information-processing point of view partly explains what hinders him from assigning attention an active role in relation to consciousness. But his model also seems to overlook the fact that both attention and consciousness can assume a variety of forms. For example, when he observes that there are "non-attentional selection mechanisms" that can produce unconscious processing of stimuli, Lamme does not seem to consider the fact that some sort of "preliminary attention" (Velmans 1991) can also exist, and that stimuli that are preliminary attended, despite being processed, might not be consciously experienced. By overlooking this fact he mistakes unconscious processing for preliminary-attended processing. Moreover, as shown by Bahrami et al. (2008), attention can also act on stimuli that have not reached awareness: stimulus competition for the allocation of attentional capacity occurs regardless of whether or not the observer is conscious of the stimulus representations. Therefore, it certainly seems to be more plausible and economical to propose a model based on the notion that attention is necessary for consciousness than a model based

on the idea that attention is not necessary for consciousness: while the latter implies two processes (one for stimuli that are conscious and one for stimuli that are unconscious), the former needs only one process (stimuli are attended: various levels and types of attention are possible).

It should be further noted that Lamme's idea that when we view a visual scene we experience a richness of content that goes beyond what we can report is questionable at least. Experiments performed with the change-blindness paradigm show that viewers are over-confident about their capacities and suffer from an "illusion of seeing": when viewing a scene, viewers who claim to perceive the entire visual scene, actually fail to notice important changes of the elements of the scene. As argued by O'Regan & Noë (2001), the "illusion of seeing" might arise because viewers know that they can, at will, orient attention to any location and obtain information from it (for a similar view, see also Dehaene et al. 2006).

As regards the finding that change detection improves when the location of the change is cued during the blank ISI (Becker et al. 2000), in my opinion it does not show that there can be consciousness without attention; rather, it only confirms that: (a) there is an early component of attention - namely, the exogenous one (Nakayama & Mackeben 1989) - that can capture a specific item in iconic memory if sufficient time is afforded (change detection and identification tend to worsen at longer ISIs between the offset of stimulus 1 and the onset of the cue); (b) once attention has captured the item, the item is (or can be) transferred to a short-term-memory buffer, where it may be compared with a later-occurring item, thus leading to change detection (change detection and identification tend to improve at longer ISIs between the onset of the cue and the onset of stimulus 2).

4.1.2.6. Afterimage and Bistable Perception

Koch and Tsuchiya (2006) report some studies on the formation of afterimage and freezing in bistable perception as evidence that attention and awareness can oppose each other. For example, they quote Suzuki and Grabowecky (2003), who examined the effect of attention during adaptation on subsequent negative afterimages. Participants were asked to attend to one of two overlapping triangles with different colors for a 7-10 sec. adaptation period, and to not attend to the other triangle. The experiment showed that the triangle that was attended during adaptation produced an afterimage having weaker intensity and shorter duration than the afterimage produced by the unattended triangle. According to Koch and Tsuchiya, this would represent an example of the dissociation of the effects of attention and awareness.

In my opinion, Koch and Tsuchiya's argumentation seems to be based on a wrong deduction confusing conscious processing with the effects of conscious processing. Generally speaking, selectively attending to a stimulus produces conscious perception of the stimulus, which, in turn, can produce some other effect, for example, a decision to search for another stimulus, or to continue to observe the previous stimulus: but the effect of conscious perception cannot be mistaken for conscious perception. In the afterimage case, attending to a triangle produces first of all a conscious perception of the triangle, which in turn produces some effect (namely, an afterimage having certain properties, such as being weaker and shorter than an afterimage produced by an unattended triangle). But the afterimage is precisely the effect of conscious processing: it is not the conscious processing of the stimulus. As such, the afterimage is *a direct consequence* not so much of the focusing of attention, as of the conscious perception of the triangle. Koch and Tsuchiya claim that top-down attention

produces weaker afterimages. This is only partially true: top-down attention (possibly) produces weaker afterimages *indirectly and via* conscious perception of the attended stimulus. Without such conscious perceptions, afterimages might not possess any of the specific properties (namely, the characteristics of being weak and short) they acquire thanks to conscious processing. Therefore, from a purely logical point of view, Suzuki and Grabowecky's findings do not show that *attention* produces effects that contrast with conscious perception; rather, they show the effects that *conscious perception* can produce (weak and short afterimages). This fact is partly caught by Srinivasan's (2008) observation that weakened afterimages of attended stimuli might be necessary for a clear awareness of subsequently attended stimuli, something akin to the phenomenon of inhibition of return, in which previously attended locations are inhibited to facilitate allocation of attention to the following locations of interest. In the case of afterimages, the afterimage of the previously attended stimulus is weakened to facilitate awareness of the stimulus that has to be subsequently attended.

Moreover, regardless of these logical considerations, Koch and Tsuchiya's interpretation of the studies on afterimages and bistable perception also seems partly questionable in face of Baijal and Srinivasan's (in press) empirical findings. Baijal and Srinivasan show that both the spatial extent of attention (focused vs. distributed) and the level of attentional processing (global vs. local) affect afterimage duration. Participants viewed either single small letters, single large letters, or hierarchical letters implying global and local levels of processing (a large letter made up of smaller letters). The hierarchical letters were always incongruent, that is, the letters at the global and local level were different. The letters were presented in the center of a blue square frame inducer. Participants had to count the number of letters while adapting to the inducer frame, in four different conditions: (1) the global condition, in which they had to count the number of hierarchical letters that have the global structure of a left-facing 'U', regardless of the shape of the stimuli's constituent elements; (2) the local condition, in which they viewed similar stimuli but had to count the number of stimuli composed of small left-facing 'U' shapes, regardless of the stimuli's global shape; (3) the condition in which only single small letters appeared; (4) the condition in which only single large letters appeared. After the letter stimuli disappeared, a blank screen was presented on which the afterimage was formed. The participants then had to indicate the duration of the afterimage. The experiments showed that afterimage duration was significantly longer when the identification and counting task was performed with small compared to large letters, local compared to global stimuli, small compared to local stimuli, and (Experiments 2 and 3) global compared to large stimuli. On the whole, Baijal and Srinivasan's (in press) study shows that increases in the spatial spread of attention result in the decrease of afterimage duration, and that, when attending to large spatial scales, stronger afterimages are produced when distributed versus focused attention is deployed.

Therefore, Baijal and Srinivasan show that when interpreting studies on afterimages and bistable perception, one must also consider that: subjects can adopt different attentional strategies (for example, distributed attention vs. focal attention) depending on the specific task they have to perform; different attentional strategies may yield different types of awareness (for example, background consciousness vs. object consciousness, or phenomenal consciousness vs. access consciousness); different types of consciousness may lead to different effects (for example, weak afterimages vs. strong afterimages). Overlooking these

facts may lead to mistaking the effects of a form of attention for the effects of another form of attention, and to attribute to a form of attention what belongs to another form of attention.

In concluding this section devoted to the experiments designed, or interpreted, to show that there can be consciousness in the absence of attention, we can generally affirm that attention is necessary for consciousness. However, not all forms of attention produce the same kind of consciousness, and conversely not all forms of consciousness are produced by the same kind of attention. Neither attention nor consciousness are unitary phenomena; rather there are various forms of attention and consciousness. Each form of attention produces a specific kind of consciousness. Not considering this fact may lead to the wrong belief that there can be consciousness in the absence of attention.

4.1.3. Experiments Aimed at Demonstrating Attention in the Absence of Consciousness

The fact that attention is necessary for consciousness does not imply that attention generates or can modulate *only* conscious phenomena: it can also generate and modulate unconscious ones (which in turn can influence or bias both *which* and *how* stimuli will be subsequently consciously perceived: for a review, see Merikle et al. 2001). For example, Naccache et al. (2002) demonstrate that it is possible to elicit unconscious priming in a number-comparison task, but only if the subject's temporal attention is allocated to the time window during which the prime-target pair is presented: unconscious priming vanishes when temporal attention is focused away from this time window. Likewise He et al. (1996), exploiting the visual crowding effect (it is known that when a single grating is presented in the periphery of the visual field, observers are aware of its orientation, but when it is flanked by other similar gratings - a condition known as "crowding", its orientation becomes impossible to discern), found that when stimuli hidden from consciousness are attended, they are nevertheless processed by the primary visual cortex without disruption, producing undiminished orientation-specific adaptation. Sumner et al. (2006) showed that attention modulates neural sensorimotor processes that are entirely separate from those processes supporting conscious perception.

The fact that attention can also generate unconscious phenomena is not per se evidence of the fact that there can be focal attention without consciousness. In fact, as we will see, the view that there can be focal attention without consciousness will turn out to be wrong. However implausible, this view is held by researchers such as Koch and Tsuchiya (2006) and Velmans (1991). In my opinion, this wrong view can originate from at least two different fundamental reasons: (1) the absence of a first-person perspective; (2) confusing the perception of absence with the absence of perception. Let's examine some of the examples that were put forward to support this view, by classifying them according to the two different reasons that, in my opinion, may have originated it.

4.1.3.1. The Absence of a First-Person Perspective

Velmans (1991 p. 665) affirms that, "in principle, it might be possible to obtain evidence of focal-attentive processing in the *absence* of awareness of what is being processed". He does not claim that an object can be perceived consciously without the intervention of attention. Focal-attentive processing provides the necessary condition for conscious awareness, and there cannot be consciousness without attention: consciousness results from focal-attentive processing as a form of output. However, attention and consciousness are not

the same thing, and can be dissociated, because there can be attentional processing without consciousness.

Velmans' aim is to confute the conventional assumption by psychologists that "preconscious" processing is identical to "pre-attentive" processing and "conscious" processing is identical to "focal-attentive" processing. This assumption implies that "preconscious/pre-attentive" processing is involuntary, automatic, fast, and restricted to simple, familiar stimuli, whereas "conscious/focal-attentive" processing is voluntary, subject to intentional control, slow, and flexible. Velmans' confutation is based on evidence that preconscious processing is not inflexible and limited to simple, well-learned stimuli: he supplies many examples of preconscious analysis of novel and complex phrases and sentences, implicit learning, preconscious selection and choice, unconscious control of complex, novel motor adjustments, and unconscious planning. Consequently, it would be misleading to think of the preconscious-unconscious processing of stimuli as non-attended or pre-attentive: preconsciously processed stimuli, being subject to sophisticated, elaborated analysis, *are* receiving attentional resources, although they may not enter consciousness. Moreover, there is evidence (Kahneman and Chajczyk 1983) that "involuntary, preconscious" analysis of stimuli is not necessarily effortless, and that it draws on, and competes for, limited processing resources, which confirms the involvement of attentional resources in preconscious processing (see also Lavie 1995). Therefore, rather than speaking of non-attended or pre-attentive processing (vs. focal-attentive processing), it would be better to speak of *preliminary attention* (vs. focal attention) (Velmans 1991. p. 655).

I think that Velmans' work does not demonstrate that focal attention and consciousness are dissociated, as his intention seems to be, but only that "preliminary attention", as he calls it, and consciousness can be dissociated. The cases he takes into consideration give evidence only of the fact that stimuli to which subjects pay limited, preliminary attention are nevertheless preconsciously processed, and therefore that preliminary attention and consciousness can be dissociated. They do not show that there can be focal-attentive processing without consciousness. Whether the evidence he cites refers to dichotic listening tasks and shadowing tasks (Treisman A. 1964a, 1964b; Lackner and Garrett 1973, MacKay 1973), visual masking experiments (Marcel 1980, 1983), Stroop effect, implicit learning (Nissen and Bullemer 1987, Hartman et al. 1987), or control of action, what they all show is only that stimuli can be preconsciously processed on condition that they are given at least a minimal level of attention.

Indeed, as observed by some authors (Neuman 1984, Holender 1986, Logan 1995), in these cases, as well as in others such as the flanker compatibility effect or negative priming effect (Tipper 1985), subjects *do* pay a certain, even if marginal, level of attention to the to-be-ignored, unwanted stimuli, even though they are instructed not to pay attention to them, or are prevented from paying attention to them. This marginal level of attention can be brought about and maintained in various ways: one of the most common is by widely distributing the focus of attention. For example, McCormick (1997, 178), commenting on his finding that an exogenous cue presented below a subjective threshold of awareness captures attention automatically and without awareness, explicitly observes that "this finding and the issue of the automaticity of exogenous orienting is limited to specific experimental conditions (...) In my experiments, the observers' attention was likely distributed widely over the visual field in anticipation of the pending cue and target events, thus it could be involuntarily attracted to the cue".

For example, the fact that amnesic patients and normal subjects, exposed to successive exemplars of recurring patterns of which they were unaware, can implicitly learn those patterns without spontaneously noting any repeated sequence (Nissen and Bullemer, 1987, Hartman et al., 1987), does not imply that they have used their focal attention to learn those patterns: in fact, they have been instructed to pay attention to the single items composing each pattern, and not to the recurring pattern. Therefore, it is inappropriate to affirm that there is focal-attentive processing of a pattern in the absence of awareness of that pattern, because what subjects attentively process is not so much the pattern as the single items of the pattern. Most probably instead, they have been able to learn the patterns because they have spent a marginal amount of their attentional resources on it: so marginal an amount that they could not consciously realize what they were doing, even though it was sufficient to make them learn the patterns.

Therefore, Velmans' work is certainly convincing as long as it shows that there can be a limited level of attention (preliminary attention) without consciousness, but it does not prove that there can be focal attention without consciousness.

Most probably, what leads Velmans to claim that consciousness can be dissociated from attention in general, thus overlooking the fact that only preliminary attention, but not focal attention, can be dissociated from consciousness, is the absence of a first-person perspective. As he admits, he adopts a purely information processing perspective, identifying attention with the capacity to process information and analyze stimuli. This perspective certainly gives him the possibility of considering those aspects of mental processing that are usually associated with attention - such as reaction time, accurateness in answering, etc. - but it does not let him see the importance of attention for the emergence of consciousness and the construction of the person. This is because information processing models systematize what can be observed only from a third-person, external observer's perspective, whereas, as we have seen, the phenomenal aspect of attention and consciousness can be analyzed only by taking a first-person perspective. Therefore, it may be that, by assuming the information processing perspective, he has been able to see only one aspect of attention, and this has led him to think that it should be the only one.

An author who, assuming a first-person perspective, does not overlook the fact that only preliminary or low-level (but not focal) attention can be dissociated from consciousness is Damasio (1999). In his definition, consciousness is the "umbrella term for the mental phenomena that permit the strange confection of you as observer or knower of the things observed, of you as owner of thoughts formed in your perspective, of you as potential agent on the scene" (*ibid.*, p. 127). Throughout his work, consciousness is seen as the main reason for the feeling we have of ourselves as the subject of our own actions, that is, for the fact that we sense that what we are doing is done by us, and not by someone else. He rightly underlines that the lack of consciousness causes the disappearance of the sense of self: in fact, as we have seen, it is conscious activity that determines the emergence of the person.

According to him, some diseases, such as akinetic mutism, epileptic automatism and advanced stages of Alzheimer's diseases, demonstrate that there can be fleeting, low-level attention without consciousness. Evidence of the dissociation between low-level attention and consciousness is given by patients who, while exhibiting some elementary signs of attention such as the ability to form sensory images of objects and execute accurate movements relative to those images, do not develop any sense of self, of an individual organism wishing, considering, wanting, of a person with a past and a future. Moreover, they do not show any

sign of emotion either. Finally, Damasio points out that only a kind of attention that is high-level, extended in time and focused on appropriate objects is indicative of consciousness (*ibid.*, p. 91).

Despite not specifying exactly what the difference is between low-level and high-level attention, these findings seem to support nonetheless, contrary to Velmans' opinion, the hypothesis that focal or high-level attention cannot be dissociated from consciousness. Only low-level attention or, as Velmans calls it, preliminary attention, can be dissociated from consciousness.

4.1.3.2. Confusing the Perception of Absence with the Absence of Perception

Koch and Tsuchiya (2006) maintain that focal attention and consciousness are dissociated not only because there can be consciousness in the absence of focal attention, but also because there can be focal attention in the absence of consciousness. They state that "Subjects can attend to a location for many seconds and yet fail to see one or more attributes of an object at that location" (Koch and Tsuchiya 2006, p. 17). Likewise, Mack and Rock (1998, p. 245) state that "It is not an uncommon experience to be looking for something or keenly awaiting its appearance in the absence of perceiving it (…) Both the looking for and the awaiting are part of what we mean by attention in our ordinary language, but in cases such as these the looking for is not associated with any perception".

Generally speaking, I think that when one states that there can be attentionwithout consciousness or without perception, one should carefully specify what the expressions "without consciousness" or "without perception" imply. Indeed, as we have seen, there are cases in which attention can also generate and modulate unconscious phenomena. However, when such cases occur they do not imply that, *in general*, there is no consciousness or perception at all. Rather, they imply that a person can be aware of something without being aware of something else, or even that a person can be aware of not being aware of something. That in some cases one can focus one's attention to something without perceiving it does not imply that one does not perceive anything at all: rather it means that one perceives something else, or that one perceives the absence of the thing one is focusing on. As Mole (2008) correctly observes, cases in which one is on the lookout for something that does not appear, are not cases of attention without perception; rather, these are cases where one is perceiving that nothing has yet occurred. Overlooking this means mistaking the perception of absence for the absence of perception. According to Mole, this mistake can be better understood if we consider the phenomenon of the physiological blindspot, that is, the fact that a part of the field of vision cannot be perceived because of the lack of light-detecting photoreceptor cells on the optic disc of the retina where the optic nerve passes through it. A classical demonstration of the physiological blindspot occurs when looking at a figure such as Figure 5.

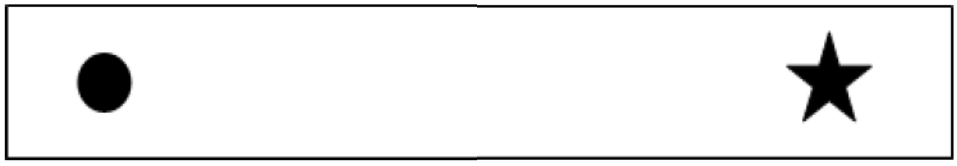


Figure 5. Demonstration of the blindspot.

If you cover your right eye, focus the left eye on the star, and slowly move the page away from yourself, you will realize that at a certain distance the dot on the left disappears, while the star continues to be visible. What the blindspot demonstration shows is that it is possible for us to be aware that we are not aware of something: it is only because we are paying attention to the figure and are aware of it, that we can notice the dot disappears.

Therefore, in my opinion, when quoting experiments such as He et al.'s (1996) and Montaser-Kousari and Rajimehr's (2004), one should specify that these experiments provide evidence not so much of "focal attention in the absence of *any form* of consciousness in general", as of "focal attention in the absence of consciousness of something, but in presence of consciousness of something else", or of "focal attention with consciousness of the absence of something". Focal attention always implies some form of consciousness, even if only consciousness of the absence of the thing one is focusing on or is looking for.

A very interesting experiment with a blindsight subject, G.Y., which seems to support the view that there can be focal attention in the absence of *any form* consciousness (at least, in the blind area of the subject), was reported by Kentridge et al. (1999). Blindsight subjects are perceptually blind in a certain area of their visual field: they deny having any awareness whatsoever of any visual stimuli presented in that area, or they acknowledge only limited awareness of some phenomena within the blind area, such as movement, but not visual percept. Despite this fact, they are able to discriminate and localize visual stimuli presented in the blind area at levels significantly above chance. In their experiment, Kentridge et al. (1999) adopted a cue-target paradigm. A target, which could appear in one of two possible locations, was presented to the subject; the target was preceded by a cue which might or might not indicate the correct location of the target; the subject was instructed to report - upon hearing an auditory tone that followed the presentation of the visual cue signaling the probable target location - whether or not a visual target had accompanied the presentation of the auditory tone, guessing if necessary, and then to make a second response indicating whether he had had any experience whatsoever. Before the start of each experiment the subject was given instructions indicating the two possible target locations, and in which location the target was more likely to appear. Two main different cueing methods were used in the various experiments in order to investigate whether attention and awareness are inextricably linked or whether there can be endogenous, voluntary attention in the absence of awareness: in the central cueing experiment and in the direct peripheral cueing experiments, the target was more likely to appear at the location indicated by the cue than at the other location; in the indirect peripheral cueing experiments, the target was more likely to appear at the location opposite to the one indicated by the cue than at the location indicated by the cue. It is known that indirect cues require voluntary, endogenous attention as opposed to automatic, exogenous attention: in fact, the former imply the application of an arbitrary rule (as opposed to an automatic one) relating the cue and the target location, and the suppression of automatic, exogenous orienting of attention to the cue location. Moreover, it is generally maintained that endogenous, voluntary orienting requires conscious awareness (Posner 1994a). Consequently, Kentridge et al. (1999) predicted that if G.Y. could use the indirect peripheral cue to re-orient his attention, and yet remain unaware of the cue, they would demonstrate that there could be endogenous, focal attention in the absence of consciousness. Indeed, their experiments showed that when an indirect peripheral cue was used, G.Y. could direct voluntary, endogenous attention within his blind field, despite being unaware of the cue he used (upon being questioned after each test on whether he had had any experience whatsoever, he

answered that he had had no awareness of any cues). Therefore, Kentridge et al. (1999) concluded that "the spatial selection of information by an attentional mechanism and its entry into conscious experience cannot be one and the same process".

I think that Kentridge et al.'s (1999) findings cannot be straightforwardly interpreted as evidence of focal attention without consciousness, but rather that they deserve further and more careful examination, and that at least two other alternative interpretations are equally plausible.

According to the first alternative interpretation, the fact that G.Y. *verbally* reported that he had had no awareness of cues does not automatically imply that he had had no conscious experience of anything. As Bartolomeo et al. (2007, p. 157) state: "although an appropriate verbalization can be considered as a reliable indicator of conscious processing (…), the converse is not necessarily true". Indeed, it possible to distinguish, as the phenomenological tradition has proposed, between "spoken" and "acted" forms of perception, that is, between a high-order, reflective form of consciousness, and a primary, direct form of consciousness (Bartolomeo et al. 2007, Bartolomeo 2008). Evidence of a dissociation between these two forms of consciousness comes from neuropsychological studies of brain-damaged patients (for example, an amnesic patient with anosognosia who is able to intellectually acknowledge the presence of his deficits, as well as his incapacity to directly appreciate them, for a review, see Bartolomeo and Dalla Barba 2002 and Bartolomeo et al. 2007), and from psychological observations (consider for example the case in which people observing an array of letters for a very short time are aware of having seen letters but can only name some of them). Therefore, from this viewpoint, it is plausible to interpret Kentridge et al.'s (1999) finding as a case of endogenous, focal attention without reflective consciousness, but with direct consciousness.

According to the second alternative interpretation - which incidentally Kentridge et al. (1999, p. 1810) themselves seem to suggest when they acknowledge that: "it is clear that, while the direction of attention towards a stimulus may be necessary if it is to reach awareness (…), attention is not sufficient for awareness" -, the fact that G.Y. could re-orient his attention does not automatically mean that he could fully take advantage of *all* the processes and neural mechanisms entailed and elicited by endogenous, focal attention. According to this view, attention is not so much a unitary process or entity, as a complex control system, or a set of coordinated processes; therefore it is possible to explain G.Y.'s behavior as the result of a partial working of such a complex control system. This is exactly the kind of explanation of Kentridge et al.'s (1999) experiments that has been given, for example, by Taylor (2008). In order to understand Taylor's argumentation, however, it is necessary to briefly introduce his CODAM (Corollary Discharge of Attention Movement) neural network control model of consciousness (2002, 2007a, 2007b).

The CODAM model, which is based on the main idea that consciousness is created through attention, consists of input processing modules (oriented bar analyzers, etc.), an object representations module (the object map), a goals module, an inverse model controller (creating a feedback attention signal to the object map and input modules, so as to move the focus of attention, as biased by the goals module), a working memory buffer site (to hold attention-amplified activity for report and awareness), a corollary discharge buffer (as a copy of the attention movement signal - that is, the signal that causes the focus of attention to be changed – to give an early prediction of the expected report signal from lower cortices on the buffer working memory), and a monitor module (to create an error signal so as to correct for

possible attention errors). The main feature of the CODAM model is the speed-up and error-correcting mechanism based on the efference copy or corollary discharge of the attention movement control signal. The corollary discharge provides a precursor signal that not only helps speed up and correct the processing of data, but is also at the basis of the experience of ownership of the about-to-be experienced content of consciousness.

According to Taylor (2008), the result of Kentridge et al.'s (1999) experiments can be understood in terms of CODAM as there being a corollary discharge and attention feedback amplification of the target stimulus. This would then allow a response to be made through an automatic route from the partially activated sensory buffer, so as to be more successful than chance, without any need for the visual buffer to be so strongly activated as to lead to awareness.

Likewise De Brigard & Prinz (forthcoming) explain Kentridge et al.'s (1999) findings by resorting to the distinction between spatial attention, that is, attention to a region of space, and attentional modulation of perceptual representations. In their view, in the case of spatial cueing, a two-stage process occurs: firstly, attention is shifted to the region of space indicated by the visual cue, and secondly, if anything is visible in that space, that thing gets visually represented and modulated by attention. Only the latter stage would involve consciousness, not the former. Consequently, a shift of attention to a region of unoccupied space would not result in any conscious visual percept. In Kentridge et al.'s (1999) study, only the first stage could occur, causing G.Y. to attend to a region of space, but the second stage could not occur because of G.Y.'s lesion in his primary visual cortex. De Brigard & Prinz (forthcoming) also provide three possible reasons why the spatial cue could facilitate G.Y.'s performance: 1) attending to a region of space may lower signal-detection thresholds for stimuli presented subsequently in that region; 2) the spatial attention may cause receptive fields in the region to expand, with subsequent increase of neural resources for the ensuing presented target; 3) spatial attention may prime the blindsighter for behavior responses in the attended region.

In concluding this section devoted to the evidence designed, or interpreted, to show that there can be attention in the absence of consciousness, once again we have to acknowledge the importance of distinguishing between the various forms of attention and consciousness. Overlooking the existence of the various forms of attention and consciousness may lead to the wrong belief that, in general, there can be attention without consciousness. Actually, as we have seen, there can be low-level attention or preliminary attention without consciousness, but there cannot be focal or high-level attention without consciousness. Focal attention always implies some form of consciousness; on the contrary, low-level or preliminary attention can either imply consciousness (such as when the cocktail party effect occurs) or absence of consciousness (Merikle et al. 2001). There is no doubt that one of the main factors that determines whether a stimulus to which the person has paid only limited attention can reach awareness is processing time: for example, McCormick (1997), using a cue-target paradigm with informative cues and variable stimulus onset asynchrony (SOA) between the cue and the target (Experiment 3), showed that the effect he found (an exogenous cue presented below a subjective threshold of awareness captures attention automatically and without awareness) is attributable to the time necessary to process the cue to the point of awareness: that is, the exogenous cuing effect occurs in the unaware condition because observers do not have enough time to complete the processing of the cue before the arrival of the target; Libet et al. (1991) showed that an unconscious function may be transformed into a conscious one simply by increasing the duration of the appropriate brain activities to a

minimum of about 500 msec. The authors verified this condition by applying stimulus trains of variable duration (from 0 to 750 msec) to a subject's ascending sensory pathway in the thalamus, and having the subject face a panel containing two buttons, each of which could be lit up briefly alternatively for 1 sec. The subject had to indicate in which of the two lit periods the stimulus was delivered: he had to make that decision even if he were not aware of any sensation produced in the test. The subject then had to report his level of awareness of the stimulus (felt; not certain that it was felt; felt nothing). By a statistical analysis, Libet et al. determined that the difference in stimulus duration between the condition in which the subject responded correctly despite having no awareness of the stimulus, and the condition in which the subject responded correctly having awareness of the stimulus, was due to an increase in stimulus duration of about 400 msec. This duration would therefore represent the "neuronal code" for the emergence of awareness (see also Libet 2004).

4.1.4. Attention and Consciousness Are not the Same Thing

The fact that attention is necessary for consciousness and that focal attention always implies some form of consciousness does not imply that attention is the *same* thing as consciousness.

Firstly, as we have seen, consciousness also needs some other components, such as sense-organs, somatosensory organs, and a working memory. There are authors like Srinivasan (2008) who think that components such as expectations and capacity of anticipation are also necessary for consciousness: indeed, what inattentional blindness and change blindness experiments seem to show is that the observers' failure to detect changes may be due to their expectations of a stable world and inability to anticipate the stimulus (in the sense that, for example, observers do not expect people to suddenly change into someone else). It should be noted, however, that it is always possible to incorporate such components directly into the attentional system: for example, Taylor (2002) has put forward a model of attention control that includes, among the other modules, the corollary discharge of the attention movement signal, which contains the information of the about-to-appear input that is being attended to.

Secondly, stream of consciousness can only be generated if the schema of self is also added.

Thirdly, consciousness *results* from the activity performed by attention, that is, from the application of attention to the other organs or to attention itself, and the consequent modulation of the state of the organ of attention. This difference is partly captured by Baars' (1997b, p. 364) description of attention as something more active than consciousness, and of consciousness as the result of this activity: "It is as if attention resembles selecting a desired television program, and consciousness is what appears on screen" (I say "partly" because, in his theory, Baars only acknowledges the selective function of attention, without recognizing its role in generating the phenomenal, qualitative aspect of consciousness).

Therefore, to the question whether there can be human consciousness at all, as we know it, without the schema of self (and its fundamental set of rules that runs the perceptual system), the sense-organs, the somatosensory organs, and working memory, and the connections linking one component to the others and to the organ of attention, my answer is obviously not: the organ of attention alone is not sufficient and the other components are also necessary.

Anyhow, attention represents the core element of consciousness: it is attention that makes the main characteristic of consciousness and conscious experience possible, that is, its phenomenal, qualitative aspect. Any model that aims to explain how consciousness works must necessarily include attention as its most important component. Indeed, many models of consciousness take it into consideration, assigning different levels of importance to it (just to mention a few: Baars 1988, Chella 2007, Crick 1994, Edelman 1989). There are also those like Taylor (2002, 2007a, 2007b) who, as we have seen, explicitly and extensively uses attention as the basis on which to develop his model of consciousness. However, despite taking attention into consideration, almost none of these models offers, or intends to offer, an explanation of how attention generates the phenomenal, qualitative aspect of consciousness (to my knowledge, the only partial exception is represented by Haikonen 2003, whose work we will consider later on). This is mainly due to the fact that they are developed using a third-person or purely information-processing approach, which implies all the problems we have seen in the initial paragraphs.

4.2. Attentional Activity Can be Performed Thanks to Nervous Energy, Which Is Supplied by the Organ of Attention

I derived the idea that attentional activity can be performed because of nervous energy from Ceccato's (1985, p.24; see also Ceccato and Oliva 1988) work, who stated that the human being is provided with a form of energy that can be defined as "nervous" if considered in physiological terms, and as "mental" if considered in attentional ones.

Certainly, the concept of "nervous energy" can prove to be quite abstract and problematic for those who, adopting a physical point of view, consider energy as the product of force and distance. However, I think the concept becomes less problematic when we consider the main ideas it wants to convey, namely that: (a) we are provided with "something" that allows us to perform a certain kind of activity or work, generally known as "mental activity", that is, to think, remember, decide, make plans, feel emotions, perceive, be aware of, perform unconscious processes, etc.; (b) this "something" is limited, in the sense that we can only do a certain amount of work per unit of time; (c) this "something" dissipates and runs out as we perform mental activity (but can be, at least partly, restored thanks to nourishment, rest and sleep).

Considered under this point of view, the concept of "nervous energy" becomes less abstract and can be assimilated to more familiar notions such as "a fuel that is consumed" or a "battery", even though, as Szalma and Hancock (2002) observe, a major problem with using non-biological metaphors (such as economic or thermodynamic/hydraulic models) to represent biological processes or systems is that the former can fail to capture the complexity and the unique dynamic characteristics of the latter. Indeed, non-biological metaphors may fail to account for some important characteristics of nervous energy, such as the fact that it is a pool that is flexible, in the sense that it fluctuates with arousal, so that in some situations increasing the task load may increase arousal, leading to a release of a larger supply of resources. In this sense, as Szalma and Hancock (2002) suggest, a regulatory model based on physiology, such as Cabanac and Russek's (2000), may serve as a metaphor to better describe the role of nervous energy in human cognition and performance (even though, as Szalma and Hancock correctly point out, a physiologically-based theory of nervous energy must also be

tempered by the problems inherent in reducing psychological processes to physiological activity).

Moreover, it should be noted that the concept of energy and the ideas it conveys are not at all foreign to researchers dealing with brain studies, even though they are not directly used to investigate the mechanisms responsible for the production of qualia. For example, Shulman et al. (2009) observe that high energy consumption is a necessary property of the conscious state. More precisely, empirical evidence from PET and fMRI studies led them to hypothesize that: 1) "the conscious state in the resting-awake human is supported by a high and relatively uniform state of baseline brain energy consumption and (by inference) neuronal activity" (Shulman et al. 2009, p. 66); 2) when the energy is sufficiently reduced, there is loss of consciousness: for example, loss of consciousness during anaesthesia occurs when regional energy levels are uniformly reduced by 40-50% from the resting-awake values; 3) responses to sensory and cognitive inputs are relatively small perturbations of the conscious state, that is, neuronal responses to sensory and cognitive stimuli are much smaller than the neuronal activity maintaining the baseline state.

The concept of energy dissipation and consumption is also taken into consideration for its importance in understanding the function, design and evolution of sense organs and brains (Laughlin 2001, Laughlin & Sejnowski 2003). Indeed, energy consumption can be conceived as a constraint that impinges on all aspects of neural function: as such, it can help understand why nervous systems evolved the way they did. For example, it is known that nervous systems consume metabolic energy at relatively high rates per gram, and that energy supply limits traffic in the brain. As Laughlin & Sejnowski (2003) observe, it is precisely by taking such kinds of metabolic and energy constraints into account that it is possible to explain why evolution favoured the appearance of cortical networks characterized by miniaturized components, in which information is represented with energy-efficient codes and superfluous signals are eliminated.

Furthermore, the idea of a limited resource akin to energy or strength is also at the basis of an interesting research program on self-control and self-regulation. According to Baumeister (2002), acts of self-control, volition, choice and taking responsibility operate on the basis of a limited resource that can become depleted through use. He conducted a series of experiments to see what happened to self-control in two consecutive tasks: he reasoned that if self-control operates like an energy, then the first act of self-control would consume some quantity of this resource, and therefore subjects would face the second task with a diminished capacity to engage in self-control. His findings repeatedly supported the energy model: whether the subjects' first task consisted in regulating their emotions, suppressing their thoughts, or resisting temptations, their ability to regulate themselves on the second task was inevitably impaired.

The ideas implied by the concept of "nervous energy" (nervous energy is a pool that allows us to do a certain kind of work, is limited, runs out, is replenished, is flexible) have been variously highlighted and analyzed in relation to attention by many authors. Various terms – such as "psychic energy", "limited capacity processor", "resource", "effort", "commodity" and "pool of limited capacity" - have also been used to (either partially or fully) express the same ideas as those implied by the concept of nervous energy (Peter Jakubik, in a personal communication, also suggests using "operational capability"; however, by adopting "nervous energy", I intend using a less generic term that identifies a specific kind of energy, and differentiates it from the other kinds of energies: precisely, it identifies the kind of energy

that is produced by the organ of attention and used to pilot and run the motor organs, the sense-organs, the somatosensory organs, working memory, and the schema of self).

For example, in his study on the phenomenon of "flow", Csikszentmihalyi (1992) refers to attention as a psychic energy that allows us to perform mental activity and that is dissipated in doing this activity: "Because attention determines what will or not will not appear in consciousness, and because it is also required to make any other mental events - such as remembering, thinking, feeling, and making decisions - happen there, it is useful to think of it as psychic energy. Attention is like energy in that without it no work can be done, and in doing work it is dissipated. We create ourselves by how we invest this energy" (Csikszentmihalyi 1992, p. 33).

Mach (1890), in his work on time-sensation, speaks of attention in terms of a limited pool that runs out during the day, leading to sleep: "Since, so long as we are conscious, time-sensation is always present, it is probable that it is connected with the organic *consumption* necessarily associated with consciousness, - that we feel the *work of attention* as time. (…) When our attention is completely exhausted, we sleep" (Mach 1890, pp. 111-112).

Kahneman (1973) on the footsteps of David Rapaport, put forward the idea of attention as a limited general purpose resource which can be flexibly allocated from moment to moment according to the person's needs, goals and motivations. Attention can be focused on one particular activity, or can be divided among a number of activities. When one needs to perform two attentionally demanding tasks at once, one can share one's processing capacities between the tasks according to priority. Moreover, the amount of attentional capacity can vary according to motivation and arousal: if one puts more effort into a task, one can do better. However, since attentional resources are limited, there is a limit to the possibility of sharing attention - when one task demands more resources, there will be less capacity left over for the other tasks - as well as of increasing mental processing capacity by increasing mental effort and arousal.

Although initial research seemed to confirm the existence of the general-purpose resource hypothesized by Kahneman, subsequent experiments (McLeod 1977, 1978, Duncan 1984, Fagot and Pashler, 1992, Pashler, 1989) have shown that there are a variety of resources that are task-specific rather than a single, multi-purpose central pool of processing resources. In McLeod's experiment (1977), for instance, two groups of subjects performed a continuous visual input/manual output task simultaneously with a two-choice tone identification task. While one group responded vocally to the tones, the other group responded with the hand not involved in the continuous tracking task. It was found that the continuous task was performed significantly worse when the two-choice responses were manual, that is, response production was affected by the production of manual responses but not by the production of vocal responses. McLeod concluded that this difference was due to the fact that while the two manual responses were produced by a single limited capacity process, the manual and vocal responses were produced by independent processes. Psychological refractory period (PRP) studies (Pashler, 1998) have also given clear evidence of the existence of independent resources: they show that there is a dissociation between the perceptual processing stage and the central processing stage (roughly speaking, the activity of thinking is, to a certain extent, independent of the activity of perceiving).

Wickens (1984) defined resources as an intervening variable to account for variability in the efficiency with which individuals can divide attention among tasks.

Certainly, the theoretical construct of attention as a form of resource pool does not seem to be a completely unproblematic one (Navon 1984, Szalma and Hancock 2002. For example, Navon (1984) argues that the very notion of resource (or of one of its predecessors: effort, capacity, etc.), as a hypothetical construct, may turn out to be "excess baggage": "most effects that are often interpreted in terms of resources may be accommodated well enough within theories that do not assume any limit on resources, or theories in which such an entity does not exist at all" (Navon, 1984, p. 221). In this sense, some other ways of explaining the same effects could exist: side-effects, the poor quality of the sensory input, some kind of mechanism regulating the accessibility of some enabling mental entity that is unlimited, etc. Here I can only observe that both the notion of resource and the alternative notions of side-effect, quality of the sensory input, etc. are all "hypothetical constructs", and that there are not notions that are truer than others; as such, they can only be judged on the basis of their usefulness and successfulness in describing and explaining phenomena in a more comprehensive and economical way than other constructs. In this sense, the clear theoretical advantage of the proposal I have put forward here over some other kinds of proposals is its capacity to explain a variety of conscious phenomena by means of a very basic component such as attention, without needing to resort to additional components.

Similarly to the concept of "nervous energy", the notion of "organ" can also prove to be problematic. In physiology, for example, an "organ" usually denotes something that is anatomically delimited, while in the case of attention it could turn out that many structures are involved at various levels. Therefore, it could be better to use some other term, such as for example "nervous structures". At present, however, I think the term organ is the preferable one because it requires and conveys the complementary idea of function, which is fundamental at this initial stage of research on the brain structures underpinning consciousness.

Even though the notions of "organ of attention" and of attention as an activity that can be performed thanks to a form of energy, can prove to be problematic for the reasons stated above, many scientists have nonetheless started investigating the physical substrate of attention and the nervous structures constituting the organ of attention. For example, Crick and Koch maintain that the thalamus is the organ of attention (Crick 1994, Crick and Koch 2003). Mesulam (1990) proposes a network model of attention in which several distinct cortical regions interact: the posterior parietal cortex (which provides an internal perceptual map of the external world), the cingulated cortex (which regulates the spatial distribution of motivational valence), and the frontal cortex (which coordinates the motor programs for exploration, scanning, reaching, and fixating), all of which are influenced by the reticular activating system (which provides the underlying level of arousal). La Berge's (1995) neural model of visual attention involves the thalamus, the oculomotor regions of the superior colliculus, and the posterior parietal cortex. Posner and his colleagues (Posner 1990, 1995; Posner and Petersen 1990) present a model of attention consisting of three interconnected networks: a posterior attention network involving the parietal cortex, the pulvinar, and the superior colliculus; an anterior attention network involving the anterior cingulated cortex and supplementary motor areas in the frontal cortex; and a vigilance network involving the locus coeruleus noradrenergic input to the cortex. Each area performs a specific attentional operation: the parietal cortex disengages attention from the locus of the present target; the superior colliculus acts to move the spotlight of attention to the intended target; the pulvinar is involved in the engagement of attention on the intended target; the anterior network, which

is involved in the detection of events and the preparation of appropriate responses, exercises executive control over voluntary behavior and thought processes; the vigilance network is crucial for maintaining a state of alertness.

To my knowledge, the individuation of the organ of attention based on the assumptions I have put forward here (that is, as the main organ responsible for the production of conscious experience, which derives from the modulation of the state of nervous energy through the use of nervous energy itself) has not yet been undertaken. It is true that researchers have already started investigating whether attention and consciousness share common neural structures (see for example, Rees and Lavie 2001, Naghavi and Nyberg 2005, Bartolomeo 2008; for a recent review, see Cavanna and Nani, (2008). According to Cavanna and Nani (2008), for example, the frontoparietal network and recurrency (Lamme 2003) could represent the essential neural ingredient of the overlap between consciousness and attention; Bartolomeo (2008) suggests that frontoparietal networks underlie both spatial attention and primary consciousness. However, this research is still inspired by a limited and partial idea of attention as a purely selective filter, which has the capacity to voluntarily or involuntarily give priority to some parts of the information available at a given moment.

Therefore I cannot provide any empirical evidence for its existence, but only argue for it. Certainly, the empirical identification of such an organ is not a simple task, above all because of the kinds of basic roles attention plays in mental life. For Haikonen (2003), for example, attention is "a biological neural system's basic way of favoring the strongest signals, a process that is present already in the simplest central nervous system" (Haikonen 2003, p. 70). According to him, therefore, there would be no need for any special "attention box", since the attention mechanism is distributed within the whole neural system. In my opinion, the successful identification of such an organ presupposes a clear and comprehensive description of its functions. Only by having previously described such functions and developed a theoretical model of the organ, can scientists identify the physical structures responsible for the production of those functions: using Cavanna and Nani's (2008) words, "we will not be able to find anything if we do not know exactly what we are looking for". My proposal is that the organ of attention performs not only those operations that we all know attention allows us to do, such as focusing or zooming on an object, maintaining a state of alertness, selecting items, filtering unwanted information, and so on, but also the fundamental function of generating conscious experience in its various qualitative and quantitative aspects.

4.3. Attentional Activity Affects the Organ of Attention, Causing a Modification of the State of Nervous Energy itself, which Constitutes the Phenomenal Aspect of Consciousness

I partly derived the idea that feelings and conscious experiences are the result of a change in the state of nervous energy (induced by the use of the nervous energy itself) from Valéry's (1973a) observation that sensation is a variation of the state of energy of a closed system: "Sensation does not consist so much in an introduction of something from the outside, as in an intervention, that is, an inner transformation (of energy) made possible by an external modification, a variation in a state of a closed system (…) sensation is due to some kind of disequilibrium (…) sensation is what occurs between two states of equilibrium" (I have translated this from the Italian version, 1988, pp. 411-412).

This idea seems quite plausible if we assume a first-person perspective. In this perspective, a person emerges from, and thanks to, his/her continuously performing a certain kind of activity (attentional activity). The process of emergence of the person can take place only if the person's activity allows the person to differentiate him-herself from the other entities, beings, and objects. This implies that the person has the ability to determine his/her own limits and boundaries, and concurrently the limits and boundaries of the other entities. The person's limits and boundaries are principally represented by the constraints imposed on the person by the specific structure of his/her body (for example, we cannot perform all the kinds of movements we want: our body allows us only certain degrees of freedom) and by the relations resulting from the interaction between his/her body and the other entities. Such constraints manifest themselves during the person's activity and movements, and *are* the basic elements of perception: perception is based precisely on these constraints, and percepts are formed and constituted by these constraints (for a similar view, see Morris 2004. When discussing Carello and Turvey's [2000] experiments, for example, he states: "What we are perceiving when we perceive felt length is a constraint, a limit on movement" p. 65). Here it must be stressed that these constraints are the result of the person's activity, that is, of his/her continuously using and applying his/her attention: they originate from, and are produced by the person's use of his/her attention, and they *consist precisely of* the interruption, hindrance, slowing down, facilitation, stimulation, acceleration, and so on, of the attentional activity. Every time the person finds an obstacle or cannot extend his/her limbs beyond a certain extent or cannot make a movement, his/her attentional activity, and along with it, all his/her being, is slowed down or even temporarily stopped, so much so that the person must either apply his/her nervous energy in a new way or redirect it to something else, if he/she wants to unblock the situation. It is by means of this use and application of attention that the person can perceive constraints as such (that is, as constraints on his/her own activity). Indeed, the person has no other means of directly "feeling" and experiencing them: the person can only rely on his/her own (attentional) activity. And whoever wants to analyze how a person perceives things also has to rely on the person's own activity, unless they think that it is better to rely on an internal homunculus, thus falling into endless circularity.

To better understand the mechanism by means of which the attentional activity performed by the organism induces a variation in the state of the nervous energy of the organism, we can resort to the comparison between this mechanism and a standard power supply, such as a battery. Indeed, as we have seen in the previous section, the concept of nervous energy can be assimilated to more familiar notions such as a "battery" or "a fuel that is consumed". However, there are some important differences in addition to the one we already considered (nervous energy is flexible, in the sense that it fluctuates with arousal): (a) while the working of the battery has only one effect on the battery itself, that is, dissipating its own charge, the working of attention modulates the state of nervous energy, in the sense that it can for example stimulate a larger production of nervous energy, speed it up, hinder it, or block it; (b) while a battery releases energy only when it is needed by a circuit, the working of attention goes on continuously (most probably, as we have seen, in a cyclical way) in waking hours, so much so that we cannot stop thinking, imagining, remembering, perceiving, and more in general having conscious experiences.

A partial but very interesting parallel with my model of how attentional activity affects the state of the nervous energy of the organism is offered by Cabanac and Russek's (2000) model of regulated biological systems. Cabanac and Russek starts by correctly pointing out

that describing regulation in biological systems in the classical terms of control theory presents the disadvantage of not distinguishing signals from energy: control theory is more concerned with signal processing than with energy flow, which is on the contrary the main problem of any living being

> A computer, or a T.V. set, are plugged into an infinite energy supply, and energy counts for little in the problem engineers face in building or using them. On the other hand, energy and matter supply is a major problem for animals. It is therefore necessary to revise the concepts of regulation in order to face this specific problem in living beings (*ibid.* 2000, pp. 141-142).

According to Cabanac and Russek, living beings are open systems that accumulate free energy and reduce their entropy at the expense of the energy input: they reach a steady state, so that a constant amount of free energy available for use is maintained, and the input and output flows of energy are equal and constant. Their capacity of reducing their local entropy and of organizing themselves at the expense of the energy flow through them, may represent the thermodynamic basis of life and evolution. Cabanac and Russek's model of regulation in physiological systems (Figure 6), which is essentially a homeostatic one, is based on a *set point* that indicates the normal level of function. Perturbations of the steady state require the system to compensate for deviations from the set point. The compensation is achieved through a regulation of the input and output flows, which are anatomically distinct (body outflow - urine, heat loss, etc. - is not the same loop as inflow – water intake, heat production, food intake, etc.). The inflow regulation is a negative feedback loop, in which an input subsystem responds to perturbation of the steady state by increasing the flow when energy is drained and decreasing it when energy levels rise above the set point. The outflow is a positive feedforward loop in which changes in the state relative to the set point induces changes in the same direction in the output subsystem.

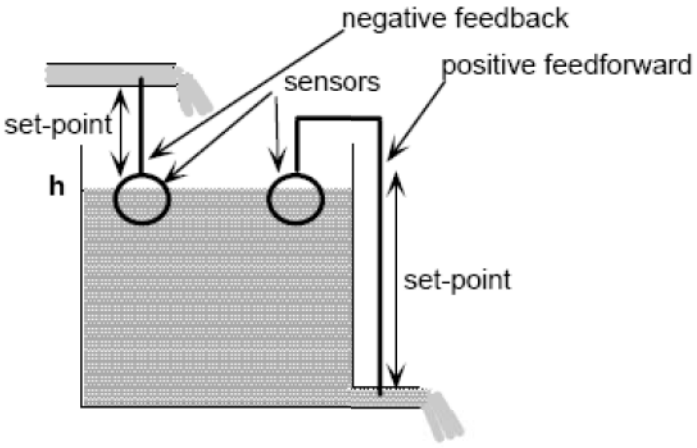


Figure 6. Cabanac and Russek's (2000) model of regulated biological systems.

Cabanac (2000) observes that sensations of pleasure and displeasure are strongly dependent on the actual internal state of the system, that is, how much the level of free energy available for the system deviates from the set point: for example, while hypothermic subjects feel cold stimuli as unpleasant and warm stimuli as pleasant, hyperthermic subjects feel the

opposite in response to the same stimuli: as soon as subjects return to normothermia, all stimuli lose their strong pleasure or displeasure component and tend to become indifferent. Thus pleasure can take place only in situations in which an internal perturbation has to be corrected (for example, hyperthermia or hypothermia); once the internal perturbation is corrected through the regulation of the input and output flows, all stimuli become indifferent (unless, of course, the perturbation they introduce in the energy level of the system is such that the pain threshold is reached or crossed, in which case they arouse displeasure). Cabanac uses the word "alliesthesia" to indicate the fact that the hedonic dimension of sensation is contingent upon the internal state of the stimulated subject: sensory pleasure is a dynamic characteristic eventually generating its own extinction. Therefore, sensory pleasure can be characterized by its physiological usefulness in correcting a physiological trouble or deficit.

If we apply Cabanac and Russek's model to my attentional model, the energy flow becomes the nervous energy which is continuously used by the organism in the form of attention. The application of attention induces perturbations of the energy level of the system, which can generate either pleasant, unpleasant or indifferent sensations. The hedonic dimension of the sensation - that is, its pleasantness, unpleasantness or indifference - depends substantially on whether the energy level of the system is moving away from, or toward the set point (as we have seen, pleasant sensations occur when perturbations are corrected, bringing the energy level toward the set point, while unpleasant sensations occur when perturbations are introduced, which brings the energy level away from the set point), the distance between the actual energy level and the set point (indifferent sensations occur when the energy level is near the set point; painful sensations occur when the energy level reaches a certain distance from the set point), and most probably the speed at which the energy level moves.

Let's try to imagine how the internal state modifies when the person, touching a surface, feels a sensation of "soft". The initial application of attention – through the organ of touch - to the surface produces a slight expenditure of nervous energy, which induces a temporary decrease of the energy level of the system. This in turn entails – through the regulatory negative feedback – the opening of the faucet at the input so as to let the energy level rise in order to restore the set point. Subsequently, with the surface of the object not offering any resistance to the fingers, less nervous energy is required at the output. The sudden increased input flow not counterbalanced by an equal output flow makes the energy level return to the set point, with the accompanying sensation of pleasure.

On the contrary, a sensation of "hard" implies, after the initial application of attention, a subsequent increase of output flow, which, not being duly counterbalanced by the input flow, leads to a further decrease of the energy level, with the accompanying sensation of effort and sometimes also displeasure.

As I said, Cabanac and Russek's model offers a partial analogy of my attentional model: for example, it does not address the problem of the segmentation of the organ of attention in specialized sub-units - which Szalma and Hancock (2002) term "structural considerations", nor does it account for the cyclical character of attentional activity – even though, in his other works (Cabanac 1992, 1996, 2002), Cabanac clearly states that every conscious experience is characterized by, and can be analyzed along four dimensions, two of which are duration and quality (the other two being intensity and pleasure/displeasure), which, at least partially, account for the segmented and cyclical nature of consciousness. Cabanac and Russek's model

does however represent in an essential and vivid way the main mechanism by means of which attention produces the phenomenal aspect of consciousness.

By offering a model of representation that is common to both human consciousness and the other main physiological functions (such as pulmonary ventilation, blood circulation, etc.), Cabanac and Russek's model also gives biological plausibility, from an evolutionary point of view, to my model of consciousness as a system that evolved from more primitive ones (according to the old principle *Natura non facit saltum* adopted also by Charles Darwin). The fact that there is continuity between old and new systems, however, does not necessarily imply that there are no differences between them or that they perform comparable functions. Firstly, each system deals with a specific kind of energy. Secondly, while the old ones have the main function of keeping the energy flow and oscillations under control, thus *maintaining* as much as possible a constant amount of free energy available for use, human consciousness has the primary aim of *utilizing* the energy flow and oscillations for the purpose of controlling the other organs and systems. That is, human consciousness has the privilege of controlling the other organs and systems by means of a unique and common kind of energy: nervous energy.

This latter aspect of my model of consciousness is also well captured by Cabanac's (1996, 2003) idea of the affective dimension of human consciousness as the "common currency" for the trade-offs that take place in the mind to achieve the ranking of priorities and insure that the most urgent motivation has access first to the behavioral final common path: which, in Cabanac's view, is what makes human consciousness useful for the person (for a partly similar idea of the usefulness of the hedonic dimension for the person's choices, see Osvich, 1998).

But there is also another important aspect that, in my view, makes human consciousness useful and above all advantageous for the person: the flexibility it allows. Human consciousness, by controlling the other organs, allows the person to allocate his resources according to the various needs and contexts, thus providing him with a higher degree of freedom and autonomy than the other living beings have. This flexibility is primarily attained by means attention, which the person can voluntarily focus both on his various organs, the other beings and the environment, for variable amounts of time. This flexibility allows the person to also face unexpected and new events, or devise new strategies to overcome unresolved problems. Compared to other living beings that simply react to stimuli according to preprogrammed, inherited patterns of behavior, human beings have the competitive advantage of elaborating new behavioral reactions.

The idea that consciousness arises as a consequence of the modification of the energetic state of the organ of attention induced by the use of attention itself is not at all common amongst scientists dealing with consciousness: actually, as far as I know, it is quite new. However, in my view, it is possible to find a partial suggestion in Haikonen's (2003) idea that some conscious states derive from the modulation of attention. When dealing with the problem of the feelings of pain and pleasure, Haikonen notices that they cannot be explained by means of a sensor detecting the property of an external entity: pain and pleasure are not representations of things and objects of the outside world. They are not properties of a sensed entity. The non-representational nature of pain and pleasure is further exemplified by the fact that we cannot memorize pain and pleasure, and evoke them afterwards. But if pain and pleasure cannot be explained by means of a sensor detecting the property of a sensed entity, how can we account for them? According to Haikonen:

> Pain sensors do not sense pain, the sensed entity is cell damage and the caused signal indicates only that pain is to be evoked. Thus the feel of pain is not a representation, instead it is a system reaction. The pain signals themselves do not carry the feel of pain, instead the feel arises from the effects that these signals have on the system and this in turn depends on the way the signals are connected to the system (ibid., p. 103).

Therefore, Haikonen considers feeling pain as a "system reaction". What does this "system reaction" consist of?

> Pain "demands attention"; it disrupts any attention that is focused on any ongoing task. Obviously pain signals are transmitted to every modality in the frontal cortex and the message, so to say, is "stop whatever you are doing and try something else so that this signal might stop!". This is because the pain signal itself does not know who should do what to stop the damage and therefore it has to broadcast its message to everybody and thus disrupt the attended processes within each modality. Pain does not allow the other modalities to relax, instead it tries to stop their present activity and start something else. (…) I consider this disruptive broadcasting as a fundamental property of pain and I would like to go as far as to propose that the subjective feeling of pain is indeed caused by attention disruption especially in the frontal cortex area (ibid., p. 104).

(it should be noted that, for Haikonen, attention is a biological neural system's basic way of favoring the strongest signals, a process that is already present in the simplest central nervous system).

In Haikonen's view, feeling pleasure also is a system reaction: "Pleasure, like pain is not a property of a sensed entity. There is no pleasure to be sensed and represented, instead pleasure is a system reaction that can be evoked by various sensations" (*ibid.,* p. 105). More specifically, pleasure entails: a) continuing the pleasure-causing activity to sustain the feeling of pleasure; b) focusing attention on the pleasure-causing activity, and excluding attention on other stimuli; c) memorizing pleasure-causing things and acts, so that they can be identified and repeated in the future. For Haikonen, pleasure, like pain, is connected to attention as well, but in a different way from attention:

> While pain uses brute force to disrupt the attention within modalities pleasure tries to sustain its attention focus by having non-related circuits and modules relax. In this way only the pleasure evoking activity will be continued while other activities are suppressed (ibid., p. 105).

In addition to pain and pleasure, Haikonen lists some other elementary sensations ("elementary" as opposed to more demanding sensations from a processing point of view, such as the visual and auditory ones) that would elicit a basic system reaction, namely:

(a) good taste and smell, which elicit positive responses, such as acceptance of, and approaching, the source of the good taste and smell;
(b) bad taste and smell, which elicit negative responses, such as rejection of, and withdrawal from, the source of the bad taste and smell;
(c) match, which implies sustained attention;

(d) mismatch, which implies refocused attention;
(e) novelty, which implies focused attention.

According to Haikonen, system reactions are direct and rather automatic pre-wired responses to elementary sensations: they do not require a complicated cognitive evaluation of the stimulus or of the situation, thus enhancing the prospects of survival. The various combinations of system reactions give rise to various emotions: curiosity, astonishment, caution, fear, anger, desire, love, happiness, sadness, envy, horror, etc.

Having explained feelings and sensations (such as pain, pleasure, taste, smell, match, mismatch and novelty, but also beauty and ugliness) in terms of system reactions, Haikonen defines strong qualia as: "temporal behavior patterns of inner attention caused by system reactions (…) We have strong qualia because we have system reactions that affect attention" (*ibid.*, p. 148).

Therefore, Haikonen's proposal, basing strong qualia on attention, and more precisely on its variations ("I have proposed that 'pain', 'pleasure', 'good' and 'bad' get their specific feel via the attention affecting mechanisms", *ibid.*, p. 116) seems to tackle the problem of phenomenal consciousness in a way similar to mine.

However, as far as I understand, there is a fundamental difference between his model of consciousness and my model of consciousness. While in my model, the phenomenal aspect of consciousness is explained with the modification of the energetic state of the organ of attention which is determined and induced by the use of attention itself (in other words: qualia *are* the modifications of the state of nervous energy supplied by the organ of attention), in Haikonen's model, attentional variation causes subjective feelings, but *is not*, and *does not coincide with*, them. In fact, Haikonen's model resorts to some additional components (namely, "system state sensors" and their "related perception process") to explain the phenomenal aspect of consciousness, and how system reactions can be consciously felt:

> In order to perceive and internally represent system reactions the system needs *system state sensors* and their related perception process (…) pain, pleasure, taste and smell (good/bad) sensations as well as match/mismatch/novelty states are able to initiate the basic system reactions such as those listed before and also other physiological reactions. These system reactions *are perceived by system sensors and their respective perception process* (*ibid.*, p. 113) (italics are mine).

The explanation of how a machine can experience strong qualia is therefore shifted to the perception process (indeed, Haikonen clearly states that: "perception processes are a necessary prerequisite for consciousness", *ibid.,* p. 149, and that: "Consciousness arises from perception, without percepts there is no consciousness", *ibid.* p. 271), pushing it back into another unit. Moreover, recognizing that not all percepts reach consciousness even though they may affect behavior, Haikonen admits that "the perception process alone is not sufficient to explain consciousness" (*ibid.*, p. 250). So, what is involved in conscious perception? What is it that makes a percept conscious? According to Haikonen:

> the difference between conscious and non-conscious operation would be the level of active cross-connections and binding between modalities; the cross-modality reporting and learning

> of related associative connections and thus the establishment of episodic memories of the event. In non-conscious operation the cross-connections are minimal and the operation of the different modalities is not unified, it is not about the same topic, there is no binding. In conscious actions the operation of the different modalities would be unified; the inner attention of each modality would be focused on the same topic (ibid., p. 254).

As we can see, Haikonen resorts to the notions that are very well-known in consciousness studies of binding (see for example: Singer 2001) and widespread brain interactions (see for example Baars 1988). However, this does not yet constitute an explanation of what happens *inside* the perception process module that makes a percept conscious. This certainly represents an explanation of what happens outside the perception process, of how the various perception modules interconnect, and how all the system focuses on the same topic; this can certainly explain some important features of consciousness, such as reportability - that is, the capacity to report, either verbally or in another way, what is consciously experienced - and the facilitation of further associations and actions on the percept. Moreover, there is no doubt that Haikonen's model represents a considerable advance on previous ones for several reasons: compared to Baars's model, for example, it explains in applicable engineering terms how inner speech arises (for a more extensive review of Haikonen's model, see Marchetti 2008). However, it does not explain which mechanisms and operations occur inside the perception module to turn system reactions or any other sensations into strong qualia. As I have tried to show in this chapter, qualia can be simply explained by resorting to the notion of the modification of the energetic state of the organ of attention induced by the use of attention itself. This notion implies that there is no need to move, in an endless regression, the explanation of the phenomenal aspect of consciousness to an additional component, such as the "system state sensors": to account for qualia: it is enough to consider the working of attention.

5. Final Comments

In this chapter I have tried to give an answer to a fundamental question concerning human consciousness: how can we explain the phenomenal quality of our conscious experiences? To answer this question, I resorted to two basic concepts: the perceptual system and the schema of self. The perceptual system makes it possible for an organism to be conscious, whereas the schema of self provides the rules that make an organism perceive, move, act, behave, and live in general. From the uninterrupted interaction of the schema of self and the perceptual system the stream of consciousness arises. Every conscious perception affects the schema of self, modifying and updating it. Every modification of the schema of self implies a new particular instruction to the perceptual system, and in general to the organism. The uniqueness of each single "pulse of consciousness" (James 1890) is determined by the particular instruction that the schema of self gives to the perceptual system each time.

Attention, which can be considered as the core part of the perceptual system, is not only responsible for the selective aspect of consciousness, but also for its phenomenal quality. The organ of attention is the source of the organism's nervous energy; nervous energy gives the organism the possibility of attentionally operating, thus performing actions capable of directly affecting the organism's state of nervous energy. The attentional activity performed by the

organism involves a variation in the state of nervous energy. It is this variation that constitutes the phenomenal aspect of consciousness. When acting, the organism can directly experience and feel its actions and the results of its actions, thus making possible the delimitation and emergence of the person.

The schema of self - once it has learnt and embodied the notion that the organism, by means of conscious perceiving, is able to affect the course of its own actions - provides the organism with a new degree of freedom that gives it the possibility of directly controlling itself. The schema of self, whose main goal is to keep the organism operating, thus succeeds in equipping the organism with the capacity to self-regulate itself, and consequently find its own best ways and means of assuring its survival and of creating new strategies and aims. This constitutes the fundamental passage from consciousness to self-consciousness.

Chapter 2

MEANING

1. CONSCIOUSNESS: THE ORGAN OF MEANING

As we have seen in Chapter I, consciousness - by letting us directly experience ourselves and other entities (I use the expression "other entities" for sake of simplicity, to refer to all that which is distinct from us, whether it is another living being, an object, an event, a sound, a word, or an abstract idea or thought), the consequences of our actions on other entities, and how other entities affect us - gives us the possibility to form and constitute ourselves, and emerge as persons. At the same time as we emerge as persons, the other entities emerge as something distinct from us. This process of emergence is made possible by the continuous attentional activity we perform, which allows us to differentiate ourselves from other entities. By applying our attention, we become aware of our limits and boundaries, of how and to what extent our actions can modify and affect other entities, of how other entities can modify or limit us, etc.; in short, we become aware of ourselves.

In the differentiation process that makes us and other entities co-emerge, we continuously relate ourselves - by means of our attention –to other entities. By relating ourselves to other entities, we come to learn and understand: how, when, where and why we relate with other entities (for example: how the perceived shape of an object changes depending on the angle we view it from; in how many various and different ways we can handle an object; for how many different purposes we can use the same object); the value, importance and functions that other entities have for us (for example, a given object may imply danger for us while some other object may imply survival; a given object may help us achieve a certain goal while some other object may hinder us from achieving it, or may even be neutral); how we can affect or change other entities; how other entities affect us and make us change or not change (for example, meeting a certain person or coming to know a certain idea or opinion can bring a dramatic change in our life; performing a certain activity may leave us completely indifferent; etc.). Some of these relations, once experienced, do not change but remain constant (we know that fire burns); others, on the contrary, can vary and change with time (we can become intolerant to a certain food). Subsequently, and on the basis of this first-level knowledge acquired through the conscious experiences of the relations between us and other entities, we can build a second-level knowledge of the relations existing between other entities (for example, we can understand how we can relate one object to the others, or how one object modifies the others). All these relations (between us and other entities, and

between other entities themselves) contribute to form the meanings that other entities have for us.

My use of the term "meaning" in this context needs some explanation and qualification. Firstly, I use the term "meaning" in its most general sense, comprising both linguistic, pragmatic and non-linguistic meanings.

Secondly, I intend to refer to both the bulk of knowledge that the human species has developed in its phylogenetic evolution, and the personal, specific knowledge that each single person develops during his/her life: while the former is usually coded into a symbolic system - such as language, mathematics or logic – and therefore is quite easily transferred from individual to individual, and from generation to generation (on the transmission of knowledge through symbolic systems, and more in general on how the evolution of symbolic systems affects human's knowledge, see Logan, in press), the latter is usually less structured, not coded into a formal system, and not easily transferrable. In this sense, the term "meaning" identifies all those conscious constructs that condense our experience and knowledge. I say "conscious *constructs*" because usually they are the result of the assemblage and combination of various simpler conscious elements, such as basic sensations, memories, and emotions: for example, the meaning of the word "apple" is composed of visual, tactile, olfactory and gustatory sensations at least. Moreover, I also add the adjective "condensed" because such constructs isolate, reduce and decontextualize the ever changing and multiform conscious experiences constituting the basis out of which they are built into a purely mental form.

Thirdly, and most importantly, my use of the term "meaning" implies that the knowledge each meaning expresses and refers to was (and is being) developed and built on, and thanks to, a continuous interaction between human being(s) and other entities; an interaction that is based on and made possible thanks to attentional activity, specifies the relations existing between human being(s) and other entities, and is guided by the hierarchy of principles, rules and goals of human being(s). In this sense, my use of the term "meaning" is very akin to Zlatev's (2002, p. 258) definition of meaning:

> *Meaning (M)* is the relation between an *organism (O)* and its physical and cultural *environment (E),* determined by the *value (V) of E for O*

(however, it should be noted that while I use this notion of meaning only in relation to human consciousness, he also applies it to very elementary forms of life, such as bacteria and worms).

Meanings can refer to entities that are as disparate as physical inanimate objects, subjective feelings, perceptions, living beings, events, situations, actions, outcomes of actions, purely mental operations such as comparing, summing, abstracting, etc. However, whatever meanings refer to, all of them result from, and are based on, our continuous activity of exploration of, and interaction with other entities. This activity originates from the specific purposiveness (or as philosophers say, intentionality) that characterizes us: a purposiveness that has its source in what I have identified as the algorithm of life (or of the being): "operate in order to continue to operate" (other authors have identified the origin of such purposiveness in some other principle or instinct. For example, Perlovsky speaks of the "knowledge instinct": "Knowledge is not just a static state; it is in a constant process of adaptation and learning. Without the adaptation of concept-models we will not be able to understand the ever-changing surrounding world. We will not be able to orient ourselves or

satisfy any of the bodily needs. Therefore, we have an inborn need, a drive, an instinct to improve our knowledge. I call it *the knowledge instinct*" [Perlovsky 2006, p. 29]).

Indeed, an object becomes an object and acquires a form and meaning for us only as long as, in some way, we can interact with it and relate it to ourselves (and subsequently to other objects) (for a similar view see Cisek 1999). By making us experience directly how the object relates to us and to other objects, what kind of effect the object has on us, how the object limits us, and how our activity can modify the object, consciousness is the privileged way for us to acquire and construct our knowledge of the object. It is through consciousness that we understand how an object relates to us and to the other objects, learn how to use it, and get to know it. Consciousness gives us an immediate understanding of the object, and of the meaning that the object has for us. By understanding what relation exists between the object and us we give a meaning to the object, and the object acquires a meaning for us. The meaning the object has for us corresponds to our conscious experience of the (condensed combinations of the) relations between the object and us.

Conversely, understanding what relation exists between us and the other entities also implies for us to be able to acquire a form and – through self-consciousness – to assign a meaning to ourselves.

We acquire the form that the relation between ourselves and other entities makes possible. An important step in this formation process is represented by the awareness we gain of ourselves as beings who can build an abstract level of knowledge starting from specific, individual conscious experiences. This self-awareness makes us understand for example that we can: group and collect objects and entities in general classes; establish different relations between the same entities (we can imagine or perceive "a man *and* a hat" or "a man *with* a hat" or "the hat *of* the man"); set the same relation between various and different entities; perform various and different (physical, psychological, mental) operations on the same entity (we can physically transform an object A; we can mentally compare or associate an object A with an object B; etc.).

We acquire a meaning when, by self-consciously seeing ourselves as an object, we are able to conceive ourselves as a means or instrument to an end, and consequently to set an end for ourselves. We emerge therefore as an entity having our own form, autonomy, independence, and meaning through a continuous process of differentiation that highlights and establishes the difference between ourselves and the other entities.

The form and meaning we conscious beings have or acquire and the form and meaning the other entities have or acquire are thus closely interwoven. An object exists, has a form and a meaning because we conscious beings exist who give it a form and a meaning, and we conscious beings exist, have a form and a meaning because by acting we have been able to differentiate ourselves from that object.

Therefore, *consciousness and self-consciousness can be defined as the organ of meaning*: they are the fundamental device by means of which: a) objects, events and other beings of the world - becoming the means that make a conscious being take shape - acquire a meaning and a form for us; b) we conscious beings - differentiating ourselves from other entities - take shape and acquire a meaning.

It could be claimed that the idea of consciousness (and self-consciousness) as the prime organ that allows us to directly know, and assign a meaning to, objects, events and beings of the world by relating them to ourselves and to each other is too restrictive and does not account for all that consciousness allows us to do. Undeniably, such a claim would seem

more than reasonable if one considers, for instance, the eighteen functions listed by Baars (1988): definition, context-setting, adaptation, learning, editing, flagging, debugging, recruiting, controlling, prioritizing, access-control, decision-making, executive, analogy-forming, metacognitive, self-monitoring, autoprogramming and self-maintenance. As he argues: "it is doubtful whether any shorter list can do justice to the great and varied uses of conscious experience" (*ibid.*, p. 347). I believe, however, that the variety of functions he lists can be reduced to the one I propose inasmuch as they let us relate ourselves to the objects and events of the world, thus making us understand both ourselves, the objects and the relations between ourselves and the objects. Indeed, all the activities we can consciously perform - reducing and resolving ambiguity of interpretation (definition, context-setting, editing, flagging, debugging, and analogy-forming function), learning and adapting to novel events (adaptation and learning function), setting goals, organizing, carrying out and controlling our mental and physical actions (flagging, recruiting, control, decision-making, and executive function), assigning priorities to the information to be processed (prioritizing and access-control function), and controlling and acting upon our own conscious states (metacognitive, self-monitoring, autoprogramming and self-maintenance function) - allow us to understand how events, objects and other beings of the world relate to us (and to each other): that is, they allow us to define, and assign a meaning to, both them and ourselves.

Conversely, it is precisely because we already have some knowledge of ourselves, as well as of the objects, the events and the other beings of the world, and of the relations between them and us, that we can perform certain actions and set ourselves certain goals. And this holds true even though not everything we do takes us to, or is based on, a full understanding of the objects and events of the world, and of the relations between them and ourselves. After all, a limited, partial, imperfect knowledge or, even worse, a lack of knowledge, represents for us a certain kind of cognitive basis on which we can proceed to construct future, more comprehensive knowledge.

1.1. Additional Comments

Allow me to make a few comments on my view that consciousness and self-consciousness entail a continuous process of differentiation between ourselves and other entities, which allows us to emerge as persons.

Firstly, some people could argue that the capacity to recognize differences and distinguish something from something else cannot be ascribed only to consciousness: even unconscious processes and machines that cannot be said to be conscious at all are able to detect limits and differences.

My answer is that while unconscious processes and machines that are properly programmed can undeniably detect differences and limits, only differences and limits that are consciously detected allow an organism to emerge as a person: that is, only the distinctions drawn through conscious and self-conscious processes allow a person – through the modification of his/her schema of self - to autonomously set his/her own aims and objectives, thus giving him/her the possibility of continuously and dynamically redefining and reconfiguring the basis on which to build and delimit him/herself. Just think, for example, about the difference between heating systems and human beings. A heating system regulates the heating elements on the basis of the differences of temperature it detects in the

environment, where detection and regulation are done automatically based on the program devised by the designer; unless the program is modified by an external operator (or some other kind of agent), the heating system will continue to detect temperature differences and regulate the heating elements in an invariable, inflexible way. When we are little children, we usually behave like machines, reacting instinctively to stimuli when detecting them: we cry, shout, move our arms and legs automatically, etc.; but, thanks to our conscious experiences (which, in the first years of our life are piloted mainly by the scolding, indications and warnings of our parents, relatives, and other adults, and later on by our self-reflections) we learn to *use* the differences that we perceive, in order to: modify our behavior (here, our parents' warnings or scolding are simply their way of making us aware of a difference: we should behave in this way and not in that way, we should follow this model and not that one, the correct thing to do is this and not that, etc.); set new aims (when we realize that we are pursuing an objective that we cannot achieve - which is simply becoming aware that the difference between our current status and the objective we want to achieve is too high- we can decide to stop trying to achieve it); consider things from new and different points of view (which implies making new distinctions, perceiving differences where first we could not see any, or conversely, no longer perceiving the differences we used to perceive); etc.

Secondly, someone could note that my idea (that is, thanks to consciousness and self-consciousness, we emerge as persons through a continuous process of differentiation that establishes the difference between ourselves and other entities) is not new. Indeed, there is – to my knowledge - at least another author who holds a similar view: Maturana (1995): "My proposition is that the experience that we connote as we use the word consciousness is one of self-distinction as we distinguish ourselves making distinctions" (*ibid.*, p. 148).

However, I must note that although my view shares some features with Maturana's (such as that of conceiving the nervous system as a closed operating system, whose operations change as the system changes), it substantially differs from his for two main reasons:

a) Maturana conceives both consciousness and self-consciousness as being the product of language: "language constitutes the operationality that gives rise to the conditions that make possible the experiences of self-consciousness and consciousness" (*ibid.*, p. 174); in my view, on the contrary, while language may play a fundamental role in self-consciousness, it is not necessary for consciousness: just think for example of all those instances in which we do have a conscious experience of something, but lack the words to express it because the experience is completely new, or of all the forms of non-linguistic thought (Gambarara 1996).
b) My model provides a way of connecting, though the working of the organ of attention, consciousness (and self-consciousness) to the physical substrate (namely, the nervous system), thus bridging the mind-body gap; on the contrary, Maturana, defining consciousness and self-consciousness as the product of language, precludes himself any chance of bridging the gap between body and mind. Maturana's definition of consciousness is most probably due to his main (correct) concern of avoiding to analyze consciousness by using a purely physical vocabulary and description: "Consciousness is not localized in the nervous system or in the body in general" (Maturana 1995, p. 166). This concern, associated with the lack of (or rather, the refusal to adopt) an operational model capable of linking consciousness and self-consciousness to the operations of the nervous system ("consciousness …

cannot be handled … as an operation in the nervous system" *ibid.*, p. 166), lead him to remain inside one of the domains produced by consciousness, that is, language, This prevents him from providing a possible explanation of how the operations of the nervous system can produce conscious experience.

2. The Conscious Experience of Meanings

Consciousness is the privileged place for the study of meanings. The meanings that other entities have for us (and we have for ourselves) coincide with the conscious experience of the (condensed combinations of the various) relations between us and them (and between us and ourselves). Studying and analyzing meanings means studying and analyzing the conscious experiences of such (condensed combinations of) relations, and how they form and develop.

This approach to the study of meanings has some important implications. Firstly, it conceives meanings as being something produced by the person consciously experiencing and constructing them, rather than something independent of the activity of the person (the concept of meaning as something primarily produced by the person's activity has also been put forward by many other authors - even if with various degrees of stress and within different theoretical frameworks – such as, for example, Edmund Husserl, Maurice Merleau-Ponty, Silvio Ceccato, Ernst von Glasersfeld, Humberto Maturana: for a review, see Armezzani 2002). Secondly, it conceives meanings as being unavoidably characterized by the hallmark of the person's consciousness producing them, in the sense that their qualities and characteristics derive and arise from the person's way of applying and using his/her attention. Thirdly, it conceives meanings as not something that is necessarily static, fixed for ever, unalterable, but on the contrary as something that can change in time, according to the person's activity and interactions with other entities.

Here, some could argue that meanings, despite being produced in and through consciousness, are not themselves consciously experienced: that is, once they have been built, they become unconscious and work at an unconscious level. In my opinion this is only partially true. I do not deny that when perceiving words we do not unconsciously process them; nor do I deny that the meanings of words can unconsciously operate and elicit some other kinds of conscious or unconscious processes. I too hold that upon consciously perceiving the physical side of a word (its acoustic or visual form), the schema of self *unconsciously* processes it. But I also maintain that: (1) after this step is accomplished, the schema of self makes the organ of attention perform the operations constituting the meaning of the word; (2) once the organ of attention has performed such operations, the person becomes *conscious* of the meaning of the word; (3) and finally, if there is sufficient time, the conscious experience of the meaning can in turn be unconsciously processed by the schema of self: which may imply additional conscious and unconscious processing, thus making the person have further conscious experiences, such as images, thoughts, etc. (it should be noted that a word can also be unconsciously perceived: see for example Marcel 1983; in this case, its meaning can subsequently be either consciously or unconsciously perceived).

There are many reasons why I believe that meanings are consciously perceived. When hearing or reading a word or a sentence, the first thing we have in mind is its meaning. If this does not occur, for instance because we have not caught what has been said, or because the

meaning of a certain word is unknown to us, then we immediately feel that we are lacking something: a feeling that can sometimes even assume the form of real disappointment, frustration or impotence, since it is usual for us to be aware of the meaning of words after having heard them.

Such a kind of awareness and the relevance that it has to our correctly understanding words and sentences is also very evident in all those instances where words and sentences can be interpreted in more than one way. For example, the sentence "I live near the bank" can be interpreted in at least two ways, depending on whether "bank" is taken to mean "the building where you can keep your money safely", or "the land near the river". Let us suppose that someone tells us they live near the bank, intending "near the river", whereas we understand "near the Chase Manhattan Bank". When we realize that we have misunderstood what they meant, we experience a switch in our consciousness: what was present in our mind and what we were aware of until a moment ago, is no longer present and has now been substituted by a new entity. Now we are aware of a different meaning: we feel that our consciousness is "filled" (La Berge 1995) with a new object. It is precisely the experience of such a substitution that reveals the presence in our consciousness of the meanings of the word "bank". By the way, this same experience of a switch in our consciousness testifies to the "internal consistency" of conscious experiences (Baars 1988): we are not able to consciously entertain more than one thought, idea, or perception per unit of time. As the classical experiences with Necker's cube, Ames' room or Rubin's figure show, consciousness gives rise to a unique, selective, and unitary content, however complex it may be: we cannot be conscious of two objects or think of two alternative ideas at the very same instant.

Other cases also clearly demonstrate the conscious existence of meanings, even if this is not specifically occasioned by words. Think of all those cases in which we realize that an object, which usually does not possess other meaning than the one conveyed by the word identifying it, suddenly acquires a new, particular meaning. For instance, a hat is usually seen as a hat: it conveys no particular meaning other than that of being a hat, that is, "a covering made to fit on the head, usually worn out of doors". However, it may happen that someone uses a hat as a sign to represent or indicate something particular that has nothing to do with the usual use of a hat. Let us suppose that criminals use hats to mean: "Watch out, the cops are here". If we do not know that hats can also have such a meaning, we will continue to see and consider them as usual. But when we get to realize that they also have that meaning, we experience a sudden change in our conscious state: the original and usual meaning of hat is now substituted by the new, particular meaning. The hat no longer refers to itself, but to a specific meaning. The conscious perception of the hat gives rise, and leaves room, to a new conscious presence: the consciousness of the meaning assigned to hats by criminals.

Think also of all the cases in which a tip-of-the-tongue state is experienced. Suppose we try to recall a forgotten name, or intend to say so-and-so but do not find the right word. We are fully aware of what we want to say, of its meaning, even if we do not remember the corresponding word or words. As argued by Baars (1988), this state closely resembles any other conscious state: when occurring, it excludes other conscious contents; it is interrupted by incompatible conscious events; it stops dominating our limited capacities when the right word is found; it must be a complex state, like a mental image or a percept, since it implies our ability to accurately detect matches and mismatches of the candidate word. However, in one respect, the tip-of-the-tongue state differs from all other conscious states: it does not have

the experienced qualities – like color, size or warmth – of feelings, mental images, and perceptual experiences.

Denying the fact that we consciously experience meanings would be tantamount to denying the fact that, more in general, we have conscious perceptions, images, ideas, and so on. Understanding the meaning, for example, of a word or sentence implies consciously experiencing such a meaning: that is, feeling it in, and through, our mind, having a phenomenal experience of it - however empty, poor or limited such experience may seem -, and consequently being able to differentiate it from other meanings. If we do not have such a subjective experience, we cannot be said to have understood the meaning of the word or sentence, as we cannot be said to have seen or heard a certain object if we have not consciously perceived it. What shows that we are conscious of something, whether a meaning, a perception, or anything else, is precisely the fact that we can recognize it and distinguish it from other things. If someone presents us with a banana, and if we say that we see a banana, and not an apple or something else, then we can be satisfactorily considered to be conscious of the banana; likewise, if someone tells us that he has eaten a "banana", and if we understand that he has eaten a banana, and not an apple or something else, then we can be satisfactorily considered to be conscious of the meaning of the word "banana" (incidentally, it should be noted that sometimes we are also conscious of something that we are not able to distinguish or describe: for instance, despite hearing something, we cannot describe exactly what we heard. In this case however, the only consciousness we can be said to have of what we heard is precisely its indistinguishableness: we can only distinguish it from the other objects and events of our life by defining it as undistinguishable).

However, consciously experiencing meanings (whether linguistic or not) is not the same thing as consciously perceiving, or imagining an object. The phenomenal experience we have in the former case is different from the phenomenal experience we have in the latter. When consciously perceiving an object, we have a qualitative experience that differs radically from the experience we have when we are conscious of meanings. If a friend tells us: "I have bought a car", we can understand perfectly what he means without having to consciously perceive or imagine the car he has bought, its color, size, etc. It may happen that after hearing such a sentence we imagine the car, but our comprehension of the sentence is not strictly dependent on imagining the car. Meanings are experienced differently from perceptions and images: the former do not necessarily have the same rich, clear, concrete qualities of the latter. Whereas perceptual and imaginal experiences are characterized by rich qualitative properties, such as colors, textures, size, location, and so on, meanings are not. Compared to images and perceptions, meanings are, so to speak, immediately perceptible: in order to understand the meaning of a word or sentence, it is not necessary for us to mentally represent them by means of images or other more concrete sensory modalities.

What characterizes the conscious experience of a meaning can be considered a simple feeling compared to the qualitative richness and complexity of perceptual and imaginal experiences. However, such a simple feeling conceals a huge and complex knowledge: each meaning is like a door ready to be opened onto an entire net of relations, images, sounds, emotions, and so on. After having understood the meaning of a word or sentence, it is possible for us – if we have enough time at our disposal - to have other kinds of conscious experiences connected or associated with such a word or sentence. After hearing the word "cat", we can, for instance, imagine, think about, have an idea of, or perceive a cat. The subjective, conscious experience of the meaning of the word "cat" enables us - provided we

have the necessary time - to go beyond the experience of the pure, strict mental meaning of the word, and have different conscious experiences, such as imagining or thinking extensively about a cat. The "simple" consciousness of the meaning of a word thus reveals a deeper and more articulated reality than what may appear at a first glance.

What features make all meanings share a common conscious form, and distinguish them from images and perceptions? What makes us experience and recognize meanings as meanings, images as images, and perceptions as perceptions, without mistaking one for the other? Intuitively, the basic difference between meanings, on the one hand, and images and perceptions, on the other hand, lies in the two following factors:

a) the absence in meanings of any qualitative property peculiar to sense-organs or the somatosensory system: we can understand the meaning of the word "yellow" perfectly well, without having to actually perceive or imagine the color (this characteristic is even more evident with words such as "or", "with", "yes", whose meanings do not imply any sensorial characteristic). Images and perceptions, on the contrary, do possess such qualitative properties;
b) meanings do not refer or apply to just one thing, occurrence or event, but to a whole set of things, occurrences or events. The meaning of the word "horse" applies to all sorts of horses, whatever their sex, race, age, and so on; likewise, the word "and" applies to different contexts, whatever the entities or events that it connects. On the contrary, images and perceptions refer to just one specific thing, event or occurrence (apparently, proper names seem to be an exception to this rule, since they refer to only one specific individual. However, if we consider the fact that what we usually see as an individual undergoes continuous physical, cultural and psychological transformations, we will realize that the individual can also be seen as a collection of single and unique entities, each one being different from the others. The name "Pablo Picasso", for instance, refers both to the young artist who painted the pictures of the Blue Period and to the mature artist who created the works of the Cubist Period. Therefore, in this respect, proper names can be considered equal to all other words).

In conclusion, we can affirm that meanings can be studied and analyzed by studying and analyzing the conscious experiences that we have when forming, using and understanding them (for a similar view, see also Talmy: "Meaning is a consciousness phenomenon and, if it is to be taken on as a target of research, introspection ... is the relevant instrumentality able to reach its venue", 2007a, p. xiii).

Given the preponderance, at least in terms of daily usage, of linguistic meanings over the other kinds of meanings, and the fact that the former are usually better codified in well attested systems (languages, dictionaries, grammars) and more easily available than the latter, in the following part of the book, I will mainly deal with linguistic meanings, and more specifically with the meanings of words.

3. Linguistic Meaning

The meanings of words and sentences have a special weight in the general economy of our consciousness that cannot be underestimated: we live in a world of words from the very

beginning of our life; words are continuously used both by others and by ourselves with pragmatic, educational, social, psychological, economic and political intents; words mold our experiences and perceptions. Most of our conscious life is occupied by them.

The meanings of words afford us the opportunity to have a particular kind of conscious experience: they isolate, decontextualize, "freeze" and classify in an articulated system the ever-changing and multiform stream of the conscious experiences that we have of the relations between us and other entities, between us and ourselves, and between other entities themselves.

The basic, linguistic meaning of each word isolates only some elements and some combinations of these elements from all the possible elements and combinations of our daily experience: the word "red" identifies only a certain kind of visual experience, which differs, for instance, from what the word "yellow" identifies.

The meaning of each word decontextualizes the elements and relations it isolates: the meaning of the word "apple" applies to all sorts of apples, whatever their shape, color, qualities, weight, and so on; likewise, the word "or" applies to different contexts, independently of the entities or events that it connects. By abstracting some elements and relations from any context, words can be applied to a whole set of occurrences or events.

The meaning of each word "freezes" the elements and relations it isolates, thus making it univocal, valid for, and shared by, everybody, and, to a certain extent, stable over time: consequently, the communicative function of language is safeguarded. If the other person says "I would like a cup of coffee", we understand perfectly well what he wants, even if he does not specify exactly which kind of coffee he would like, the shape of the cup, and so on. Obviously, the fact that words represent only a decontextualized version of the elements they isolate can sometimes generate ambiguities in the interpretation of what one intends when using them. These ambiguities, which originate from the extended, figurative, metaphorical or unusual use of the word, can only be resolved by resorting to implicit knowledge or to contextual information.

Words classify, in an articulated system of contents and functions, the elements and relations they isolate. Each word has certain relationships with other words, with regard to both content and syntactic function. The word "father", identifying a certain kind of parental entity, bears a certain content relation with the words "mother", "son", "brother", and "grandmother". At the same time, as a noun, it bears a certain relationship with verbs, adjectives, prepositions, other nouns, etc.: it cannot, for instance, acts as a preposition or a verb; it can be qualified by an adjective; and so on.

Therefore, the meaning of each word isolates, condenses, immobilizes and reduces the manifold, multiple and ever-flowing conscious experiences of our life in a stable, decontextualized and shared form. But how can this happen? What is it that makes meanings perform this function?

It is my opinion (see Marchetti 1993, 2003, 2006) that:

1. each meaning is composed of a sequence of elements: the invariable elements that, independently of any individual, specific occurrence of a given conscious experience, are at the core, and are responsible for the production, of any instance of that conscious experience. The sequence then represents the skeleton that supports and allows the conversion or actualization of the meaning into any of its sensible, perceptible instances, whether they are images, memories or something else;

2. the elements composing the meanings of words are attentional operations;
3. words are tools to pilot attention.

In this view, each word conveys the condensed instructions on the attentional operations one has to perform if one wants to consciously experience – either as a pure meaning, an image, a real perception, a thought process, a concept, or something else – the relations (between the person and the other entities, between the person and him-herself, and between the other entities themselves) that are expressed through and by it. When people use words and language, either to produce or to understand sentences, speech, and written texts, they perform the attentional operations conveyed by the words they use. By performing the attentional operations conveyed by words, people consciously experience their meaning (as I said before, the conscious experience of the meanings of words is primarily characterized by the absence of any rich qualitative sensory property, such as color, texture, size, images, and so on. However, this experience conceals a huge and complex knowledge that can generate a variety of conscious experiences connected or associated with the meaning of the word: indeed, if one has enough time at one's disposal, after consciously experiencing the meaning of a word, one can extensively think about, imagine, or recall various occurrences of what the word refers to).

By saying that words and language pilot our attention, I do not at all intend to imply that they are the only communication system that can do this. Many other communication systems have been created in order to convey instructions on how, when and where to move attention. Some instances are the various artistic genres - plastic and figurative arts, music, cinema, dance, architecture, etc. -, fashion, advertising, scientific notation, mathematics, logic, and so on. Although some of these (such as music: see Negrotti 1996) have reached such a point of formalization as to become real languages, natural languages hold supremacy over them in terms of usability, economy and potentiality.

Neither is it my intention to contend that only a structured language or communication system can drive our attention. We all experience daily occasional, random events, gestures, images, smells or sounds that make our attention move from where it was towards new courses, and consequently make us perform actions, have ideas, feelings, and so on. Moreover, it sometimes happens that we have a feeling or an idea that we would like to communicate to someone else, but for which we cannot find the adequate words or expression: this shows that language is not the only possible way of conveying instructions on how to move attention. More in general, language does not represent the only form human beings have to organize and process their conscious mental activity: images, perceptions and rudimentary forms of thought are some instances of the alternative possibilities (on this issue, see Gambarara 1996).

Nor do I deny the possibility that we can autonomously pilot our attention without the intervention of codified stimuli, whether words, sounds or others: as a matter of fact, we can move or focus our attention in consequence of a personal sudden impulse or a subjective urge. In this case, we generate the stimulus by and within ourselves.

What I maintain on the contrary, is, first, that our attention can be controlled and directed; second, that this can be done either through an external stimulus, or through an internal one; and, third, that such stimuli can be either structured or unstructured. The movements of our attention can be caused by what someone else says to us, as well as by what we say to ourselves; but they can also result from the action of artificial languages, as

well as from unstructured stimuli such as an unknown, abrupt sound, or a new, sudden emotion. Nevertheless, natural language remains the best structured and most common, economic, and favorite tool human beings use to influence each other's attention and their own.

3.1. Evidence Supporting the Hypothesis that Words Are Tools to Pilot Attention

The fact that words and language can pilot a human being's attention is evident above all in deictic expressions referring to spatial or temporal elements and relations, such as "The spoon is there", or "The lamp is left of the table". Expressions of this kind, often accompanied by an explicit gesture of the body, serve to show somebody the place where they have to direct their attention, turn their eyes, or direct their action.

Even expressions that do not contain deictic elements, but that nevertheless indicate the direction our thoughts must take ("Do you remember where you put the key?", "Consider this idea carefully"), or instruct us on what to do physically ("Now, press the button"), testify to the power of language in piloting attention. What we usually do after hearing such expressions, is first of all to address our attention towards the object, idea, thought or whatever else is specified by the sentence: indeed, it is only by moving our attention from where it was to where it is requested that we can accomplish what we are asked to do.

The influence that is played on attention by expressions that neither contain deictic elements, nor seem to give any explicit instruction on the course that our thoughts or actions should take may seem less evident at first sight. How could, for instance, a sentence like "a photo of a pond" pilot our attention? What kind of instruction does this sentence give to our attention?

Finally, the action of a single word on attention may seem even less intuitive. Indeed, how could a single word change the direction or the focus of our attention?

After a closer analysis, however, we discover that all kinds of expressions and, more in general, all words exert some influence on attention. Let us consider, for example, Figure 7.

The fact that we can see or describe it in many ways – such as, for instance, "trees", "a thicket", "a photo of a pond", "a nice photo", "a black and white figure", and so on – is quite obvious. Less obvious is the fact that every time we are somehow led, induced or asked to see it in a certain way, we tend to focus our attention only on certain elements of the figure, leaving the others outside of it; besides, and perhaps more importantly, we also tend to relate the focused elements to each other in a way that differs from how we would relate them if we saw it as something else. For instance, if someone tells us that Figure 7 represents some "trees", we will be led to focus our attention principally on the single trees, and to relate each single tree to the others, regardless of some of the elements of the figure, such as the water, the sun's rays, and so on. If, instead, we are induced to see Figure 7 as "a black and white figure", we will be mostly attracted by the contrast and the interplay between these two colors, and we will use the contrast and the interplay as the only basis on which to make the various elements of the figure – the trees, the pond, the sun's rays - emerge.

The idea that the meanings of words have the power to pilot the human being's attention has – to my knowledge – not yet been empirically investigated in a systematic way.

Nonetheless, some studies, especially in the psychological field, offer some initial evidence; moreover they provide some first hints on how to carry out experimentation.

Figure 7.

For example, Logan (1995) shows that linguist cues like "above", "below", "left" and "right" can be used to direct the subject's attention from one object to another. Logan hypothesizes that:

(i) such linguistic cues require the subject to impose a reference frame before the deictic relation they express can be computed (a reference frame is a set of coordinate axes that defines a three-dimensional space. A reference frame has four parameters: an origin, an orientation, a direction, and a scale. Subjects can adjust the orientation of the reference frame voluntarily: for example, a reference frame can be moved or rotated around the display by simply instructing the subject to treat different parts of the display as the top);
(ii) some regions of the space are easy to access from the reference frame and others are not. For example, objects cued on the above-below axis are more accessible than objects cued on the front-back axis, which in turn, are more accessible than objects cued on the left-right axis (these differences can be understood in terms of the support the different relations receive from the environment – gravity – and from bodily asymmetries).

In his opinion, the reference frame is an attentional mechanism because it possesses the kind of flexibility that is generally associated with attentional mechanisms like spotlights and spatial indices: it can be moved around and oriented at will (there is however a difference between reference frames and spotlights and spatial indices: while the former orient attention to space, the latter orient attention to objects).

His experiments confirm his hypotheses: for example, Experiment 7 shows an advantage (in terms of reaction times) of the above-below axis over the left-right axis in all orientations (that is, regardless of whether the subjects were told to treat the left side of the display, the right side of the display or the bottom of the display as the top). Moreover, his experiments show that while deictic relations (such as "above", "below", "left" and "right") require a

subject to impose or extract a reference frame before computing the relation they express, basic relations (such as "there") do not.

Taube-Schiff and Segalowitz (2005) show that grammaticized elements of language (conjunctions, prepositions, bound morphemes and other grammatical devices that express tense and aspects, definiteness, spatial and temporal relationships, etc.) act as an attention-directing mechanism by demonstrating that when they force an individual to refocus his or her attention, a shift cost is involved. They observe that when individuals engage in a conversation, the rapid stream of sentences requires the speakers to engage their attention control processes to allow shifting between the various ideas being expressed. For example, a sentence such as "The food remained on the plate because the boy wasn't hungry" requires a person first to focus attention on the spatial relationship between "food" and "plate" (triggered by "on") and then to shift attention to the causal connection between the upcoming second clause and the first clause (triggered by "because"). The attentional shift implies a cost that varies depending on whether the grammaticized elements require attention to be refocused on a different or a similar aspect of the mental representation of the meaning contained in a phrase. For example, the shift costs implied by the sentence "The food remained on the plate because the boy wasn't hungry" is higher than the shift costs implied by the sentence "There was food and a plate and a boy and the boy wasn't hungry".

In their Experiment 1, Taube-Schiff and Segalowitz used an alternating-runs task-shifting design in which participants learn two tasks: a location judgment task (L) and a temporal judgment task (T). The stimuli in the location judgment task were phrases referring to spatial locations (such as "above the", "below the", "under the"); the stimuli in the temporal judgment task were phrases referring to events occurring in the past or in the present signalled by the verb tense (such as "we waited", "he is standing"). The location task (L) and the temporal task (T) alternated in the predictable sequence "...LLTTLLTT...", which resulted in an alternation between repeat trials (performing the same kind of task, L or T, as was just performed on the previous trial) and shift trials (performing a different task). A comparison of the reaction times of shift trials with the reaction times of repeat trials revealed significant shift costs.

In their Experiment 2, Taube-Schiff and Segalowitz tested participants in two different conditions: one was a grammatically dissimilar condition (extradimensional attention shifting), a replication of the temporal-location judgement task from Experiment 1; the other was a grammatical similar condition (intra-dimensional attention shifting), involving two different location judgment tasks: in one task, the target phrases referred to spatial location in the vertical dimension (with stimuli such as "above the", "below the", "under the"), in the other task, the target phrases referred to relative spatial proximity (with stimuli such as "near the", "next to the", "far from the"). Taube-Schiff and Segalowitz hypothesized that shift costs would be lower for intra- compared with extradimensional attention shifts: which was exactly what the experiment revealed.

Estes et al. (2008) showed that object words referring to objects that typically occur in particular locations (such as "head" and "foot") orient the attention to the object's typical location. Previous experiments had showed that object words are judged faster when presented on a computer screen in the object's typical location (for instance, "eagle" is judged faster when presented at the top rather than the bottom of the display). Given that certain object words encode spatial associations, Estes et al. hypothesized that when such object words are used, they: (i) direct attention toward the location where their referent typically

occurs, activating a perceptual simulation of the word meaning; (ii) hinder perception of an unrelated visual target in that location (because the mechanisms responsible for target identification at that location are already engaged in the simulation of the denoted object at its typical location). In their experiments, an object word associated with an upper or lower location (such as "hat" and "boot") serving as a cue was presented centrally in the display; the cue was followed by an unrelated target letter (such as "X") that was likely to appear at the top or bottom of the display, regardless of the cue object's typical location; participants were required to identify the target letter as quickly and accurately as possible. Estes et al. found that targets were identified more slowly and less accurately when they appeared in the typical location of the object denoted by the cue object word than when they appeared in the opposite location.

The power of words to pilot the attention of human beings is also evidenced, albeit in an indirect way, by experiments on perception. In an experiment by Jonides and Gleitman (1972), subjects were asked to search for a letter or digit target embedded in either letter or digit distractors. Previous experiments had shown that when target and distractors were of the same category, reaction time increased with display size; when target and distractors differed, reaction times were independent of display size. The interesting manipulation by Jonides and Gleitman was to use the very same physical target stimulus (the symbol O) as either a letter or a digit (the target was presented to subjects as a digit "zero" or as the vowel "o"), amidst field items, all of which were either letters or digits. So while the featural, physical properties remained exactly the same, the category membership could be changed (letter or digit). Jonides and Gleitman found that depending on whether subjects were told to search for the vowel "o" or for the digit "zero", the physically identical figure behaved differently either as a letter or a digit: when target and field were of the same category, reaction times increased with display size; when target and field category differed, reaction times were independent of display size. Naming the identical physical stimulus in one way rather another makes the subject move its attention according to the instruction conveyed by the word, and consequently perceive it differently.

Conversely, Gentilucci et al. (2000) found that different words such as "near" and "far" taped on a small wooden bar located either near or far from the subject modulated the kinematics of the subject's reaching behavior: both in the near and far condition, reach was faster and slower when, respectively, the words "far" and "near" were printed on the target. Moreover, the grammatical class of the words – adjectives or adverbs – differently affected visual analysis and motor control: adjectives ("high" and "low") influenced visual analysis of target-object properties, whereas adverbs ("up" and "down") had more directly influence on the control of the action. In other words, words and grammar, piloting the subjects' attention, influence their perception of the target, and consequently the kinematics of their action.

The close link between attention and language is also evidenced by studies on sentence production. For example, Tomlin's (1997) study is intended to investigate the role of the direction of attention in the choice of syntactic subject position in English narrative. He used an animation program called "The Fish Film", in which a dark and a light fish approach each other until one swallows the other; an explicit visual cue in the form of an arrow directed the participant's attention toward one of the two fish; participants were instructed to direct their gaze to the cued fish only and describe the interaction between the two fish in any preferred way. Tomlin found that when the dark fish was cued and then eaten by the light one, participants produced passive voice sentences (such as "The dark fish was eaten by the light

fish"); when the cue was on the light fish, and then the light fish ate the dark one, participants produced active voice sentences (such as "The light fish ate the dark fish"). The study supports the hypothesis that the grammatical subject is assigned to the referent that is in the speaker's attentional focus (for a different hypothesis, and a general review of the works dealing with the role of attention in sentence production, see Myachykov et al. 2009).

4. ATTENTIONAL SEMANTICS

If words have the power of piloting the attention of human beings, then it is possible to study and analyze them in terms of the attentional changes they convey. This is precisely the objective of Attentional Semantics (Marchetti 2003, 2006): Attentional Semantics aims at finding the attentional instruction conveyed by the meanings of words, that is, the sequence of attentional operations that one has to perform if one wants to consciously experience the relations (between the person and other entities, between the person and him-herself, and between the other entities themselves) that words express. To achieve this goal, Attentional Semantics tries:

1. firstly, to identify the essential, elementary conscious experiences of the relations (between us and other entities, between us and ourselves, and between the other entities themselves) that invariably accompany, characterize, and are prompted by, the use of the word being analyzed;
2. secondly, to describe these conscious experiences in terms of the attentional operations that are responsible for their production.

The first step, the identification of the elementary conscious experiences produced by the meanings of words, can be performed thanks to the fact that any conscious experience implies the possibility of being distinguished and differentiated from the others. We can be said to be conscious of something only if we are able to recognize it and distinguish it from other things. The conscious experience of something, say of a pear, lets us distinguish it from other fruits: it has certain phenomenal qualities – shape, taste, color, etc. - that other kinds of fruits do not have; like other kinds of fruits, but unlike stones, it goes bad; it does not perform the same actions that human beings do. We are conscious that a given object is a pear only if we can distinguish it, on the basis of its shape, color, taste, etc., from other kinds of fruits, or from other objects. This holds true even if we do not possess a name for the object we can distinguish from other objects, such as when we come across an object for the first time, or when we want to say something but do not find the right word.

The fact that consciousness is a fundamental means which allows us to distinguish an object or event from other objects and events is what gives all sciences the possibility of existing and carrying out their experiments: all the steps, components and results of any kind of scientific experiment must be carefully identified and distinguished by scientists, who can do this only because they are provided with a conscious mind. Moreover, some sciences, such as psychology and psychophysics for instance, not only make an instrumental use of consciousness as a tool that allows scientists to distinguish an object from the others, but also

perform their experiments on a subject's capacity to be conscious, either to directly test it or to test through it some other capacities of the subject, such as reaction time.

When we use a certain word or inflect it in a certain way, we have the conscious experience of its meaning, that is, we know that it differs from the other words or from the same word but inflected in a different way precisely because it means something different from them: if we substitute it with another word, or if we inflect it differently, we will express a different idea or concept. It is the conscious experience of the meaning of a given word that makes us differentiate it from the meanings of other words, or that make us distinguish the objects which the word refers to from other objects. If we consider, for instance, the plural inflection of nouns, we can give a first rough description of the conscious experience it produces by saying that the plural form, as opposed to the singular form, implies for us a multiplicity of objects, actions or events: when we say "apples" we refer to more than one apple. This is not however the sole conscious experience we have when using the plural form. Actually, if we compare the word "apples" with "fruits", we will clearly notice that the plural introduces a certain kind of equivalence or uniformity between the various objects: whereas "apples" might simply give the idea that there is more than one apple, "fruits" unequivocally shows not only that there is more than one fruit, but also that it is possible to group under one common category objects of different kinds: from this point of view, apples, pears, bananas, and so on, despite their apparent diversity, are all equal, and share something in common. Obviously, by making further comparisons, we might distinguish some additional characteristics, and give a more precise and comprehensive account of the elementary conscious experiences of the plural form.

After identifying the elementary conscious experiences that invariably characterize the meanings of words, Attentional Semantics tries to describe these conscious experiences in terms of the attentional operations that are responsible for their production. For this purpose, Attentional Semantics must take into account the whole set of basic operations that attention can perform. This is a list of the most common ones:

- it can be oriented, this operation can in turn be divided in three elementary operations:
  - engaging on a target,
  - disengaging from it,
  - and then shifting to a new target (Posner 1980, 1994b, Posner and Cohen 1984);
- it can be focused at variable levels of size, being set either widely across a display of objects or narrowly to the size of a single object (Jonides 1983);
- it can be focused at variable levels of intensity (La Berge 1983);
- it can be stopped (Logan 1983, 1985, Umiltà 1988, 1994);
- it can be sustained or maintained for variable, though limited, amounts of time (La Berge 1995);
- it can combine and integrate the features or properties of objects (Treisman A. and Gelade 1980, Treisman A. 1982). It is precisely this function that allows subjects to experience colored shapes as opposed to pure shapeless colors or pure colorless shapes.

On the basis of these elemental operations, more complex ones can be performed (even thanks to the working of some other organs such as memory):

- attention can be addressed to an object or feature A, and then suspended momentarily from it, but in such a way as to keep or maintain it, as it were, in the background for a certain time, while simultaneously operating on a new object or feature B. This allows several kinds of operations to be performed, such as comparing A and B, referring A to B, constructing A using B as a model, evaluating A on the basis of B, and so on.
- each single attentional operation can be combined with other attentional operations in various ways, forming an orderly, albeit complex, sequence of attentional operations (the complexity of the sequence can vary both in terms of the quantity and the type of operations involved);
- a sequence of attentional operations can be integrated into a new single item to be stored in memory, a phenomenon known in psychology as *chunking* (Miller 1956).

Considering, for example, the case of the plural inflection of nouns, a first approximate account in attentional terms of the conscious experiences that we have identified as characterizing it, that is, the experiences of "multiplicity" and "equivalence", could be the following one. The conscious experience of "multiplicity" results from having repeatedly focused our attention, and from having each time thus obtained - whether in the form of a perception, a recollection, a mental image, or something else – an object that differs from the others in some aspect: the place it occupies, the time in which it occurs, its shape, etc. The conscious experience of "equivalence", as well as that of "difference" implicit in the experience of "multiplicity", relies instead on the possibility of performing the following attentional operations:

- addressing attention to a certain object A,
- suspending it momentarily from A, but in such a way as to keep or maintain A, as it were, in the background for a certain time,
- while simultaneously focusing on a new object B,
- comparing B with A,
- and getting the result of the comparison.

If B is equal to A, we will experience "equivalence"; if they are not equal, we will experience "difference". It should be noted that the apparent contradiction between experiencing "difference", implicit in "multiplicity", and experiencing "equivalence" disappears when we consider that the latter experience concerns the object that is pluralized, while the former concerns something that is associated with the object, such as its spatial or temporal localization, or some of its features (for a more detailed analysis of the plural, see Marchetti, 1993).

As we will see more extensively later, some of these attentional operations can be performed only thanks to the working of some other organs, such as memory and a comparison system. However, what is important to notice and realize at this level of analysis is that it is thanks to the various and different kinds of attentional operations we can perform that we can have a various and composite range of conscious experiences: consequently, we

can characterize this variability and difference of conscious experiences primarily in terms of a corresponding variability and difference of attentional operations.

5. The Antecedents of Attentional Semantics

The main hypothesis of Attentional Semantics that the function of words and language is to pilot a human being's attention, is not new and has been put forward by several authors, even though with different emphasis and deepness of analysis. Vygotskij (1973) pointed out - following N. Ach - that the original function of words is to direct attention toward something; Vaccarino (1981, 1997, 2000) extensively analyzed meanings in terms of attentional operation; for Langaker (1987) language acts as an attention-focusing mechanism, directing the interlocutor's focal adjustments; Marchetti (1993) propoposed a research program to analyze meanings in terms of attentional movements; Logan clearly stated that: "The semantics specify the computational goals that the attention system must satisfy" (Logan 1995 p. 169); Slobin maintained that: "each native language has trained its speakers to pay different kinds of attention to events and experiences when talking about them" (Slobin 1996, p. 89); Talmy (2000a) analyzed how language makes possible what he terms "the windowing of attention", that is, the process by means of which one or more portions of a referent scene are placed in the foreground of attention while the reminder of the scene is backgrounded; Karmiloff and Karmiloff-Smith (2001) acknowledged the role of words in piloting a human being's attention; Benedetti (2006, 2008, 2009) proposes that the essential components of thought and language are sequences of mental operations, and that such operations are mainly (but not only) of an attentional kind; Oakley (2004, 2009) explores "the possibility of theorizing language as both conditioned by attention and, once developed, conditioning and refining the capacity to detect, select, sustain, control, harmonize, and direct attention" (Oakley 2009, p. 22).

However, as far as I know, the author who first developed the idea of analyzing the meanings of words in terms of attentional operations into a dedicated research program, was Silvio Ceccato (Ceccato 1964, 1966, 1968, 1969, 1970, 1972, 1974, Ceccato and Zonta 1980).

5.1. Silvio Ceccato's Work

Ceccato's initial interests were mainly devoted to philosophy: in his first works (1964, 1966) he carried out an extensive and articulated criticism of the philosophical tradition in which he unmasked and denounced the main negative aspect of the philosopher's practice: the "philosophical mistake". The philosophical mistake consists in believing that things, whether they are physical objects, abstract ideas, perceptions, emotions, operations, or anything else, exist in themselves, independently of the mental activity performed by the person who experiences them. According to Ceccato, this belief leads philosophers to completely overlook the importance of the mind in constructing and shaping things as we see, perceive, remember, conceive, and value them. Despite being primarily interested in matters that concern the mind, its activity and products (thought, ideas, concepts, values, etc.),

philosophers - with some notable exceptions like Kant, Berkley and Dingler, whose works nevertheless do not seem to be completely free from the philosophical mistake - are completely unaware of the importance of the mind. Consequently, philosophical theories are inadequate to explain all those matters, issues, phenomena, facts and events that are generated, elaborated and affected by the mind, or in some other way related to it.

In his subsequent studies (1968, 1969, 1970, 1972, 1974), Ceccato tried to analyze and explain how the mind works, its role in perception and observation, how it produces thoughts, ideas, meanings, and emotions, and how it generates attitudes: in brief, how it contributes to constitute all the things we see, touch, feel, perceive, conceive, think about, remember, imagine, name, etc. and that characterize our human life.

After his first attempts to develop a model of the mind, Ceccato reached the conclusion that the building block of mental life is the "attentional state", which he symbolized with an "S". Ceccato, despite admitting that attention can be focused for variable amounts of time, conceived of and above all used the attentional state as something that had essentially a digital nature, that is, as an "on-off" or "all-or-nothing" phenomenon. In his view, attention can be either focused on sense organs or on itself. When attention is focused on sense-organs, we get what he called "presentiated things" (Italian: "presenziati"), that is, what is reffered to by words such as "red", "yellow", "cold", "hot", "pain" and "pleasure". "Presentiated things" are the basis for the construction of all physical and psychological things (Italian: "osservati"), such as "horse", "sun", "book", "jealousy", and "envy". When attention is applied to itself, we get pure mental constructs, that is, constructs that do not identify any physical or psychological thing. By variously combining the attentional states with the aid of memory, we obtain various mental constructs. Ceccato called such mental constructs "mental categories": examples are prepositions, conjunctions, interrogative-indefinite-relative pronouns and adjectives, demonstrative adjective and pronouns, adverbs of place, time and manner, pronouns and adjectives of quantity, negation, numerals, "grammatical" verbs like "to be", "to be", "to have", "can", "must", etc., most morphemes indicating cases, number, tenses, moods, forms etc. (see Benedetti 2009). The combination of pure mental categories and physical or psychological constructs produces what Ceccato called "mixed constructs" (Italian: "costrutti misti"), such as "fruit" and "trumpet".

Ceccato investigated many experiential fields, such as perception, observation, thought, language and attitudes, basing his analyses mainly but not only on the attentional state. No doubt, the field where he directed most of his analytical efforts was language. Certainly, this was principally due to the fact that, compared to other phenomena, language provides the most complex, complete, articulated, and available manifestations of the activity of the mind; however, in my opinion, a relevant part in determining Ceccato's choice of language as his major field of study was played by the prevailing influence exerted, first, by neo-positivism and, then, by analytical philosophy on the cultural environment of his time.

Ceccato set up a clear and well-defined research program based on the assumption that the meanings of words can and must be conceived of and analyzed in terms of the various combinations of one single element, the attentional state. For example, he hypothesized that the combination of two attentional states, S+S produces the mental category expressed by the Italian word "cosa" ("thing"); the combination of an attentional state with the mental category "cosa", S+(S+S), produces the mental category expressed by the Italian word "oggetto" ("object"); the combination of "cosa" ("thing") with an attentional state, (S+S)+S, produces the mental category expressed by the Italian word "soggetto" ("subject"); and so on. This

method is reminiscent of Mendeleev's way of classifying chemical elements: while the number of the basic elements is very limited – here, there is only one basic element: the attentional state "S" - their combination yields a theoretically infinite number of outcomes.

Ceccato performed his analyses mainly on the basis of his personal experience, using introspection as his main research tool. He considered his analyses as provisional hypotheses that must and can be subsequently tested and verified by means of empirical methods, such as neurosciences.

5.2. The Drawbacks of Ceccato's Proposal

Despite this well-defined research program, Ceccato did not always respect, and adhere to, it. According to Benedetti's research (2001), the majority of Ceccato's analyses (120 out of about 300) are expressed using common words, that is, without resorting either to the concept, or the more technical symbology of the attentional state. This fact, along with Ceccato's own recurring dissatisfaction with, and revision of, the combinatorial structure of his analytical system, and with his open admission in his last work (1996) that analytical work cannot be carried out only in terms of attentional states, clearly shows the inadequacy of Ceccato's choice of centring and articulating his theory of mind and analyses of mental activities exclusively on such a restricted notion of attention or "attentional state" as it was conceived of by him, that is, as a phenomenon characterized mainly by: a) an essentially digital, discrete nature, and b) the property of being applicable to something.

In my opinion, most of the problems and difficulties raised by Ceccato's proposal derive from the fact that when approaching the study of mind he did not *fully and thoroughly* take into consideration and investigate its main aspect and characteristic: consciousness. If he had carefully considered consciousness, he would have been led to analyze how it forms, the mechanisms that make it appear, the importance it has for the emergence of the sentient subject and of the objects surrounding it, and its various manifestations and dimensions. Taking consciousness into due consideration would have implied for him: to reflect on and account for the role of unconscious mechanisms in generating, sustaining and shaping conscious phenomena (perceptions, meanings, memories, emotions, etc.); to consider the importance of the continuous interplay between consciousness and the unconscious for a subject to emerge as an entity differentiated from the objects that somehow have a relationship with it; to consider meanings and the process of meaning formation as a necessary step for, and a natural by-product of, the emergence of the subject; to explain phenomena like the stream of consciousness, thought and rhythm, and account for their propulsive, driving and pushing forward aspect in terms of the interplay between consciousness and the unconscious; to account for the qualitative and quantitative aspects of sensation and perception. By neglecting to consider consciousness in its whole dimension, he left the unconscious out of his analysis almost completely ; he identified mind only with part of its conscious products; he did not give any account of the qualitative and quantitative aspects of consciousness; he disregarded most of the ways in which attention works; he failed to give a systematic and exhaustive description of the meanings of words in attentional terms that could plausibly account for the conscious experience we have of such meanings.

Let us consider, for example, the problem of conscious perception. Ceccato states that when we focus our attention on sense-organs, we get what he calls "presentiated things"

(Italian "presenziati"), that is, we have those conscious experience that are referred to by words such as "red", "yellow", "soft", "hard", and so on. Though this approach suggests which road to take in order to analyze conscious perceptions, it neither fully clarifies how such perceptions occur, nor accounts for their qualitative and quantitative character.

Ceccato's proposal provides only a generic and incomplete description of the operation of "focusing", without explaining how it is possible to integrate at a specific level (the attentional, mental one) elements (sensory signals) that by definition are extraneous to that level and that, on the contrary, belong to another one (the naturalistic, physical one). Therefore, his analyses surreptitiously introduce spurious elements (the physical, sensory signal) that have little to do with the level of analysis he chose (the mental one), and that, as such, appear consequently as unanalyzed and unanalyzable *prius* or, using Laganà's definition, "extra-semantic postulations" (Laganà 1992, p. 38). As Laganà rightly observes, the analysis of meanings as it is carried out according to Ceccato's principles is (I translate into English):

> forced to incorporate into itself unanalyzable elements that inevitably reappear when any observable construct is being formed, thus endangering the principle according to which all meanings can be reduced to mental operations (Laganà 1992, p. 38).

The introduction of these spurious, unanalyzable elements is consequent to an inadequate and deficient analysis of how "presentiated things" are constructed. Ceccato, though having correctly stated that the "presentiated things" are obtained by applying attention to the sense-organs, did not however sufficiently investigate how this may come about: in fact, he completely neglected to analyze and explain how it is possible "to apply" attention to the various sense-organs, how and where a physical element (the physical, sensory signal) interacts and combines with a mental one (the attentional state), what effect this combination has on mental activity, and so on. In other words, he did not address questions such as: When attention is applied to a sense-organ, is the former affected by the latter? If so, how is it affected? What kind of influence does the sense-organ have on attention? If, on the contrary, we suppose that attention is not affected by the sense-organ, how can we explain the specific conscious, mental experience we have when applying our attention to a sense-organ, given the fact that attention is the sole element responsible for the mental, conscious presence of whatever we can be conscious of? More in general, how does attention produce conscious experience?

If he had properly thought about how it is possible to practically and feasibly realize an organism that applies its attention to its sense-organs, and that consequently has certain conscious experiences, sensations and perceptions, he would have realized that his restricted notion of attention as a phenomenon that is characterized almost exclusively by the fact of having a digital nature and of being applicable to something is neither sufficient nor adequate. Indeed, the application of attention to the sense-organs produces conscious sensations and feelings that are qualitatively distinct from those we experience when using it at a purely mental level, such as when we deal with words like "end", "plural", or "and". Moreover, when applied to sense-organs, attention may produce very different qualitative and quantitative sensations: let us think, for instance, of the difference between colors and sounds, or between strong and week sensations. How is it possible then to explain the qualitative and quantitative differences between all these distinct instances of conscious experience by

resorting only to Ceccato's restricted notion of attention? If that which gives rise to the mental, conscious presence or experience of something is only and always the same element, that is, attention or the "attentional state", the grounds for the qualitative and quantitative differences between the various instances of conscious experience must necessarily be found *also* in it and not only in something else (for example, the sense-organs). This implies, therefore, that attention or the "attentional state" must be considered not simply and only: a) as a phenomenon having a digital nature, but also as one characterized by various quantitative degrees and that can assume various forms and dimensions; and b) for the properties it has of being "applied" to something, but also for its function in producing conscious experiences having distinct qualities: a function that can certainly be performed only when attention is applied to something, but that the sole notion of "applying" is not sufficient to explain since, as we have seen, some other notion is required, notably that of a variation in the state of the organism's attention induced by the very attentional activity performed by the organism.

By not considering consciousness in its whole dimension, and consequently by adopting his restricted, digital notion of attention as the basis of mental life, Ceccato also negatively prejudiced his project of methodically and fully analyzing the meanings of words in terms of the various possible combinations of the attentional state. According to Benedetti (2001), Ceccato's proposal raises many theoretical and technical problems:

- In Ceccato's system, the exponential growth of the number of possible combinations is not accompanied by a corresponding growth of the number of words: by combining more than 4 attentional states, the number of combinations that do not correspond to any Italian word increases dramatically, leaving too many combinations without a linguistic counterpart. This fact poses a serious doubt as to the usefulness of the proposal.
- The mathematical rigidity of the system of combinations entails a complete and exact classification covering all the possible meanings. Such a classification should be mirrored by a sort of universal language of thought, a kind of *mentalese*, shared by all human beings. What linguistic diversity shows, on the contrary, is that such a universal language of thought does not exist: some languages possess words that some other languages do not, and not always is it possible to exactly translate a word or sentence from one language to another. If a *mentalese* really existed, such problems would not occur.
- A system of analysis based on the combination of a set of basic elements works on a deductive principle. Deductive systems are risky: if even one of the basic elements or assumptions is wrong, the whole system can collapse. An inductive approach would seem to be more suitable.
- The very idea of the possibility of obtaining a system of meanings by combining few basic elements implies the idea of a set of combinations of increasing complexity: the higher the number of elements combined, the higher the complexity of the corresponding meanings. Such a system can ideally be partitioned into levels of combinations of increasing complexity: a first level of meanings formed by only one element, a second level of meanings formed by the combination of two elements, a third level of meanings formed by the combination of three elements, and so on. If we try to relate this hypothesis of a system of meanings of increasing complexity

> with children's language development, we face two alternatives: as soon as the neuronal correlates of the basic elements and of their combinations are sufficiently developed to be able to work, children can have: (1) immediate language development: they form all the possible combinations in a very short time; or (2) gradual language development: children form the combinations gradually, over the years, according to the level of complexity of the combinations. Children's language development, on the one hand, contrasts sharply with the first alternative: children need many years to learn a language, and, albeit with individual differences, seem to develop their vocabulary following a common kind of order (for instance, words pertaining to specialized vocabularies are learnt later than common words). On the other hand, it does not reflect the levels of combinations of increasing complexity inherent in Ceccato's system. Children do not learn to say first "thing", then "I" and "it", then "beginning", "end", "individual", etc., that is, they do not follow the levels of Ceccato's system: which, although not making the second alternative (gradual language development) implausible, certainly makes Ceccato's analyses highly implausible.

According to Benedetti (2001, 2005) and to me (2003), these problems can partly be solved by adopting a wider and more representative set of basic operations. Benedetti (2005), for example, identifies nine basic operations, some of which are not attentional ones: 1) attentional focalisation; 2) attentional movement; 3) evaluation of attentional movement; 4) change of intensity of attentional focalisation; 5) maintenance of attentional focalisation for variable amounts of time; 6) attentional discarding; 7) memory; 8) representation; and 9) comparison. This set of basic operations is not exhaustive, determined once and for all, but is open: it can always be expanded, reviewed and improved.

Benedetti, even though his criticism of Ceccato does not originate from the same considerations on consciousness I have made here, but mainly from methodological and technical observations about Ceccato's system, reaches the same conclusions: only by adopting an "analogical" conception of attention - which, unlike the "digital" one adopted by Ceccato, accounts for the quantitative, qualitative and dimensional variability of its states - can we adequately and accurately analyze and describe those special products of our mind that are the meanings of words.

I think that one can immediately and easily see the advantage of adopting a wider set of basic attentional operations simply by comparing the disarming and appealing simplicity of the analyses made by Benedetti with Ceccato's. While the former explains the meaning of very basic and primitive words, such as "to be", or "point" by resorting to few essential attentional operations, the latter has to resort to a longer series of operations. Even if only from the point of view of the pure phylogenetic formation of meanings and mental categories, this certainly makes Ceccato's analyses unconvincing as opposed to Benedetti's.

Let us consider for example the analysis of the word "point" (Italian, "punto"). While Ceccato (Ceccato and Zonta 1980) describes the meaning of "point" as resulting from the combination of the categories of "place" (Italian, "posto") and "singular" (it should be noted that in Ceccato's system the category of "place" results from the combination of the categories of "space" and "singular"; the category of "space" results from the combination of the categories of "thing" and "plural"; the category of "thing" results from the combination of two attentional states; the category of "plural" results from the combination of an initial

category of "thing", an attentional state and a final category of "thing"; the category of "singular" results from the combination of initial attentional state, the category of "thing" and a final attentional state), Benedetti explains the meaning of "point" as (I translate into English):

> a narrowing down of the focus of attention on its object or field, so that attention is prevented from making any further movement, and yet remains focused on them (Benedetti 1999, p. 176).

Ceccato's idea of analyzing the meaning of words in attentional terms has been extensively and systematically adopted and applied by Giuseppe Vaccarino (Vaccarino, 1981, 1997, 2000). As already pointed out elsewhere (Marchetti, 1993, 2003, 2005), I think that Vaccarino's work, despite being more rigorous and methodical than Ceccato's, has the same faults (a more modest and less systematic attempt at analyzing the meanings of words in attentional terms following in Ceccato's footsteps has been made by Ernst von Glasersfeld 1987, 1989).

6. The Importance of Non-Attentional Operations for Attentional Semantics

Benedetti's work (Benedetti 2001, 2005) hints at another fundamental aspect of research on mind that Ceccato unjustifiably and inexplicably underestimated and overlooked: the importance of non-attentional operations. In fact, Benedetti proposes representation, memory and comparison as basic operations. These operations, which in Benedetti's view are non-attentional, can nonetheless help or support attention in performing some specific activity, or can be the outcome of some previously performed attentional operation. By resorting to non-attentional operations for the study on the mind, Benedetti indirectly recognizes the importance of unconscious operations, even though he does not fully develop the consequences of such an admission.

6.1. Mental Activity Consists of Conscious and Unconscious Operations

According to Ceccato, mental activity is characterized by the fact that its products coincide with the activity itself, in the sense that they last and are present only as long as the activity itself takes place. Let us consider, for instance, the thought of a burning tree: the image of the burning tree (that is, the product of your mental activity) lasts only as long as you think about it, and fades away as soon as you stop thinking about it (that is, when you stop performing that specific mental activity). Compared to mental activity, other kinds of activities, such as for instance physical or psychological ones, are characterized on the contrary by the fact that their products outlive the activity itself, and remain quite visible even after the activity is over: when we burn a piece of wood, we can see the product of the physical activity (the ashes) quite clearly even after it has ended.

Ceccato's definition certainly captures one of the most distinctive aspects of mental activity. However it unavoidably: a) recognizes only a given kind of mental products, excluding many other products of equal importance; and b) confines mental activity only to, and identifies it only with, *conscious* mental activity, excluding *unconscious* mental activity altogether (incidentally, it should be noted that these limitations make Ceccato encounter severe problems when analyzing not only the meanings of words, but also the structure of thought and rhythm: see Marchetti, 1997a and 2005).

As to a), it can be noted that conscious mental activity produces not only mental products that fade away as soon as it stops, but also mental products that do not fade away at all when it stops. All the mental abilities and things you learn, such as for example the language you speak or your ability to make calculations, are undoubtedly the products of your conscious attending to what your parents, teachers, etc. told you when they taught you to speak and make calculations: these products certainly faded away from your *consciousness* after you stopped attending to your parents and teachers, but they did not fade away from your *mind*.

As to b), it can be observed that (at least part of) the activity we perform unconsciously possesses all the qualities of what can be defined as mental, except obviously the quality of being conscious. Let us consider this point more extensively.

Unconscious mental products and processes constitute what Baars (1988) calls the "context", that is, the complex and articulated system of rules and representations that always constraints conscious contents without itself being conscious, and without which there could hardly be conscious contents at all: to a certain extent, but consistently and substantially, it influences, determines and sustains our conscious life, whether by automatically or semi-automatically processing stimuli, performing or contributing to perform acquired skills and procedures, or creatively finding new solutions to new problems.

Obviously, some could claim that these unconscious products and processes are not at all mental, but merely physical: this seems to be the thesis embraced, for instance, by Searle when he says: "that is all that is going on inside the brain: neurophysiological processes and consciousness. On my account, talk of the unconscious mind is simply talk of the causal capacities of neurophysiology to cause conscious states and conscious behavior" (Searle 1992, p. 168).

Undoubtedly, unconscious products and processes differ from conscious ones: for example, they lack some properties of the latter, the most important one being that we do not know that they are occurring. In this view, one may legitimately claim that they are not mental phenomena. However, they also possess properties that contribute to distinguish them altogether from purely *physical* products and processes, and that make it reasonable enough to assimilate them to *mental* ones: properties such as those that: 1) allow one, after having learnt the relevant rules, to automatically apply these rules even in *new unexpected* contexts and situations, and perform *new and very complex* operations, or that: 2) allow one to *creatively* find the solution to *new* problems.

As to the former kind of properties (1), think for example of all those cases in which, despite facing a new situation, never experienced before, you are able to automatically, but sophistically, decode and react to it, without having any conscious awareness of the rules by which you do so. Velmans illustrates this situation very well: "Consider how one silently reads the following sentence: 'The forest ranger did not permit us to enter the reserve without a permit'. Note that on its first occurrence, the word 'permit' was (silently) pronounced with the stress on the second syllable (per*mit*), whereas on its second occurrence the stress was on

the first syllable (*per*mit)" (Velmans, 1991, p. 657). As Velmans argues, "the syntactic and semantic analysis required to determine the appropriate meaning of the word 'permit' must have taken place prior to the allocation of the stress pattern; and this in turn, must have taken place prior to the phonemic image entering awareness". While reading, one is not conscious at all of the complex and sophisticated processes that allow one (even when a similar combination of words is encountered for the first time) to correctly interpret the sentence: they just happen, as a consequence of having previously learned to read.

As to the latter kind of properties (2), think of all those cases in which unconscious processes help us perform cognitive, imaginative and decision-making functions in a much more creative and flexible way than conscious processes themselves. Sometimes we face a difficult problem and are not able to find an immediate solution to it: the best thing we can do in that case is to literally "sleep on it", as the saying goes, that is, let our unconscious do the job that our conscious side cannot accomplish. In fact, most of the times, the solution to our problems comes automatically thanks to the working of our unconscious, whether it occurs during sleep or in other relaxed occasions (for experimental evidence of the merits of unconscious thought in creativity, see for example Dijksterhuis & Meurs 2005, Dijksterhuis & Nordgren 2006, Zhong et al 2008. According to Dijksterhuis & Nordgren 2006, there are various reasons for most of the merits of unconscious versus conscious thought: the former does not have the capacity limits characterizing the latter; during impression formation, people stereotype more when they think consciously than when they think unconsciously; consciousness generates thoughts or ideas in a very focused and convergent way, whereas the unconscious is more divergent. However, as Dijksterhuis & Nordgren correctly point out, all this does not imply that unconscious thought *always* performs better than conscious thought, but simply that it performs better under *certain* circumstances).

All this makes it quite unrealistic to think of unconscious products and processes as purely physical and to believe that they can be described and predicted solely by an *a priori* knowledge of neuronal processes. As Libet observes (Libet 2004, p. 100): "It seems simpler, more productive, and more in tune with clinical experience to regard unconscious processes as 'mental functions', phenomena that are related to the conscious mental functions but lack the added phenomenon of awareness".

This way of regarding unconscious processes and products as mental phenomena finds further support in a definition of mental activity which, despite being broader and less specific than Ceccato's, is able nonetheless to account in a sensible and comprehensive way for a fundamental difference between the mental and the physical domain. According to this definition, *mental activity is that activity that allows an agent or being provided with a mind to act on and deal with the same object or event in different ways, and to act on and deal with different objects and events in the same way.* Here I use the verb "to act" and "to deal" in their most general sense, meaning not only "to perform purely physical kinds of actions", but also partially-physical and non-physical ones, such as thinking about, conceiving of and imagining. In this sense, it is thanks to mental activity that we can work on, perform activities on, see, perceive, think about, conceive of and imagine the same physical object or event in several, different ways, and work on, perform activities on, see, perceive, think about, conceive of, and imagine different physical objects or events in the same way. If we look at a wood, for instance, we can not only say that it is a "wood" but also "trees" or "a set of trees", or also "an area of land, smaller than a forest, covered with growing trees". Conversely, for different kinds of trees – an oak, a pine, an elm, etc. – we can say that they are all "trees". In

this sense, mental activity is completely independent of and distinguished from the physical domain.

Using Zenon Pylyshyn's notion of *cognitive penetrability* (1984), we could say that mental activity comprises all the processes that are cognitively penetrable, that is, that can be altered in a semantically regular way, by changing for example the subject's goals, needs or beliefs. An example of a cognitively penetrable process is perception: the way something is perceived can vary radically even if the physical stimulus remains the same, and can be the same even if the physical stimulus changes. According to Pylyshyn, cognitively penetrable processes do not belong to the physical domain, nor to that of the functional mechanisms, but to the cognitive one: virtually no physical properties are necessary and sufficient for the occurrence of such a kind of processes. Consequently, the only proper way of describing them is by using the vocabulary of cognitive sciences, not the vocabulary of the physical or other natural sciences.

Unconscious processes also *are*, to a certain extent, cognitively penetrable. Indeed, they can be, and actually are, restructured and reorganized according to new beliefs, intentions and goals: they can be and are continuously learnt, modified and adapted to new contexts and needs. Clear evidence is given by psychological experiments where the visual field is transformed in a dramatic way: Gregory (1966), for instance, reports experiments where subjects were fitted with prism spectacles that turned the visual image upside down. At first, the subjects saw the world upside down. However, after wearing these spectacles continuously for about a week, subjects began to be able to behave as if the image were normal. But clear evidence is also given by daily-life experiences: when, for example, we break one of our arms, or when we are forced to modify a given habit or behavior (think of when a sudden event makes us drive a different car, or take a different road, from the usual one), we have to change our usual implicit, automatic, unconscious operations, reorganizing them according to the new situation.

Let me make a final consideration about the difference between mental activity and the other kinds of activities. There are authors who claim not only that unconscious processes in particular are merely physical processes (as Searle does, for instance), but also that mental processes in general *are* merely physical processes. Undoubtedly, there could not be mental activity without the physical substrate of neurons, synaptic connections, neurotransmitters, etc. that make up the brain. However, admitting that there could not be mental activity without a physical substrate does not entail admitting that the former *is equivalent to* the latter. Firstly, mental activity exhibits, as we have seen, properties that a physical process does not and cannot possess: mental activity allows us to act on and deal with an object or event in several and different ways: on the contrary, physical activity allows us to perform only a comparably narrower range of operations. Moreover, while physical processes are irreversible (a given apple, once it has been eaten, cannot be eaten any longer), mental activity has the property of allowing us to repeat the same activity without any limit (you can imagine yourself eating the same apple for an unlimited number of times). Secondly, it is impossible to adequately capture and analyze such mental properties by using a purely physical vocabulary and description. As Pylyshyn argues (Pylyshyn 1984, p. 12): "If we attempt to describe human behavior in terms of physical properties of the environment, we soon come to the conclusion that, except for tripping, falling, sinking, bouncing off walls, and certain autonomic reflexes, human behavior is essentially random. Yet we know that human behavior, if described in cognitive terms, is highly regular and systematic". Moreover,

without previously resorting to a dedicated and specific level of description able to connect mental activity to its physical substrate, we would be in the same position as someone who knows absolutely nothing about how cars work and wants to describe their working simply by "opening up" one and describing what he observes, or, at the most, removing some pieces to see if something changes. But how is it possible, for example, to differentiate the battery from the rest of the car, without having first formulated a hypothesis, or built a theoretical model of how the car functions? What is the use of an explanation that attempts to discriminate the battery only on the basis of its physical parts (acid, leads, etc.), its shape, color or the chemical processes that take place inside it without conceiving it as an organ that is functionally linked to other organs? How is it possible to decide only if any simple wire that is connected may belong to it? You would not even think that a battery and wires existed! What you need in order to adequately describe mental properties and activities is a theoretical model and a dedicated vocabulary that specify what the main functions of the mind are (for instance, consciousness, thought, memory, perception, imagination, etc.). Only once you have developed such a model and vocabulary can you proceed with the investigation at the lower, physical level: only once you have described what the specific functions of the mind are, do you have the conceptual tool that allows you to identify the physical organs and parts responsible for the production of those mental functions. In order to exist, mental activity certainly needs the brain, physical activity; but once it has come into existence, the former follows and sets rules that are different from the rules characterizing the latter.

6.2. A Classification of Conscious Experiences Elicited and Produced by the Joint Activity of the Organ of Attention and other Organs

Mental activity seems therefore to be better and more comprehensively understood when defined in terms that capture not only its conscious side but also its unconscious one. In this view, if Attentional Semantics wants to give an exhaustive and complete account of the operations that produce the meaning of a certain word, it has to rely not only on the two different levels or steps of analysis that we have already described (that is, firstly, the identification of the elementary conscious experiences that invariably the use of the word brings about, and secondly, the description of the attentional operations that produce such conscious experiences). It must also rely on a number of unconscious and non-conscious operations, and on the respective organs, that directly or indirectly serve either as the support that makes it possible for the attentional operations (and, consequently, for conscious experiences) to take place, be completed, and occur in a certain way, or as the necessary complement that makes it possible to execute and implement the activities that are determined and triggered by conscious experiences.

Attentional Semantics proposes a classification of such unconscious operations, and of the relevant organs. The classification I propose is based on the kind of conscious experience produced by the specific relationship existing between the organ of attention (and the activitiy it performs) and the other organs. The classification also includes all those physical operations (which I will call from now on, "non-conscious") and their relevant organs that in some way interact with the organ of attention. So far, I have identified four fundamental and specific kinds of conscious experiences, each of which is produced by the specific way the organ of attention or the products of its activity affect, or are affected by, the other organs:

1. conscious experiences that are determined by the direct application of attention to the other organs;
2. conscious experiences that are determined by the direct or indirect influence on the organ of attention of some other organs and the physical substrate of the body, whether or not attention is applied to them;
3. conscious experiences resulting from the operations, performed by the other organs, on the products of the activity of the organ of attention;
4. conscious experiences resulting from activities that are triggered, organized and controlled by earlier conscious mental acts.

Let us now analyze in some detail these four kinds of conscious experience, and describe the organs and operations that make them possible.

6.2.1. Conscious Experiences Determined by the Application of Attention to other Organs

The first kind of conscious experience is, no doubt, the most common one and is exemplified by most of the physical sensations and perceptions we can have (tactile, auditory, visual, etc). They can be either stimulated by a real external stimulus that we passively undergo or actively search and expect, or elicited and evoked by retrieving the information stored in our memory. We produce them by focusing our attention either on our sense-organs and proprioceptive system, or on our memory system: what we obtain are respectively real sensations and perceptions, and imagined or remembered sensations and perceptions.

The organs necessary for attention to produce this first kind of conscious experience are therefore the sense-organs, the proprioceptive system and memory. It is the activity done by these organs that supplies the organ of attention with the material that allows us to have physical sensations, perceive and feel physical things, imagine, recollect, evoke and represent physical objects, events and situations, but also to have hallucinations (as observed by Ceccato [1974, p. 221], we have hallucinations when we take or mistake what is actually a product of representational activity for a product of perception). Yet, these experiences could not take place without the active participation of attention. In fact, what mainly characterizes them is the fact that they last only as long as we focus our attention on our sense-organs and proprioceptive system, or on our memory system: as soon as we withdraw our attention from these organs, these conscious experiences disappear.

It is important to underline that the sense-organs and the proprioceptive system do not only supply what we could define raw, unstructured sensations, such as colors, sounds, smells, and the like, but also, up to a certain degree, structured perceptions. For example, Spelke's (1990) work shows (but see also Soja et al. 1991), infants innately possess a set of principles about the physical word that serves as the basis for their subsequent learning and for directing their attention to the relevant aspects of the input. Spelke has identified four such principles guiding the infant's perceptual analysis of the physical word: boundedness, cohesion, rigidity and no action at a distance. These principles, which are not modality specific, reflect basic constraints on the motions of physical objects, and make it possible for infants, as well as for adults, to identify one or more objects even when they are adjacent or partially occluded by each other. They permit perceivers to see physical objects as persisting bodies with internal unity and stable boundaries.

Pylyshyn (1999) lists some other evidence concerning visual perception that clearly confirms that our sense-organs and proprioceptive system provide us with structured perceptions. No doubt, the more striking evidence is that optical illusions are not destroyed by demonstrating their falsity: even after you have had a good look, for instance, at the Ames room, it still looks as though the person on one side is much bigger than the person on the other side. Therefore, our perceptual system, when we apply our attention to it, supplies more than raw sensations: it supplies us with partly structured perceptions.

Another important source of evidence is represented by the experiments on visual search. A vast amount of research undisputedly shows that at the first stage of vision, which, strangely indeed, psychologists label as "preattentive" or "vision before attention", some features pop-out and guide the following, subsequent stages of vision (Wolfe 1994) (I say "strangely indeed" because this first stage of vision actually involves some kind or amount of attention. In visual search experiments subjects are requested to look for one target item in a display containing a number of distracting items. Therefore, they apply their attention to their visual system, even if for a short period. In my opinion, then, it would be better to speak of "preliminary attention" rather than of "preattentive" or "vision before attention"). The features that certainly have this property are: colors, orientation, motion, size, curvature, various cues of depth, and several aspects of form. "Preattentive" processing of more complex properties like object shape, letters or faces seems to be efficient only if stimuli are overlearned (Wolfe 1998, 2000). Further evidence comes from the asymmetry of many basic feature searches: in a display, it is easier to find a moving stimulus among stationary distractors than to find a stationary target among moving distractors; it is easier to find the presence of something than to find its absence; it is easier to find a deviation from a canonical stimulus than it is to find a canonical stimulus among deviants. Using Wolfe's words (Wolfe, 1998): "preattentive processes divide the scene into 'things' and the preattentive basic features describe the 'stuff' out of which perceptual 'things' are made". All this clearly testifies to the complex role played by our perceptual system in supplying structured perceptions.

6.2.2. Conscious Experiences Determined by the Influence on the Organ of Attention of other Organs and the Physical Substrate of the Body

These conscious experiences arise because of the influence that, in general, the physical substrate of the body and, more specifically, the activity of some other organs have on the organ of attention (even though attention is not applied to them). We can distinguish here between two different kinds of experiences according to which kind of influence is exerted on the organ of attention. The first is elicited when an organ or the physical substrate of the body affects, pervasively and unselectively, the organ of attention, thus indistinctively altering or modulating all its operations; the second, when an organ sends circumscribed and selective instructions to the organ of attention on the operations it has to perform.

Typical examples of conscious experiences elicited by the first kind of influence are physiological states such as pain, pleasure, thirst, hunger and tiredness, and psychological states such as emotions, moods and impulses. Usually, their occurrence is accompanied by, or is a sign of, a temporarily general transformation in the working mode of our brain and body: all our brain processes and physical activities result as either speeded up, slowed down or altered in some other way. As a consequence, we cannot behave as if such conscious experiences were not occurring. They share, in common with the conscious experiences

analyzed in the preceding section (those determined by the application of attention to the other organs), the character of *immediacy* and *intuitiveness*, that is, using Ducasse's (1944, p. 134) words, the fact that "however much we may learn *about* them, yet we do not know *them* unless we ourselves have felt their intrinsic quality". They have this character because of the pervasiveness of the influence of the physical substrate of the body and the activity of the other organs on the organ of attention: indeed, they affect and alter, directly or indirectly, its way of working in a global and indistinct manner for periods of time that may even be relatively long. As a consequence, our perceptions, thoughts and sensations, in a word, all our conscious activities, assume a distinct character that is specific to each kind of physiological or psychological state. When, for example, we feel "enthusiastic", all our movements, actions and thoughts seem to be driven by a force that comes from within us but that we cannot control, a force that pushes us to perform them and makes them easy to perform. This kind of influence on the organ of attention therefore gives a distinct form to all the conscious experiences we can have: thoughts, perceptions, images, memories, etc.

The second kind of influence affects not so much the organ of attention as the operations it performs. While the first kind of influence affects indirectly, yet pervasively, the operations of the organ of attention, the second kind pilots them directly, yet selectively. The first kind of influence is exerted on the organ of attention, and has a physical character; the second, on the operations of the organ of attention, and has a symbolic and procedural character. The first kind of influence modulates the global working of the organ of attention, whatever the operations it has to perform; on the contrary, the second kind specifies precisely what operations the organ of attention has to perform. While the first kind of influence gives a distinct form to all the conscious experiences we can have, irrespectively of whether they are thoughts, perceptions, images, memories, or something else, the second gives origin to specific thoughts, perceptions, images, memories, and so on. The second kind of influence can be brought about by all the automatisms, schemas, frames or unconscious procedures that we have acquired and learnt during our life, and that help us perform complex activities such as speaking, driving, playing games, doing specific work, achieving goals, and so on. This kind of influence is also exerted by all those mental or psychological elements that are not innate, but subjectively or culturally acquired, determined, and usually structured and organized in fields or networks, such as concepts, memories, representations, motivations, expectations, interests and aspirations.

Let us now make some additional considerations about the first kind of experience, which is induced on the organ of attention by the pervasive and unselective influence of the physical substrate of the body and the activity of the other organs.

Due to the close interconnection of all the organs of our body, practically any of these can directly and indirectly affect the organ of attention, even though certain organs seem to have been selected through evolution as a specialized means of modulating brain activities in general: an example is given by the organs that secrete hormones, neurotransmitters and neuromodulators.

A specific kind of conscious (and unconscious and non-conscious) experiences are those elicited by, or somehow linked to, the consumption of the energy level of the organ of attention. The consumption may be induced by various causes, such as stress, physical activity, lack of food, mental activity, etc., and produces some important phenomena such as sleep and time sensations.

Everyday we experience feeling physically and mentally exhausted, not being able to do any kind of activity any longer, and the consequent necessity to rest and sleep. Sleep is the principal means our organism has of recovering lost energy. Since dreamless sleep is characterized by the fact that, while some vital functions of our organism continue to be performed, we cannot exert any control over our attention, and we have no conscious activity or experience whatsoever, one can infer that one of the most important kinds of energy that has to be restored is that necessary for the organ of attention to work. According to La Berge, "the major 'computational' goal of resting sleep appears to be the blocking of sensory information from reaching the cortex and the prevention of information processing within and between cortical areas" (La Berge 1995, p. 185). The brain would achieve this goal through a dramatic shift of activity of the thalamocortical circuitry, which is one of the main organs responsible for attentional activity, from a regular-spiking mode to a burst-firing mode.

A very special kind of conscious activity we have during sleep is dreaming. Dreaming is the product of the combination of two different kinds of conscious experience: those determined by the direct application of attention to our memory system, and those elicited by the influence exerted on the organ of attention by the other organs and the physical substrate. Indeed, dreams are made of sensory conscious experiences: we see, hear, smell, touch, etc., which makes us feel active, participate directly in our experience; but dreams are also made of a part that does not depend on our will: they proceed independently of our decisions, they go on even if you do not want them to. As Paul Valéry observed (I translate from the Italian version): "When one dreams, one cannot choose" (Valéry 1973b, p. 144).

An important conscious experience connected with the consumption of energy of the organ of attention is that of time. As I will extensively show in the next chapter, the conscious experience of time is elicited by the continuous and incremental application of a portion of our attention to the conscious product of the activity performed by means of another portion of our attention: this in my view requires the support of some other organs such as working memory. In this sense, the classification of the sensation of time proves to be quite problematic, because it could also be classified under the next category, that is, as a conscious experience resulting from the operations performed by the other organs on the products of the activity performed by the organ of attention.

On the basis of the conscious experiences determined by the direct application of attention to the other organs, and by the direct or indirect influence on the organ of attention of the other organs and the physical substrate of the body, it is possible to build the forms of conscious experiences that will be analyzed in the following two sections. These latter forms are more elaborated than the former, and their formation requires the intervention of self-consciousness.

6.2.3. Conscious Experiences Resulting from Operations, Performed by other Organs, on the Products of the Activity of the Organ of Attention

This kind of conscious experience arises when the products of the activity performed by the organ of attention - that is, other conscious experiences - are combined, used to form other mental constructs, or further worked out thanks to the activity performed by one or more other organs. We all commonly experience, for instance, the possibility of comparing things: we can see and say that a given person is "taller" than another, or that a given food is "saltier" than another. This possibility has even been grammatically formalized in our languages by means of the comparative forms. We do not know how it works: we simply look at things, or

consider them, and find that we are able to say: "A is more interesting than B", or "A is more beautiful than B". We are conscious of the starting situation ("A" and "B") and of the final situation ("A is more interesting than B"), but we are not aware of the mechanisms that allow us to get from the former to the latter. We can therefore only formulate some hypothesizes about what these mechanisms are and what kind of operations they perform. One can assume, for example, that in order to perform a comparison there must be at least a memory system that stores the conscious information concerning the term of comparison ("B"), and a mechanism that measures the thing to be compared ("A") against the term of comparison. The important thing to know however is that, whatever these non-conscious mechanisms are, they are nevertheless necessary to make a comparison between A and B, and that attention alone is not sufficient: without these non-conscious mechanisms we will never be conscious of the differences between A and B.

Many kinds of operations can be performed on the products of the activity of the organ of attention, and consequently many kinds of conscious results can be obtained. We can perform some quite abstract operations, such as: refer a thing, object or event, say A, to another, say B; evaluate A on the basis of B; integrate a sequence of attentional operations, say A, B, into a new single item, say C, a phenomenon known in psychology as *chunking* (Miller, 1956); abstract what is common to A and B, thus getting a new superordinate category, say α; add A to B; subtract A from B; multiply A by B; divide A by B. But we can also perform additional concrete, perceptible operations, such as: turn a pure mental construct, such as a meaning, into a mental image or a perceptible representation; elicit ideas, representation, emotions, desires, etc. from a given conscious experience by means of free association; imagine something that has not yet occurred, or mentally represent how a given situation could evolve, what form a certain object will assume (an experience that has been tested and analyzed by psychologists in various ways: see, for instance, the experiment on the mental rotation of a three-dimensional object reported by Shepard and Metzler 1971); and so on. Undoubtedly, the production of such images or representations requires a mechanism that can combine and work out the perceptive material stored in memory. These kinds of representations or images must not be confused with the representations or images we get by simply focusing our attention on our memory system, that is, with the first of the four kinds of conscious experiences we are describing, those determined by the direct application of attention to the other organs. While the representations we get by focusing our attention on our memory system *reproduce* in a simplified way something we have already experienced, the representations we get by elaborating and further working out the perceptive material stored in our memory system *produce* something new, allowing us to anticipate future events and even what we might never have seen before: a difference that is well-known to psychologists (see, for instance, Denis 1991).

All the operations that are performed on the products of the activity of the organ of attention by one or more other organs are identified and designated by the words "to think", "thinking" and "thought". Not all authors share this opinion however. For Ceccato and Zonta (1980) these words refer only and specifically to that kind of activity, or to the results of such a kind of activity, by means of which we mentally connect things – whether they are meanings, images, ideas, thoughts or feelings - relating one thing or group of things to another. Ceccato and Zonta conceive thought as being a correlational or combinatorial activity that allows us to relate or connect a given mental construct A with a mental construct B via a certain kind of relation C. Undoubtedly, in most of the cases, when we think we

correlate things to each other, and we do this for many purposes: to measure the distance between things, to assess their mutual size or quality, to infer one from the other, to establish a causal relationship between them, to combine them, to separate them, etc. Many kinds of relationships can then be established between things: causal ("A is due to B", "Because of A, B lost his job"), spatial ("B stayed in front of A"), temporal ("A arrived before B"), logical ("If A, then B"), physical, psychological, aesthetical, and so on. Considering that correlational thought play a predominant and import role in our everyday life, and that the manifold diversity and variety of relationships that can be set between things is reducible to a general, basic form of activity - the correlational one -, it is easily understandable why one can be led to suppose that thought has this very specific form.

However, in my opinion Ceccato and Zonta's definition of thought and thinking as a purely combinatorial or correlational activity seems to be too limited: it does not cover all the various and different instances of thought experience. This is due to several reasons.

Firstly, we use the words "thoughts" and "to think" to indicate some other kind of mental activity that can hardly be conceived of as a combinatorial or correlational one. Sometimes the verb "to think" is synonymous with "calling to mind", "remembering" or "directing one's attention to something" as in: "He thought of his father"; sometimes it is synonymous with "occupying one's mind with something" as in: "I can't stop thinking about her". In all these there is no correlational activity at all, or there is not necessarily correlational activity: we call to mind a thing, direct our attention toward a thing, have in mind and cannot free ourselves of a thing, but do not (necessarily) correlate that thing to, or combine it with, something else. What our attention is doing is moving toward a thing, or trying to escape from it, but not relating it to something else.

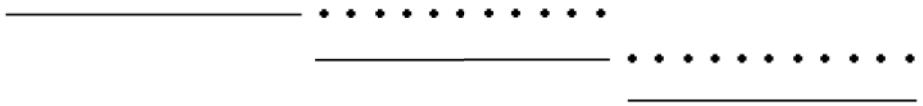
Secondly, it does not account for some instances of visuo-spatial thought. When we think, for example, about a flower as it opens, an image that is usually shown in naturalistic documentaries, or how clouds change their shape, we are not relating things to each other: we are simply applying a certain transformational rule to the object of our thought (the flower, the cloud). We do not relate the flower (or the cloud) at time T_1 to the flower (or the cloud) at time T_2. We do not segment our experience into parts that we combine by means of a conscious relation; on the contrary, our experience acquires a sense of uninterrupted continuity.

Thirdly, although it describes how two things can be combined, it does not account for the possible result of the combination. When we add 2 and 3, we get 5. The correlational conception of thought describes how it is possible to relate a certain thing to another thing, but it does not show either that a given specific relation can produce a certain result, or how that given specific relation produces that result. It describes how 2 can be combined with 3, but it does not show either that this combination makes 5, or how the combination makes 5. The correlational conception of thought specifies what position the mental constructs occupy in the correlation and the sequence in which they occur. It does not consider the propulsive, driving and pushing forward aspect of thought, that is, the fact that a correlation of things, but even one single thing, can produce, cause, recall, evoke, and summon up another thing. While it provides a description of the way the various mental elements follow one another in the correlation, it does not provide a description of how the combination of these various elements produces, or can produce, a certain effect, consequence, outcome, etc.

Furthermore, Ceccato and Zonta's account of the correlational activity of thought raises two difficulties.

Firstly, their hypothesis (which derived most probably from the belief that all instances of thought can be reduced to the general, basic form of correlation) of the existence of a specific organ of thought having the specific function of correlating mental elements seems highly implausible. Ceccato and Zonta (1980, pp. 62-63) state that (I translate into English):

> If we want to give an organ to thought, we can imagine it as a combiner of micro-units. The minimum combination is made up of three units and these always differ from each other because of the different moments they occupy while producing the flow of thought. In this way each one is characterized, even if by no other particularity, by this moment assigned to it by the combiner. Here are the three moments. The first thing is kept present as the second is added, which in turn is kept present as the third is added, which then takes the place of the preceding one. Here are the times represented in a diagram:



> where the dotted line represents the maintaining of the unit in such a way that it is partly concurrent with the others. (...) But to make things clearer let's adopt what could be a less correct but more immediate, topological, diagram in which the unit present together with the other two occupies the upper box, and the other two the lower box, of half the length:

> A second particularity of this triadic combination is that the unit present with the other two, and therefore straddling them, is always made up of a relationship between the two as a result of attention (…) The following names have been adopted for the three units which make up a correlation – that is, the minimum unit of thought: *correlator* for the unit straddling the other two; 1st *correlatum* for the first unit present; 2nd *correlatum* for the second unit present.

Undoubtedly, Ceccato and Zonta supply here a general description of the way correlational thought unfolds and develops in time which, in so far as it concerns the serial order in which the various mental elements follow one another, seems to be quite plausible. However, there are cases in which this description does not hold. Sackur and Dehaene (2009) report some experiments in which participants were required to add (or subtract) two to a stimulus number (either two, four, six or eight), and then compare the result with five. They found evidence for an approximately sequential processing, but with an important qualification: the second operation (comparison) appears to start before completion of the first operation (addition/subtraction), in that initially it takes as input the stimulus number rather

than the output of the first operation. As Sackur and Dehaene observe: "The second operation, which should wait until some information about the result of the arithmetic operation is available, actually starts ahead of time. (...) Therefore, seriality of the composition is defeated by a specific form of crosstalk. There seems to be a partially parallel execution of the two operations" (*ibid.*, p. 207)

Moreover, Ceccato and Zonta's proposal of the existence of a specific "organ of thought" is also quite questionable. Why should we resort to such an additional, specifically dedicated organ as the "organ of thought" to account for a function that can be also carried out thanks to the joint and coordinated action of some other organs that were originally designed to perform other, more basic functions? Why should nature have developed an extra, specific organ to perform a certain activity when that same activity could be performed equally well by the already existing organs? One should remember in these cases the dictum: *Natura non facit saltus.* As I have shown in my analyses (Marchetti 1993, 1994), in order to produce such "correlating elements" (Italian: "correlatori") as the conjunction "and", the "noun-adjective correlation" and "noun-verb correlation", you do not need a specific "organ of thought": you can produce these by means of more basic, primitive, multi-function organs, such as memory and a measurement or comparison system. Therefore, rather than proposing that an organ of thought is dedicated to a specific function, as Ceccato and Zonta did, it seems more sensible to opt for a solution of a system or set of different and distinct organs, each one devoted to performing a generic function, that can independently, when necessary, be used to originate and produce different kinds of "correlating elements", operators, and the like.

Secondly, Ceccato and Zonta's account of the thought process in terms of the overlapping of mental elements does not provide an adequate explanation of the phenomenon. They do not clearly specify whether (i) this overlapping implies that the two mental elements are both consciously present, or (ii) that only one is conscious and the other is unconscious. In either case, however, their account is not satisfactory. Indeed,

(i) in the former case, the overlapping of simultaneous conscious elements conflicts with evidence from both what one can subjectively, personally experience and what laboratory research shows: it is not possible to be conscious of two different scenes, however complex they may be, or simultaneously think about two or more different things or have, or keep in mind two or more ideas, concepts, or meanings. Moreover, as shown by the PRP (Psychological Refractory Period) effect, central, post-perceptual stages of mental processing are subject to a single-channel bottleneck. When people try to concurrently select and produce two independent speeded responses (task 1 and task 2), central processing limitations arise: the decision-related stages of task 2 cannot commence until the corresponding stages in task 1 have been completed. The planning of one response delays the planning of another, even when the person attempts to produce both as fast as possible. This queuing arises when tasks involve post-perceptual processing such as the planning of actions, perceptual comparison, mental rotation, and memory retrieval. As Pashler observes: "It seems probable, therefore, that many operations that comprise thinking are limited to taking place one at a time" (Pashler 1998, p. 404) (below some threshold of processing demand, many *perceptual* elements can, on the contrary, be processed in parallel without evident capacity limits).

(ii) in the latter case, the fact that there are unconscious mental elements or operations that occur at the same time as the conscious ones, despite being highly plausible from a psychological point of view, does not represent *per se* an *explanation* of how they can interact, connect or relate, but only a likely, and to be ascertained, *description* of the phenomenon: indeed, this co-occurrence may be a simple and accessory consequence of a more basic process. Different and various unconscious mental operations can take place in our brain simultaneously, and they can occur at the same time as the conscious ones, but this does not necessarily imply a causal or actual relationship or link between them. Phenomena can co-occur without being, for this only reason, correlated.

Libet (2004) also stresses the importance of the overlapping of mental elements, but for another reason: it will avoid breaks in the stream of consciousness, and more precisely, in the stream of thoughts - the feeling of continuity in sensory experiences being assured by what he calls the mechanism of "automatic subjective referral" (Libet 2004, p. 113). Apart from the implausibility - which has been revealed by the PRP effect (Pashler 1998) - of the simultaneous occurrence of several different conscious non-sensory experiences and more in general postperceptual events, Libet's hypothesis seems untenable for another reason. If the feeling of continuity we experience in our stream of consciousness was to be determined only by the overlapping in time of conscious events, it would be impossible to explain why the gaps created by dreamless sleep, anesthesia or some other kind of interruption are not experienced directly as such, that is, as gaps of consciousness, but indirectly, as a conscious experience of having lost consciousness. As Evans observed (1970 p. 185): "It is only by inference that we know that we have been unconscious, or by being told of this by someone else. In a sense, therefore, consciousness does not record its own interruptions, but gives the impression of being unbroken, although it is not". No one can be conscious of being unconscious. The feeling of continuity is assured even when there is an actual temporary interruption, due to either sleep, anesthesia or some other reason, in our conscious life, that is, when it is absolutely impossible for an overlap of conscious events to occur.

Our subjective feeling of a smooth flow in a series of thoughts, and more in general of all the other kinds of mental elements, does not depend so much on the overlapping of such elements, as I tried to show in the previous chapter. It depends on a more complex and continuous interplay between "the schema of self" and the "perceptual system", which yields an uninterrupted sequence of single units of conscious perception secured by the fact that the previous units play a direct, causal role in the production of the following ones.

Apart from the specific difficulties raised by the description of thought in terms of an overlapping of mental elements, the definition of thought as a purely correlational activity is, in any case, too restrictive. Correlational thought is certainly an important kind of thought, probably the most important, and can certainly be described in a very general way, but it is just one kind of thought. By defining thought only as a correlational activity, Ceccato and Zonta seem to have made the same mistake they attribute to other authors (Ceccato and Zonta 1980, p. 68): that of confusing a specific kind of thought with the general structure of thought, which is tantamount to defining music through, or as, one of its particular species, such as a sonata or a fugue.

In my view, correlational thought is a particular species of a more general class of conscious experiences: a class identified by, and composed of, the conscious experiences that arise when the product of the activity performed by the organ of attention (that is, an earlier conscious experience) is worked out by some other organ. We could represent this more general form of thought as follows:

$$op \rightarrow \mathbf{C} \Rightarrow \mathbf{C_1}$$

where C_1 represents the conscious experience that arises as a consequence (=>) of the operation (*op*) unconsciously performed (→) on an earlier conscious experience C. It is important to note that while the operation on C is performed by an unconscious mechanism (we do not know what kind of operations our mind performs when we add 2 and 3: the only thing we are aware of is that we get 5), the instruction to perform it may be either consciously given or unconsciously occasioned (we can deliberately decide to add 2 and 3; but a certain idea or sensation can come to our mind because of free association, without any deliberate input).

This way of representing thought accounts for and covers all the instances in which:

a) we perform any kind of operation on a conscious experience. When we "think of" someone, in the sense of directing our attention toward someone, we perform a certain operation *op* (direct our attention toward) on (→) someone (C); as a consequence (=>) we will have the image of that someone (C_1) in our mind. Likewise, when we "think about" a flower as it opens, we apply a certain transformational rule *op* (open) to (→) a flower (C); as a consequence (=>) we will imagine a flower opening (C_1);
b) we produce a conscious experience from an earlier one. When we evoke a sensation by means of free association with an image, we produce (=>) a given sensation (C_1) by operating on (→) an image (C) applying a certain association rule (*op*). When after seeing some dark clouds, we think that it will rain soon, we produce (=>) the idea that it will rain soon (C_1) by performing some kind of inferential operation (*op*) on (→) the perceived dark clouds (C). When adding 2 and 3 we get 5, we perform a certain operation *op* (add 3) on (→) 2 (C), having 5 (C_1) as a result (=>);
c) we relate things to each other. If, for instance, we want to compare someone (John) with someone else (his wife) to see who is taller, we perform a certain operation *op* (compare against John's wife) on (→) John (C) that will give as a result (=>) "taller" (C_1): which will be expressed by a sentence like: "John is taller than his wife". If we want to consider or analyze the consequences of smoking tobacco, we perform a certain operation *op* (analyze the consequences of smoking) on (→) tobacco (C) that will give as a result (=>) "cancer" (C_1): which will be expressed by a sentence like: "Smoking tobacco causes cancer" or "Smoking means cancer". If we want to describe who is with John, we perform a certain operation *op* (describe who is with) on (→) John (C) that will give as a result (=>) "Mary" (C_1): which will be expressed by a sentence "John is with Mary" or "John and Mary".

Obviously, the new conscious experience $\mathbf{C_1}$ (for instance "Cancer", in "Smoking tobacco causes cancer") can in turn be further operated on:

$$op \rightarrow \mathbf{C_1} \Rightarrow \mathbf{C_2}$$

giving rise to a new conscious experience $\mathbf{C_2}$ ("Stop smoking"), which can be operated on in turn. This opens the way to the possibility of forming long and articulated thoughts, and developing our thoughts along infinite, different lines, or towards infinite, different directions and dimensions. Most probably, just because of the relevance this possibility has for the cultural and scientific development of human society, human beings contrived and developed in their history dedicated linguistic and symbolic tools designating specific ways of operating on conscious experiences, producing new conscious experiences from earlier ones, and relating conscious experiences to each other. Conjunctions, prepositions, the subject-verb correlation, the noun-adjective correlation, mathematical and logical operators and the like have precisely these functions.

In this section we have analyzed at some length the operations that can be performed on the products of the activity of the organ of attention: these operations are generally designated by the words "to think" and "thought". We have seen that attention alone is not sufficient to perform such operations. Some other organs are needed, such as memory, a comparison system, and a representational system: they perform those unconscious operations on the products of the attentional activity that allow us to produce new conscious experiences from earlier ones, and relate conscious experiences to each other: in a word, to think.

6.2.4. Conscious Experiences Resulting from Activities that Are Triggered, Organized and Controlled by Earlier Conscious Mental Acts

This kind of conscious experience arises as a consequence of previous conscious mental states such as decisions, volitions, desires, intentions, plans, interests, motivations, aspirations, necessities, possibilities, and so on (from now on, for sake of brevity, I will call them "intentional states"): that is, mental states by which we purposefully deliberate to do things, move, work, think about things, imagine, perceive, etc. Even though this fourth kind of conscious experience may in some way resemble the first and the third kinds of conscious experiences described above, it actually differs from them. Indeed, while the first kind shows how we can consciously experience perceptions, images and memories, and the third kind how we can consciously experience thoughts and elaborate representations, this fourth kind shows how we can consciously *decide, will, intend, plan, etc*. to consciously perceive, represent, remember, and think. Moreover, it also encompasses all those cases that are not comprised by the other two kinds of conscious experiences, that is, all the occurrences in which we put into action plans, ideas or intentions that do not have as their primary goal that of eliciting sensations, images and memories, or of further mentally working out previously produced mental constructs, but something else: for instance, performing physical actions such as walking, sitting, moving hands, arms, etc.

Apart from the conscious experiences, explicitly triggered by an intentional act, that can be classified under the three classes we have previously seen (such as, for example, the experience of "eating something", which I can have after having "decided to eat something"), intentional states give rise to two kinds of conscious experiences. These two kinds are a sort

of by-product of the act performed intentionally: they are not intentionally and explicitly produced, but nonetheless they accompany almost every intentional act:

1. The first kind is represented by all those conscious experiences - physical sensations, emotions, feelings, thoughts, ideas, etc. – that unavoidably accompany, follow on, and are strictly relevant to, the specific activity triggered by the intentional state. If we decide to stand up and walk, for instance, we will have not only the experience of standing up and walking, but also some other accessory, unwanted and unexpected experiences: we will see things from a different perspective, we will feel more tired than before, or perhaps we will have a temporary sense of dizziness.
2. The second kind is represented by those conscious experiences that still more indirectly, yet in a more profound and fundamental way than the second, qualify the activity triggered by the intentional state. In fact, these conscious experiences make us aware of the fact that, by means of our conscious activity, we can govern and exert a voluntary control over our own actions, affect the course of our own actions, set our own aims and objectives, and choose what to do next: in a word, become self-conscious. The recurring and frequent experience that a given intentional state, for instance the intention to stand up and walk, has, or has not, produced the desired effect or course of actions, makes us aware of the fact that "if we want to stand up and walk, we can" or that "we are able to stand up and walk". Usually, this kind of self-awareness is expressed by means of the auxiliary verbs "may", "can", "must", "need", "shall", and "will", or by means of verbs such as "to want", "to have to", "to be able", "to choose", and "to intend". These conscious experiences can then be considered as a kind of *meta-conscious experiences*.

These two kinds of conscious experiences, despite being prompted by a previous operating of the organ of attention, cannot arise and take place without the involvement of some other different organ. Without, for instance, the musculoskeletal system, we could never perform those physical actions we want or have to do, and therefore we could never experience the causal link between our decision to perform a given action and the performance of that very action. Likewise, without the "schema of self" we could never attain self-consciousness.

It is important to note, however, that the involvement of organs other than the organ of attention, such as the "schema of self", while being necessary for the production of conscious experiences typically associated with self-consciousness - that is, those that are usually expressed by means of verbs such as "may", "can", "must", "need", "shall", "will", "to want", "to have to", "to be able", "to choose", and "to intend" – is not sufficient. Indeed, the conscious experience of volition differs from one of duty, or possibility, despite the fact that both share the necessity, in order to occur, to involve organs other than the organ of attention: when we say: "I want to work", we express a conscious experience that is quite different from what we express when we say: "I have to work", or "I can work". What is it that makes them differ? What is it that characterizes a conscious experience of volition as such? A conscious experience of volition is built on the same structure on which a conscious experience of duty, or of any other intentional state is based: a certain intentional state causes a certain action.

What differs between these various conscious experiences is the different stress that each lays on the intentional state prompting the action and the action it prompts. These differences in stress can only be determined by the activity of the organ of attention: they cannot be ascribed to any other organ.

Table 3.

Italian	French	English	German	The intentional state prompting the action	The actual action prompted by the intentional state
Potere	Pouvoir	Can, To be able to	Können		The actual action depends solely on the subject's capacity
		May, Might	Dürfen		The actual action depends on the permission given to the subject
Volere	Vouloir	To want	Wollen	The act of triggering the intentional state depends on the subject	
		Would like	Mögen	The action depends on the subject's intentional state	
Dovere	Devoir	Must, To have to	Müssen	The act of triggering the intentional state does not depend on the subject but on an external authority/obligation	
		Shall, should, ought to	Sollen	The act of triggering the intentional state does not depend on the subject but on an external advice/convention	

Let's analyze some of these conscious experiences more in detail, trying to identify what implications they have for our attention: how does each of them pilot our attention? What does each of them draw our attention to? Let's start with a "neutral" situation, where no intentional state is implied, for instance: "I open my hand". Now compare this situation with one where our action is guided or prompted by an intentional state, such as: "I can open my hand". We immediately feel a difference. Let's try to describe this difference in attentional terms: where does our attention go? What does our attention do? The use of "can" implies a specific stress on the action prompted by the intentional state: it underlines the fact that we have no problem in opening our hand, if we desire to do that. Now let's try with a different kind of intentional state: "I want to open my hand". The attention brought here is not so much

on the action prompted by the intentional state, as on the intentional state itself: the verb "want" specifies that we have no problem in mentally triggering or activating our intentional state because the act of triggering or activating it depends completely on us (but it does not specify whether the action can be as easily prompted: indeed, one thing is to want to do something, quite another to be able to do what one wants to). Also the sentence: "I must open my hand" focuses our attention primarily on the intentional state: it does not state anything about our actual capacity to perform the action. However, unlike "to want", "must" underlines that the intentional state, and its activation, depends not so much on us as on someone or something else.

We can also extend this analysis to other verbs and languages. Table 3 shows some of my tentative, coarse comparative analyses between the main English, German, French and Italian verbs expressing volition, duty and capacity. If we divide the common structure on which these kinds of conscious experiences are based into its two main parts, that is: a) the intentional state prompting the action (what one intends to, wants to, desires to, can, must, etc. do), and b) the action that is actually prompted by the intentional state (what one actually does as a consequence of one's desires, intentions, necessities, etc. to do), we can easily specify toward which part each specific conscious experience draws our attention, and for what purpose.

6.3. A Classification of Non-Attentional Operations Supporting the Production of Conscious Experiences

The classification of the conscious experiences, produced by the joint activity of the organ of attention (and the activity it performs) and the other organs, that I have sketched in the previous sections, allows us to identify four main kinds of unconscious and non-conscious operations:

1. those performed by the sense organs, the propriocetive system and memory that elicit most of the physical sensations and perceptions we have (tactile, visual, auditory, olfactory, gustative, proprioceptive);
2. a) those performed by the interoceptive system, the internal milieu and viscera, nociceptors, and all those substances (such as hormones, neurotransmitters, neuromodulators) that elicit physiological states such as pain, pleasure, thirst, hunger and tiredness, and psychological states such as emotions, moods, and impulses.
   b) those represented by all the automatisms, schemas, frames and unconscious processes that we have acquired and learnt during our life and that help us perform complex activities such as speaking, driving and playing games;
3. those performed by organs such as memory, comparison systems and representational systems that allow us to combine our conscious experiences in various ways and to relate conscious experiences to each other: simply put, to think;
4. those performed by organs such as the schema of self that allow us to intentionally plan and perform actions and activities, and to have those conscious experiences that are associated with self-consciousness: that is, those that make us aware of the fact that, by means of our conscious activity, we can govern and exert a voluntary control

over our own actions, affect the course of our own actions, set our own aims and objectives, and choose what to do next.

The identification of these unconscious and non-conscious operations is essential for an exhaustive analysis and description of the elementary attentional operations that compose the meanings of words, and the way these attentional operations are combined. Without them it would be practically impossible to account for the different ways attentional operations take place, can be combined and related, give rise to other conscious states, can be modulated and controlled by earlier conscious states. They represent the necessary complement and counterpart of attentional operations in the construction of most of, if not all, meanings (and more generally of all conscious experiences).

6.4. A Classification of Words Based on Non-attentional Operations

The classification I have proposed helps us classify words in relation to the kind of unconscious and non-conscious operations we have to resort to when analyzing their meanings. By using such a classification, we can classify words according to whether they refer to conscious experiences of:

1. exteroceptive and proprioceptive sensations, such as colors, sounds, tastes, smells and movements; sensations related to space; physical objects, beings, events and activities;
2. a) interoceptive sensations, such as thirst, hunger, tiredness and sexual desire; sensations of pain, pleasure and time; innate psychological states and activities, such as emotions, feelings, moods;
   b) culturally acquired psychological states and activities, such as motivations, expectations, interests and aspirations; complex activities which, in order to be performed, require learnt schemas, frames, and automatisms;
3. thought activity and the products of such activity, such as conjunctions, prepositions, relative pronouns, the name-adjective correlation, the subject-verb correlation, logical and mathematical operators, articles, singular and plural forms, indefinite adjectives and pronouns, abstract nouns, verbs referring to abstract actions, etc., that is, most of what Ceccato (1969) has defined as "mental categories" (see also Benedetti 2001, 2005, 2009); or:
4. meta-mental activities, usually identified by verbs such as "may", "can", "must", "need", "shall", and "will", "to want", "to have to", "to be able", "to chose", "to plan", and "to intend".

This list is not exhaustive – many words cannot be exactly classified in this list, because the are the combination of different kinds of unconscious and non-conscious operations – and should only be considered as a first approximate attempt at classifying words according to the kind of unconscious and non-conscious operations that are involved. I think it represents however a good basis for future research work and analyses on the meanings of words.

Table 4 summarizes the classification of the possible interactions between the organ of attention (and the activity it performs) and the other organs, of the relevant non-attentional

operations, and of the words referring to the conscious experiences resulting from such interactions.

Table 4. A classification of the possible interactions between the organ of attention (and the activity it performs) and the other organs; the relevant non-attentional operations; and of the words referring to the conscious experiences resulting from such interactions

Possible interactions between the organ of attention (and the activity it performs) and the other organs	Types of non-attentional operations supporting the production of conscious experiences	Classification of words based on the type of conscious experience they refer to, resulting from the interaction between the organ of attention and the other organs
Direct application of attention to the other organs	Operations performed by the sense organs, the propriocetive system and memory that elicit most of the physical sensations and perceptions we have (tactile, visual, auditory, olfactory, gustative, proprioceptive)	Words referring to exteroceptive and proprioceptive sensations, such as colors, sounds, tastes, smells and movements; sensations related to space; physical objects, beings, events and activities
Direct or indirect influence on the organ of attention of the other organs and the physical substrate of the body, independently of whether or not attention is applied to them	a) Operations performed by the interoceptive system, the internal milieu and viscera, nociceptors, and all those substances (such as hormones, neurotransmitters, neuromodulators) that elicit physiological states such as pain, pleasure, thirst, hunger and tiredness, and psychological states such as emotions, moods and impulses.	a) Words referring to interoceptive sensations, such as thirst, hunger, tiredness, and sexual desire; sensations of pain, pleasure and time; innate psychological states and activities, such as emotions, feelings and moods;
	b) Operations represented by all the automatisms, schemas, frames and unconscious processes that we have acquired and learnt during our life and that help us perform complex activities such as speaking, driving and playing games	b) Words referring to culturally acquired psychological states and activities, such as motivations, expectations, interests and aspirations; complex activities that, to be performed, require learnt schemas, frames and automatisms
Operations, performed by other organs, on the products of the activity of the organ of attention	Operations performed by organs such as memory, comparison systems and representational systems that allow us to combine our conscious experiences in various ways and to relate conscious experiences to each other	Words referring to thought activity and the products of such activity, such as conjunctions, prepositions, relative pronouns, the name-adjective correlation, the subject-verb correlation, logical and mathematical operators, articles, singular and plural forms, indefinite adjectives and pronouns, abstract nouns, verbs referring to abstract actions
Activities triggered, organized and controlled by earlier conscious mental acts	Operations performed by organs such as the schema of self that allow us to intentionally plan and perform actions and activities, and to have those conscious experiences that are associated with self-consciousness	Words referring to meta-mental activities, such as the verbs: “may”, “can”, “must”, “need”, “shall”, and “will”, “to want”, “to have to”, “to be able”, “to chose”, “to plan”, and “to intend”

7. The Methods and Techniques of Attentional Semantics

The main aim of Attentional Semantics is to give an exhaustive and complete account of the attentional operations that produce the meanings of words. Given the two main assumptions on which it is based – a) conscious experience is determined by attention: there cannot be consciousness without attention; b) words and language are tools to pilot attention - Attentional Semantics relies principally on two main different and subsequent levels or steps of analysis:

1) the identification of the elementary conscious experiences of the relations (between us and other entities, between us and ourselves, and between other entities themselves) that invariably are brought about by the use of words, and
2) the description of the attentional operations that produce such conscious experiences.

As we have seen, however, most of our conscious experience is due to the support of unconscious and non-conscious operations. Some of these unconscious and non-conscious operations, by modulating attention, have a direct impact on our conscious experience; some others bring to bear only indirectly on consciousness. Therefore, it would be rather difficult to explain how conscious experience occurs without resorting to such unconscious and non-conscious operations. Consequently, Attentional Semantics must also rely on a third important level of analysis:

3) the identification of unconscious and non-conscious operations, and the respective organs, that serve either as the support that makes it possible for attentional operations to take place and to be completed, or to occur in certain way, or as the necessary complement that makes it possible to execute and implement the activities determined and triggered by conscious experiences.

These three main steps, however, do not represent and include all the methods and techniques that have to, or can, be adopted to adequately analyze meanings in attentional terms. As Benedetti (2001) has shown in his work on mental categories, it is not only possible but also recommendable for researchers to adopt some other specific strategies and techniques capable of reducing the possibility that they make mistakes when analyzing meanings. Benedetti (2001) suggests adopting the following list of methods and techniques when dealing with words that designate mental categories:

- The first thing the researcher has to do is to ask himself: "What mental operations *can* I perform when I use a certain mental category?". This question has the advantage over similar questions (such as for example Ceccato's question: "What mental operation *do* I perform when I use a certain mental category?") of highlighting the limitations we undergo when using a mental category. Indeed, the use and application of a given mental category is highly constrained both by its own structure and by the situation to which it is applied. Not all mental categories can be applied indifferently to all situations. Certain mental categories can be used only in certain situations, and not in others: "when", for instance, can be applied only to

temporal situations, and not to spatial ones. Being aware of the limitations of the application of a given mental category represents the first important step towards understanding its structure. Indeed, if we know when the mental category can be applied and when it cannot, and if the physical situation where the mental category is used is known (a prerequisite satisfied by the fact that perception precedes, and is independent of, the use of mental categories), then we should have all the elements necessary to identify the structure of the mental category:

Known variables			*Unknown variable*
Physical situation +	Rules of applicability of the mental category	>	Structure of the mental category

The path from the two known variables – the physical situation and the applicability of the mental category – to the unknown one – the structure of the mental category – is the same for both the child who is learning to build his/her first mental categories and the researcher who has to identify the structures of the mental categories. There is a difference however between the child and the researcher: while the former, when learning words, is already able to perform the basic operations necessary to build mental categories, the latter has to get to identify the structures of mental categories by hypothesizing the kind and set of such basic operations.

- The second thing to do is to try to identify and make a list of the words that presumably correspond to those mental categories that have the simplest structure. In this way, on the one hand, we avoid neglecting all those mental categories we could occasionally not have thought of. On the other, we prevent philosophical tradition from influencing us: an influence that even Ceccato and Vaccarino, admitting that categories such as "object", "time" and "space" are more fundamental and simpler than others, could not always escape. Benedetti lists a series of criteria serving this purpose. According to him, the simplest mental categories are those designated by the words that:
  (a) children begin to use first;
  (b) are used very frequently in common language (prepositions, conjunctions, etc.);
  (c) have a general meaning, and can substitute words having a similar but more specific meaning. For instance, the Italian word "spazio" ("space"), which philosophical tradition considers a basic category, can be substituted by "posto" ("place") in many cases, much more than the former can substitute the latter. Consequently, contrary to what philosophical tradition maintains, "posto" seems to have a more general and basic meaning than "spazio";
  (d) we cannot do without when speaking;
  (e) are not composed of other words;
  (f) appeared in the remotest time.

  Benedetti proposes dictionaries and grammar books as possible sources from which one could draw the list of the mental categories having the simplest structure (permit me to also include the lists of children's first words). To these, however, he prefers another one, the set of stems and roots of the Indo-European language,

because, affording the minimum number of words that satisfy most of the criteria defining structural simplicity, it does not present the same problems as the other two.

- The real analytical work consists in using the mental category to be analyzed in different contexts - or, conversely, in keeping the same context while changing mental categories - and identifying what remains constant and what changes. If we want to analyze, for instance, the word "in", we will compare its use in clauses or phrases such as: "sitting in an armchair", "the key in the lock", "to be in love", etc., and will try to identify what these different situations share. This method was widely used by Ceccato (Ceccato & Zonta 1980). Benedetti suggests that in using it the researcher should take the precautions of limiting the examples to physical situations, and of excluding the figurative and extended use of the terms: in such a way, the researcher will avoid dealing with more than one unknown factor at a time.
- Another important analytical strategy consists in comparing the word to be analyzed with its synonyms (and conversely, with its antonyms): the comparison can indeed reveal the differences and similarities between the former and the latter.
- A very important support for the analysis of words comes from etymology. It helps corroborate or refute analyses in that it allows the researcher:
  (a) to understand if two or more words have a common root, and hence a common structure;
  (b) to recognize if a word results from the composition of two or more words;
  (c) to ascertain how old the word is, and hence how simple its structure is.
- Another important source of evidence that can confirm or disprove the analyses is represented by the study of gestures accompanying speech. Gestures are fundamental in language learning: when speaking and teaching words to children, adults tend to accompany their speech with them. They serve as a primordial and privileged tool for piloting the attention of other human beings: they share this function with words, and this is why analyzing them can help to understand the attentional structure of mental categories.

By adopting these methods and techniques, Benedetti (2001) has unmasked some of the main analytical mistakes made by Ceccato and Vaccarino. It should be noted that the problem of determining which methodological principles and analytical techniques must be adopted when analyzing the meanings of words in attentional terms was only tangentially and incidentally tackled by those who firstly envisaged and theorized this possibility. Ceccato, for instance, principally relied on the general ability of researchers to slow down their mental activity, and to analyze and describe their mental operations while performing them. He also proposed some specific techniques to analyze the meaning of words, such as using the same word in different linguistic contexts, comparing different situations and describing what changes and what remains constant (if we want to analyze, for instance, the meaning of the word "at", we will compare phrases or sentences where the word "at" is held constant while the context changes, such as "at home", "at night", "at first", and so on); or, describing the same identical physical situation by using different words, or different physical situations by using the same word, and analyzing what changes and what remains unchanged. However, he was not worried about verifying and systematizing such methods and techniques as much as he was about developing his model of mental activity, performing analyses, and applying his

findings in various and different fields (automatic translation, pedagogy, aesthetics, etc.). Vaccarino (1981, 1997, 2000), on the contrary, is undoubtedly more rigorous than Ceccato as far as the systematic nature of the work is concerned. He has built a well-structured analytical system based on few assumptions, whose organization itself should represent – according to him - the guarantee of the correctness of the analyses. This very organization, however, while representing the only kind of constraint researchers should satisfy, can bias their work to the point of making them overlook or neglect other equally important factors, and consider meanings as abstract entities completely separated from the phenomenal dimension in which they are originally used and experienced. Consequently, their analyses can be greatly prejudiced.

A very important support for the analysis of words can also be provided by the experimental methods and techniques of empirical psychology, psycholinguistics, and neurobiology (see for example Gonzales-Marquez et al. 2007), and more in general by all the experimental findings on the conscious experiences related to the analyzed words.

However, it must be said that, in general, methods and techniques do not represent *per se* a guarantee of the absolute correctness and validity of the results of the analyses. Methods and techniques are founded on, and by theories: theories devise and use methods and techniques to produce and measure phenomena and data that are identified and predicted by the theories themselves (on a detailed discussion of this topic, see Guerra 1997). Methods and techniques do not and *cannot* guarantee the scientific nature and validity of the data they reveal: they can only minimize the possibility of researchers making mistakes *within* the framework set up by theories. It is up to theories to provide sound, valid, non-contradictory frameworks.

In the field of neurobiological studies of language, for example, this fact was acknowledged by Pulvermüller who, referring to the difficulty of modern neurobiological techniques in localizing the cortical areas involved in semantic processing, observed that this shortcoming of cognitive neuroscience is probably partly due to the lack of an adequate theoretical apparatus: "In spite of the undeniable progress made possible by empirical results obtained with newly introduced techniques, it is likely that theoretical advances are necessary as well" (Pulvermüller, 2002, p. 47).

Moreover, in order to allow researchers to perform empirical research, the theoretical apparatus must be such that the analyses carried out within its framework can be empirically tested. I therefore think that the semantics - such as Ceccato and Zonta's (1980), Benedetti's (2005, 2006, 2008, 2009) Operational Semantics, and Attentional Semantics – that analyze the meanings of words in terms of attentional (and non-attentional) operations have a tremendous advantage over the other kinds of semantics: that of adopting a vocabulary that shares some important common terms with empirical sciences – primarily, the concept of "operation". By means of the concept of "operation" researchers can capture, on the one hand, the activity the mind performs when producing conscious mental phenomena, and, on the other hand, the physical brain activity that is necessary to support mental activity. Importantly, the link between the activity of the mind and the activity of the brain can be captured at and for different levels of complexity of operations.

An example of how empirical research could be carried out using the findings of Attentional Semantics and Operational Semantics is represented by Benedetti et al.'s (in press) proposal. The proposal is based on the putative correspondence between the operations identified, by Attentional Semantics and Operational Semantics, on the one hand, and by

Fingelkurts and Fingelkurts' (2001, 2005, 2006) Operational Architectonics, on the other. Operational Architectonics, which is based on the joint analysis of cognitive and electromagnetic (EEG and MEG) data, identifies a hierarchy of brain operations of increasing complexity: functional neuronal assemblies, single metastable brain states or Operational Modules, complex Operational Modules, very complex Operational Modules. Operational Architectonics holds that each level of the hierarchy supports mental operations of a different complexity. The first experiments aim at relating the hierarchy of the brain operations identified by Operational Architectonics to the hierarchy of operations identified by Attentional Semantics and Operational Semantics (elemental mental operations, mental categories, correlational network). Once the relation is established, further experiments can be carried out to verify the semantic analyses performed by Attentional Semantics and Operational Semantics.

8. Research Programs with the Aim of Systematically Analyzing Meanings in Attentional Terms

We have seen in the preceding paragraphs that the idea of analyzing the meanings of words in terms of attentional operations was originally proposed and developed by Silvio Ceccato, and systematically pursued and applied by Giuseppe Vaccarino. The idea has since been amply revised, reformulated and improved by the proposals of Attentional Semantics and by Giulio Benedetti's (2005, 2006, 2008, 2009) Operational Semantics. It should be noted that Operational Semantics and Attentional Semantics share most of their theoretical foundations and analytical methods, as well as many of the semantic analyses performed so far. They have a different view of the possibility of accounting for what Ramachandran & Hirstein (1997) call strong, vivid qualia, such as percepts: Operational Semantics, not being explicitly based on a theory of consciousness, is not intended to account for the meanings of words referring to vivid qualia, but only for the meanings of the grammaticized elements of language, such as prepositions, conjunctions, interrogative-indefinite-relative pronouns and adjectives, demonstrative adjectives and pronouns, numerals, grammatical verbs like "to be", "to have", "can", morphemes, adverbs; on the contrary, Attentional Semantics is intended to analyze the meanings of all words, including those referring to vivid qualia.

Are there, or have there been, other kinds of semantics or research programs that have set themselves the aim of systematically analyzing the meanings of words and sentences in attentional terms? To my knowledge, there is at least another research program that has so far expressed an objective similar to, even if with important distinctions from, Attentional Semantics: Todd Oakley's (2004, 2009). Moreover, I think that Leonard Talmy's (2000a, 2000b, 2007b) work, despite not being explicitly devoted to this aim, also deserves to be carefully considered because of the implications it bears on the study of language in attentional terms, the promising direction it has recently taken, and the richness and quality of its proposals and analyses.

In the following sections I will briefly present and analyze their work: when analyzing Oakley's work, I will mainly refer to (Oakley 2004); the pages of the quotations of Talmy's (2000a and 2000b) work refer to the paperback edition of 2003.

8.1. Todd Oakley's Work

Todd Oakley's (2004) main concern is that of offering a model of attention as a heuristic for forming and mapping out a dynamic theory of meaning: which shows indeed a significant resemblance to the objective of Attentional Semantics. The conceptual and theoretical background from which Oakley's work stems is patently not the same as that for Attentional Semantics. In fact, Oakley's work originates mainly from the tradition of cognitive studies, especially those which consider human cognition as situated, embodied, and perceptual (just to mention the more representative authors: Lawrence Barsalou, Gilles Fauconnier, James Gibson, Mark Johnson, George Lakoff, Ronald Langacker, Michael Tomasello, Mark Turner). Moreover, Oakley's work does not bear any sign of even the slightest influence of the thought of Silvio Ceccato or Giuseppe Vaccarino. This fact is very significant because it shows how it is possible for different people of different countries and in different cultural contexts to reach the same conclusion while starting from different and independent premises. Indeed, while Ceccato and Vaccarino reached the idea that mental activity in general, and the meanings of words in particular, can be analyzed in attentional terms by passing through the hard work of criticism of the various philosophical theories of knowledge, none of their particular work of criticism is present in Oakley's research. Nor is Oakley's main intent to attack and criticize the philosophical theories of knowledge, though his Introduction he sketches a short criticism of the Scylla and Charybdis of theories of meaning, rationalism and radical relativism. Moreover, his criticism of rationalism and relativism leads him to take an abductive realistic position, which fits within the greater metaphysical tradition of naturalistic emergentism, that can hardly be said to coincide with the "operational" or "constructivist" solution envisaged by Ceccato's and Vaccarino's formulation (on the contrary, von Glasersfeld's "radical constructivism" can certainly be considered nearer to Oakley's position: see von Glasersfeld 1998). Indeed, while abductive realism commits to the position that "the world out there exists" and that "the structure of the perceptual world is already given to an observer in an unambiguous way, because organisms (including human beings) attune to environmental properties directly" (Oakley 2004, Introduction), Ceccato's operational solution neither poses any "existence of reality out there", nor takes the unambiguousness of the perceptual world for granted: on the contrary, it relies only on a human being's most important capacity to mentally construct the world he/she lives in.

Likewise, the main interpretive method that Oakley uses to perform his analyses – the "Mental Spaces and Blending Theory" originally developed by Fauconnier and Turner – has nothing to do with the methods contrived by the Italian researchers (Ceccato, Vaccarino, Benedetti and Marchetti). The models and methods worked out by the latter are primarily dedicated to the analysis of the meaning (or meanings, in case of homographs, metaphorical or derivative use, etc.) of the single word, in the belief that without such a preliminary and fundamental analysis it would be impossible to account for the way in which the linking together of words in a clause, sentence or discourse progressively gives rise to an evolving overall meaning. On the contrary, the Mental Spaces and Blending Theory seems to admit the possibility of analyzing the online, moment-by-moment construction of the meaning of the entire clause, discourse, or text as it unfolds in real time and in a given context, even if no previous analysis of the meanings of the single words composing the clause, discourse, or text has been performed.

Despite these differences in background and method, Oakley's view about the role played by attention in meaning construction closely resembles that of the Italian researchers. In his opinion: "a theory of attention stands as a prerequisite for building the theoretical framework of a cognitive semiotic: the study of the online construction of meaning as we stand, walk, sit, think, speak and listen, read and write, and otherwise apprehend, perceive, and muse *in* and *about* the world, *with*, and *about* ourselves and others" (Oakley 2004, Introduction). And again: "a theory of attention is the most appropriate metatheory for developing a theory of meaning" (*ibid.*, Introduction).

Such a view of the role of attention necessarily leads Oakley to design a model of attention capable of accounting for how human beings construct meanings. Oakley identifies six components of attention that "may count as the basic cognitive scaffolding of complete semiotic theory" (*ibid.*, Chapter I): *alerting, orienting, selecting, sustaining (focusing), controlling (switching & dividing)* (Oakley has recently reviewed his system, identifying eight components of attention: alerting, orienting, detecting, sustaining, controlling, sharing, harmonizing and directing: see Oakley, 2009). According to him, meaning construction can be explained by means of these six fundamental processes. They represent the necessary conditions for the construction of meaning (as well as for the execution of other cognitive processes, such as perception, conceptualization, consciousness, memory, learning, social interaction), even though they are not sufficient because they are determined by memory, categorization, valuation and emotion. They are the building blocks on which he founds his analyses of the acts of meaning construction that occur verbally, non-verbally and communally.

Oakley's analyses generally differ from those of the Italian researchers, both in method and kinds of case studies. On some rare occasions, however, he comes very close to the Italian style of research. In Chapter III (Oakley 2004), for instance, while comparing the phrases:

(a) …now just a click away
and
(b) …now only a click away,

he analyzes the adverbs *just* and *only*:

> These adverbs focus attention on complementary aspects of the process associated with getting what you want: the adverb *just* focuses on the manner or duration of execution; the adverb *only* focuses on the number of executions required. *Just* construes perspective as internal to the event of clicking, (…) whereas *only* construes an external perspective of iterative instances of clicking and the fact that only one instance is necessary as opposed to many. *Just* profiles short duration while *only* profiles the number of sequenced steps required of the computer user.

Another example is represented by the analyses of the nominal:

(c) just a click away
and the verbal
(d) click your way.

The nominal (c):

> focuses attention on the endpoint. (…) The mental simulation is construed statically as plotting a course from one fixed location to another and assessing its relative distance". On the other hand, the verbal (d): "focuses attention on the process of moving to the desired location. The mental simulation is construed dynamically so that the person doing the pointing and clicking is creating her own path to a desired site rather than traversing an already plotted trajectory (*ibid.*, Chapter III).

In their informal, coarse, but nonetheless essential formulation, these analyses closely resemble some of the analyses performed by Italian researchers, above all those that are preparatory to a more accurate and formal formulation. Indeed, the research performed by the Italians is very often characterized by the fact i) of analyzing the meaning of each single word at a time, as opposed to the whole and complex meaning of a phrase, clause or sentence, and ii) of being based on the comparison of the analyzed word with other words by alternating the former with the latter in the same, or in a similar, phrase or clause. By changing the word, the phrase or clause assumes a different meaning. The researcher then tries to account for each different meaning of the phrase or clause by identifying which different mental operations (mainly attentional ones) the analyzed word implies (the opposite procedure is also sometimes used: the researcher uses the same word in different phrases or clauses, and tries to account for what remains unchanged through the different phrases or clauses by identifying which mental operations remain constant).

Even so, the kind of analysis just mentioned represents an exception in Oakley's work. In fact, he is mostly interested in analyzing case studies of texts operating in specific settings and contexts. This is due to the fact that he considers the influence of the context as decisive for meaning construction, and as prevailing over the basic meaning of each single word, even though he recognizes that "basic meanings are, for the most part, remarkably stable, and it is their stability that allows us to continuously generate new (enriched) meanings" (personal communication). As he observes, the situation in which meaning arises strongly contributes to determine it: the immediate environment, the interaction with other human beings and more in general the context, determine the mode of constructing meaning. In his view, it is therefore necessary to "construct an approach to meaning construction that would be at once semiotic, linguistic, and rhetorical in character" (*ibid.*, Introduction), that is, a method able to incorporate into its analyses the specific physical, social, cultural and contextual conditions of enunciation.

This necessity leads him to adopt Fauconnier and Turner's modelling device of the Mental Spaces and Blending Theory, because it affords: "a mechanism for grounding acts of meaning making in the immediate physical surroundings human beings invariably find themselves" (*ibid.*, Chapter II). A mental space is a dynamic, real-time enactment of a mental model activated to satisfy specific local purposes. It is phenomenologically characterized by a temporal window of two-three seconds (according to Oakley, this is the "rhythm of our lives", the interval out of which we live our lives, and which is necessary for us to become aware that an event has a particular quality). Mental spaces exist in networks: we are constantly building, elaborating, modifying and disintegrating networks of mental spaces. Meaning arises both within and among these dynamically connected entities. Mental space networks, once up and running, tend to produce and develop new integrated spaces called "blends",

which contain selected aspects of structure from each input space and an emergent structure of its own. Blends are the processes that account for human creativity. The Mental Space and Blending Theory "provides psychologically plausible constraints for semioticians to model the online construction of meaning" (*ibid.*, Chapter II).

How does Fauconnier and Turner's modelling device relate to a theory of attention? According to Oakley, the composition, development, integration, and erasure of mental spaces are attentional phenomena *par excellence* (*ibid.*, Chapter II). The blending process of composition, for instance, which involves attributing a relation from one mental space to an element or elements from another mental space, is the effect of selective attention. Similarly, the blending process of completion, which occurs when structure projected from the input spaces recruits conceptual structure from long-term memory, corresponds to sustained attention. The speaker produces mental spaces to bias and pilot the listener's attention. While producing and developing blends, mental spaces allocate "attention to specific tightly organized scenes for satisfying perceptual, conceptual, analogical, deductive, explanatory, deliberative, and emotional purposes" (*ibid.*, Chapter I).

In all his analyses, Oakley shows very clearly how the working of mental space networks pilots the reader's or listener's attention, moving it from one space to another, prompting the reader to shift his/her attention backward and forward, disengaging it from a scene, dividing it between two or more elements, or sustaining it appropriately on some feature for a certain time. An excerpt from Chapter V (Oakley 2004) concerning the analysis of a set of instructions for a fictitious detective who wants to learn to navigate a virtual reality program shows Oakley's typical way of investigating meaning construction:

> Close examination of lexical and grammatical structure reveals how the writer manages *to shift the reader's focus of attention* within the mental space network. The first six sentences keep the Reality space as the viewpoint while adding new structure to the Virtual space, *making it the focus of attention*. This is evidenced by the role of personal deixis (…). These forms establish the Reality space as the initial viewpoint from which new information from the other spaces is made accessible, *which effectively divides attention equally between* the Reality and the Virtual spaces, so the reader *can focus her attention on* the relationship between initial computer command and the subsequent screen event (the italics are mine).

Oakley's method of analyzing meaning certainly represents a first important step toward identifying the sequence of attentional operations that give birth to, and are necessary to understand, the unfolding and overall meaning of phrases, clause, sentences, and discourses: a method, however, that in my opinion needs further refinement with respect to its capacity to translate and describe in attentional operations what has previously been analyzed in terms of the Mental Spaces and Blending Theory. Despite giving, from the Mental Spaces and Blending Theory's point of view, a clear idea of how the overall meaning of a phrase or clause takes form, his descriptions of the working of attention seem to be too gross-grained and in need of additional refinement. The qualitative gap between the descriptions in Mental Spaces and Blending Theory terms and the descriptions in attentional terms is quite evident. While the use of the vocabulary and model of the Mental Spaces and Blending Theory gives rise to extensive, fine and reasonably exhaustive descriptions of the interplay of mental spaces, the use of the vocabulary of attention originates only limited and partial analyses. I believe this is mainly due to the fact that, compared to Oakley's vocabulary and model of

attention, the Mental Spaces vocabulary is more developed, articulated and structured. Consequently, the Mental Spaces vocabulary overwhelms the attentional one, both in frequency of use and effectiveness. The general impression, therefore, is that Oakley's attentional analyses are not only subsequent to Mental Spaces analyses, but also marginal and subsidiary with respect to them.

Oakley's intention is not only to develop a model of attention as a heuristic for forming and mapping out a dynamic theory of meaning, but also to "re-read" and "re-think" the disciplines charged with investigating the human construction of meaning: semiotics, linguistics and rhetoric. Oakley intends to perform such an operation on the basis of his theory of the six components of attention. As far as linguistics is concerned, for instance, he claims that "the six components provide the sensational, perceptual, and conceptual anchor of language" (*ibid.*, Chapter III). After having described the peripheral status of attention in the Generative linguistic tradition (Chomsky and Jackendoff), a tradition that viewed the knowledge of language as cognitively-encapsulated and separated from the outset from the other general cognitive processes (memory, attention, categorization, etc.), he presents an alternative paradigm of research: Cognitive Linguistics. Unlike Generative Linguistics, Cognitive Linguistic approaches (mainly represented by the works of Fauconnier, Lakoff, Langacker and Talmy) rally around the common theme that knowledge of language depends on other cognitive processes, attention included. Unlike Generative Linguistics, Cognitive Linguistics does not consider linguistic competence as a set of abstract, a priori rules that, with maturation, eventually link up with normal but peripheral cognitive processes. Rather, it considers linguistic knowledge as a system that is continually shaped by linguistic usage events constrained by general cognitive operations. The mastery of linguistic symbols implies linking them up with constructional schemas (moving, transferring, having, etc.) which themselves emerge from perceptual and interpersonal experience.

Oakley articulates a linguistics of attention that widely draws on the cognitive linguistic approaches:

> The guiding principle of this study is that linguistic knowledge *emerges* from and subsequently *exploits* other cognitive functions such as sensation and perception, categorization, memory and attention. (…) Language fits a brain already primed for shared attention, imitative learning and modelling devices manifest externally before manifest internally (*ibid.*, Chapter III)

Nonetheless, Oakley's linguistics of attention differs from most of the cognitive linguistic approaches for two main reasons.

The first reason is that his approach: "does not begin with structure but begins with models of interpersonal use (i.e., the sixth component of attention) or what Benveniste called *énonciation*" (*ibid.*, Chapter III). The adoption of Mental Spaces networks allows him to incorporate into his analysis the specific conditions of enunciation.

The second reason is that attention lies at the very core of Oakley's linguistic approach (and here again we can see how Oakley's position is very close to the position of the Italian researchers). He assumes that:

> language and attention are inextricably related and that the components of awareness and attention influence language structure and use in the same way they influence perception and

> sensation. Language, like perception, is a way of organizing what someone wants herself or others to pay attention to. Linguistic constructions are not just empty syntactic vessels, but instructions for making something stand out as a figure against a less differentiated ground (*ibid.*, Chapter III).

According to Oakley, the importance of attention for linguistic knowledge (and knowledge more in general) is obvious since the very beginning of the process of language acquisition. In fact, as Tomasello's work shows, shared attention between the subject and others forms the foundations of learning. Moreover, the lack of shared attentional strategies is what mainly distinguishes nonhuman primates from humans in their inability to develop structured and complex linguistic systems, and to transmit innovations and creations.

On the basis of his theory of the six components of attention, Oakley also sketches a taxonomy of the parts of speech. Selective attention, for instance, explains the use of proper nouns, common nouns, indefinite articles, deixis of place and time, verbs and other linguistic structures (e.g., adverbial and prepositional phrases): they "are typical elements of linguistic construction designed to select entities, objects, and relations for further processing". Sustained attention, on the other hand, explains the existence of pronouns, reflexive pronouns, appositives, restricted relative clauses, prepositional phrases, and definite articles: they "are elements of linguistic structure designed to sustain attention by focusing and elaborating on the selected entity or topic". If selective attention and sustained attention govern topic and focus in language at the prosodic, lexical, phrasal, clausal and sentential layers, control of attention governs the switching of topic and focus at the phrasal, clausal, sentential and discourse layers. Discourse markers (e.g., "now", "anyway"), adverbial phrases, nonrestrictive relative clauses, register shifts, deictic gestures, parenthetical remarks, rhetorical figures like *ploche*, *anaphora*, and *antimetabole,* and footnotes are among some of the linguistic and graphic elements designed to control the flow of information when speaking and listening, writing and reading.

8.2. Leonard Talmy's Work

In Talmy's view, language is a major cognitive system in its own right, distinct from the other major ones: perception, reasoning, attention, memory, cultural structure, and motor control. As such, language has some structural properties that are uniquely its own and others in common either with only a few other cognitive systems, or with all other cognitive systems (Talmy 2000a, p. 16). Such structural properties determine the specific way language organizes and shapes conceptual content and, more in general, our experience: a way that sometimes is unique to language, but that sometimes coincides with the way the other major cognitive systems structure concepts and experience.

This view of language so greatly and pervasively characterizes Talmy's work as to determine in a fundamental way the course of his linguistic research, which is mainly centred on:

a) analyzing the specific way in which language shapes and structures conceptual content, that is, the specific patterns in which, and the processes by which, conceptual content is organized by and in language (*ibid.,* p. 2),

and is highly constrained by the idea that:

b) the means and procedures language uses to shape and structure conceptual content, and the patterns in which it structures conceptual content, are to a considerable extent drawn upon, and common to, those of the other cognitive systems (visual perception, kinaesthetic perception, attention, motor control, pattern integration, reasoning, understanding, etc.).

Talmy's view of language as a major cognitive system that has its own specific characteristics and structural properties, and that, as such, differs from the other systems, despite being quite similar to Fodor's idea of "modules" (Fodor 1983), is nonetheless distinct from it, in that the former implies a cognitive organization of structural overlaps across the various cognitive systems that can neither be accounted for, nor implied, by the strictly modular organization of the latter. Talmy evidences these overlaps several times and in several ways. He draws, for example, parallels between the cognitive systems of language and visual perception (Talmy 2000a, pp. 90-92, and pp. 160-167) (some of these parallels can be found also in Jackendoff 1987, 1992). Here is a list of some parallels:

i) The two cognitive systems show the common function of providing conceptual *coherence*, that is, they act as a means of integrating and unifying a body of otherwise disparate conceptual material. Without such a kind of structuring: a) any selection of lexical specified concepts concurrently juxtaposed by a sentence would tend to be only a collection of elements, rather than elements assembled so as to convey an integrated idea or thought complex; likewise, b) any welter of optical sensations registered at any one moment from some whole visual scene would not be integrated into the kind of coherent and meaningful scene that we usually experience.
ii) In both cognitive systems, the fundamental function of providing conceptual coherence has two main forms of realization: coherence over a scene and coherence through time.
iii) Each of the two cognitive systems has a content subsystem and a structure subsystem. In language, the content subsystem is represented by the *open-class* forms, that is, the lexical elements: roots of nouns, verbs and adjectives. The structure subsystem is represented by the *closed-class* forms, that is, the grammatical elements: overt bound forms (inflections, derivations, and clitics), overt free forms (determiners, prepositions, conjunctions, and particles), abstract or implicit forms such as the major grammatical categories (e.g., verb and noun) grammatical subcategories (e.g., count noun and mass noun), grammatical relations (e.g., subject and direct object), word order pattern, and "zero" forms. In vision, the content subsystem is represented by the concrete level of palpability, that is, the level at which an observer experiences an entity "as fully manifest and palpable, as clear and vivid, with the ostensive characteristics of precise form, texture, coloration, and movement, and with a precise location relative to oneself and to its surroundings, where this precision involves a Euclidean-type geometry and is amenable to metric quantification" (Talmy 2000a, p. 144). The structure subsystem is mainly represented by the semiabstract level of palpability, that is, a level characterized by a topology-type and approximate geometry, at which an observer does not so much "see" an

entity explicitly but rather "senses" its implicit presence, whether as the internal structure of an object, the delineations of a scene, or the plan of a path to be followed through obstacles.

iv) A number of particular structuring devices match across the two cognitive systems: many grammatically specified schematic categories, such as for example the state of boundedness and level of exemplarity, correspond to structuring factors in visual perception.

As Talmy shows (*ibid.*, p. 92), however, the two cognitive systems exhibit similarities as well as differences. Some major parameters that play a fundamental role in structuring visual perception – bilateral symmetry, rotation, dilatation, and color – have little or no role at all in language. Conversely, some prominent linguistic categories ("status of reality" as expressed by inflections for mood, "status of knowledge" as expressed by evidentials, "relative temporal location" as expressed by tense markings, "degree" as expressed by inflections and modifiers, etc.) have little or no structural function in visual perception.

Another interesting case of structural overlap across different cognitive systems examined by Talmy is that of language and attention. According to Talmy, this structural overlap would be made possible by the fact that "the attentional system is able to establish active connections with aspects of other cognitive systems", and, in a linkup of this sort, to lend "its own processing properties to the usual functioning of the other system" (*ibid.*, p. 304). Talmy classifies such attentional processing properties according to whether they have a:

i) *quantitative character*: enhancing the processing of the other linked-up system; differentiating factors in the other system in a finer-more structural fashion; processing a greater number of factors in the other system than the system can process; lowering the threshold above which certain kinds of activation in the other system can lead to further neural consequences;

or a:

ii) *qualitative and executive character*: selecting certain factors within the other linked-up system for special processing; comparing and contrasting various factors in the other system with each other; bringing in processing from still other cognitive systems to form a larger field of integrated processing; modulating or bringing about interactions between the other cognitive systems so as to make their forms of processing compatible with each other (*ibid.*, p. 304).

By lending its processing properties to the other cognitive systems, attention makes it possible for the other cognitive systems to operate on the same referent object or scene in various and different ways. Attention makes it possible in fact to perceive, categorize, conceptualize, act on, reason about, and more in general experience, the same object or event according to different patterns of various strengths. By lending its processing properties to language, for example, attention makes possible the process described by Talmy as the "*windowing of attention*": a process by which one or more portions of a referent scene are "placed in the foreground of attention while the remainder of the scene is backgrounded"

(*ibid.*, p. 258). The most fundamental linguistic device that mediates the windowing of attention is the inclusion in a sentence of explicit material referring to the portion of the total scene that has to be foregrounded, and the omission of material referring to the remainder of the scene that has to be backgrounded. While the linguistic foregrounding (or windowing) of certain portions of a conceptual complex permits the allocation of greater attentional processing capabilities to only those conceptual areas that are considered as the most relevant or important relative to larger goals and concerns, the linguistic backgrounding (or gapping) of the remaining portion of the conceptual complex keeps the level of processing of the conceptual areas that are assessed as less relevant or more obvious (i.e., capable of being filled in by the hearer) at its usual unenhanced level, and allows the limited resources of the attentional system to be reserved for the more important areas.

By means of the windowing of attention, we can describe and conceptually shape the same event in different and alternative ways. An event can thus be presented either with maximal windowing over it, as in: "The crate that was in the aircraft's cargo bay fell out of the plane through the air into the ocean", or with different degrees of windowing or gapping over it, as in "The crate that was in the aircraft's cargo bay fell into the ocean" (final windowing), or in "The crate that was in the aircraft's cargo bay fell out of the airplane" (initial windowing).

The overlaps across the attentional system and the language system also make it possible for language to specify various *levels of attention*, that is, to direct greater attention either to the more integral or general characteristics of a referent, or to its more compositional or particular characteristics. Talmy identifies four different types of setting levels of attention (*ibid.*, pp. 77-84):

1) *Level of synthesis*: language can code different levels of synthesis, from the componential one to the Gestalt one. For instance, while the second NP of the phrase "A cluster of trees" specifies an unsynthesized multiplexity of independent items, the first NP specifies a particular Gestalt synthesized out of that multiplicity.
2) *Level of exemplarity*: language can express the fact that a given multiplexity of objects manifests or possesses a given behavior by placing in the foreground of attention either the full complement of the multiplexity (as in: "Oysters have siphons") or a single exemplar out of the multiplexity (as in: "An oyster has siphons").
3) *Level of baseline within a hierarchy*: "In the linguistic representation of a complex of referents that are related to each other across hierarchical levels, attention can be directed to one or another of these levels for treatment as a baseline – that is, as the principal reference with respect to which the other levels will be related" (*ibid.*, p. 81). While for instance the sentence: "The boy has freckles on his face" places the baseline at the level of greatest scope (that of the whole – the boy – that includes particular parts – the face – that, in turn, have particular features – the freckles), the sentence: "There are freckles on the boy's face" places the baseline at the level of minimal scope (that of the featural details).
4) *Level of particularity*: linguistic expressions can refer to the same entity with greater or lesser exact specificity. The level of particularity can range from greater specificity (as in: "You have made a mistake here") to greater genericity (as in: "Someone has made a mistake here").

Another important manifestation of the overlaps across the attentional system and the language system is represented by the extensive and articulated system of *factors* used by language to assign different degrees of salience to the parts of an expression or of its reference or of the context. The importance of this system can be readily understood if one considers the fact that, in a speech situation, a hearer may either attend to the linguistic expression produced by a speaker, to the conceptual content represented by that expression, or to the context at hand. As Talmy observes (Talmy 2007b), the reasons why the hearer prefers to allocate his or her attention in a certain way instead of another one (for instance, to the conceptual content of the message rather than to the linguistic form expressing the conceptual content) is only partially due to any intrinsically greater interest of certain elements over others, being on the contrary greatly determined by a system of *factors* that are of a specifically linguistic nature. Each factor involves a particular linguistic mechanism that increases or decreases the attention on a certain type of linguistic entity. Talmy has identified over fifty basic factors (Talmy 2007b; on the linguistic principles for assigning different degree of salience, see also Talmy 2000b, pp.128-133.) that can be classified in some ten categories according to whether they concern properties of the morpheme (such as its formal properties, its componential properties, its frame and prototype properties, and its polysemy properties), morphological and syntactical properties (such as grammatical and constructional properties, and compositional properties), forms that set attention outside themselves (such as the forms that designate an outside referent as the object of attention), phonological properties (such as the morpheme length), properties of the referent (such as the forms that explicitly refer to how the addressee is to direct and set his or her attention), the relation between the reference and its representation (such as the relation between the intended reference vs. the actual representation), the occurrence of representation (such as the presence vs. the absence of explicit representation, and the presence vs. the absence in the lexicon of a morpheme for a particular concept), or properties of temporal progression (such as the recency of representation).

In order to illustrate how these factors work, we can consider for example the role played by positioning a given linguistic entity at a given location within a sentence. Each language may have certain locations within a sentence – for instance, initial position – that tend to foreground the referent of the linguistic entity placed there. Such added salience usually implies further accompanying cognitive effects, such as making the foregrounded referent the target of a conceptual contrast. For example, a sentence like: "Right now I can't stand this kind of music" suggests, by foregrounding the temporal referent "right now", that some other time would be more suitable. On the contrary, the sentence "This kind of music I can't stand right now" suggests a different contrast, that between "this kind of music" and "another kind of music", and implies that the latter would be all right.

Another factor is represented by the formal properties of the morpheme. A concept tends to be more or less salient depending on the lexical category of the form representing the concept. In general, as Talmy observes (Talmy 2007b), open-class linguistic categories lend more salience than closed-class categories. Furthermore, within open-class categories, nouns may tend to outrank verbs while, within closed-class categories, forms with phonological substance may tend to outrank forms lacking it. For example, the concepts of relative time seem much more salient when expressed by adjectives (as in: "On his *previous* arrival…" or in: "On his *upcoming* arrival…") than by closed-class forms (as in: "When he arriv*ed*…" or in: "When he *will* arrive…").

As was the case for language and vision, in language and attention it is also possible to find not only commonalities but also differences. Not all the properties of attention are equally exploited by language. Some attentional properties that, for example, are present in the other cognitive systems cannot be found in language: as Talmy observes (Talmy 2007b), an abrupt change along any sensory parameter is one of the main mechanisms in the perceptual modalities for attracting attention to the stimulus exhibiting it: but it has a minimal role in the attentional system of language.

In his work, Talmy (2000a and 2000b) also considers the cases of structural overlaps across, and parallels between, the language system and the following cognitive systems: kinaesthetic perception, the understanding/reasoning system, the cognitive cultural system, the pattern integrating system that underlies narrative, and the affect system.

According to Talmy, these overlaps across the language systems and the other major cognitive systems are motivated by the continuity of the brain areas dedicated to the former with those dedicated to the latter:

> the language-related faculty of the brain evolved to its present character in the presence of other already existing cognitive domains (…) and no doubt developed in interaction with their mechanisms of functioning, perhaps incorporating some of these (Talmy 2000a, p. 96).

8.2.1. Some Considerations on Talmy's Cognitive Semantics

The basic assumptions that language is a major cognitive system in its own right, distinct from the other major ones, and as such has some structural properties that are uniquely its own and some others that are in common with the other cognitive systems, greatly condition Talmy's approach to the study of meaning, directing his research toward, and predetermining, a specific kind of outcome. Let us see what this outcome is.

As we have seen, Talmy's work is largely based on the comparison between the language system and the other major cognitive systems (perception, attention, reasoning, affect, etc.). The assumption that the procedures used by language to structure conceptual content, and the patterns with which it structures conceptual content, are to a considerable extent drawn upon, and common to, those of the other cognitive systems, leads him to describe and analyze such linguistic procedures and patterns mainly in terms of the procedures and patterns of the particular cognitive system with which the language system is compared each time. The unavoidable outcome of this way of approaching the study of language (which we can define a "multiple approach to language") is that Talmy produces at least as many kinds of descriptions and analyses as there are major cognitive systems. If this fact, on the one hand, positively characterizes Talmy's work as an example of the multiple and diverse ways in which linguists can approach language and the various methods and analytical tools they can adopt, on the other hand, it represents in my opinion its main limitation. Indeed, the various kinds of linguistic and semantic descriptions and analyses Talmy puts forward are so different and distinct from each other that they do not seem, at least at a first look, to be related or relatable to each other, were it not for the only reason that they are based on a general relationship between language and the other cognitive systems. Such a kind of unrelatedness unavoidably engenders the main negative impression that Talmy's work suffers from a lack of uniformity and homogeneity. This impression seems to receive further support, moreover, by the fact that not all the kinds of analyses he proposes seem to be equally and extensively applicable to all semantic phenomena, but have only a limited scope of applicability.

To illustrate the implications of Talmy's "multiple approach to language", let us consider his analysis of the grammatical category of modals in English (*can, may, must, shall, will, need, dare, had better, could, might, ought, should, would*, but also *have to, be supposed to, be to, get to*). Talmy's fundamental idea is that we understand modals because they refer to our corporeal experience of physical forces acting in the presence or absence of barriers and obstacles. In his study on *force dynamics* (Talmy 2000a, pp. 409-470), Talmy clearly shows how the grammatical category of modals in English forms a homogeneous grammatical class that can be semantically specified in terms of a dynamic set of forces: exertion of force, resistance to such a force, the overcoming of such resistance, blockage of the expression of force, removal of such blockage, and the like. If we consider for example the following sentence: "John cannot/may not/must not/will not/need not leave the house", we see that: *cannot* indicates that John has a tendency toward the action expressed by "leave", that some factor opposes that tendency, and that the latter is stronger, blocking the event; *may not* expresses this same force-dynamic configuration, but is limited to an interpersonal context, one where the opposing factor is an authority's denied permission; *must not* suggests an active social pressure acting against John to maintain him in place; *will not* indicates refusal by John to yield to external pressure to perform the expressed action; *need not* indicates the release from the subject of a socially-based obligation, imposed from outside against the subject's desire, to perform the indicated action.

According to Talmy, the analysis in terms of force dynamics seems to gain further validation by the fact that it is able to explain not only the grammatical category of modals but also other, different linguistic entities, bringing them together into a previously unseen systematic relationship. Indeed, by resorting to the semantic category of force dynamics, it is possible for Talmy to analyze the group of verbs that take a *to*-less infinitive complement, that is, *make, let, have, help* (this group of verbs together with the group of modal verbs forms what Talmy 2000a, p. 443, calls the "greater modal system": the regular-verb members of this larger category all take the Antagonist as subject, while the modals all take the Agonist as subject, so that the two subcategories complement each other), as well as the linguistic notion of "causative", which has always been considered by many linguists as an irreducible concept, and that now, according to Talmy, can be seen as a complex built up of novel primitive concepts (*ibid.*, p. 428) (the notion of "causative" puts together both cases of "causing" and "letting" and is expressed, among others, by the words "because", "despite", "although", "against" "hindering", "helping" "leaving alone" and "trying"), and some other concepts (for an extensive analysis of the semantics of causation, see Talmy 2000a, pp. 471-549).

Despite being able to cover so many linguistic phenomena, the semantic category (or *schematic system*, as Talmy prefers to call it) of force dynamics does not seem able however to explain all semantic phenomena. It is really difficult, indeed, to imagine what contribution it could give to the analysis of even very simple and elementary linguistic expressions such as: "How are you, today?", "Jim and John are two boys", or "My name is George". And I believe that Talmy too does not think that the schematic system of force dynamics can be used, or is suitable, to explain all semantic phenomena. How can his extensive use of the other schematic categories ("configurational structure", "perspective", and "distribution of attention") to describe and analyze, for example, one of the most fundamental systems of language, if not the most fundamental one, that is, the closed-class linguistic forms (*ibid.,* pp.21-96) be otherwise explained?

It should be noted, moreover, that what can be described and analyzed in terms of force dynamics, can also be described and analyzed in terms of different schematic systems. For example, as Talmy himself shows, the causative construction is analyzable not only within the framework of force dynamics as the product of opposing forces, but also within the framework of the distribution of attention as a sequence of linked events or sub-events, that is, as a causal-chain event frame that can be attentionally windowed in various ways (*ibid.*, pp. 271-279) or as a relationship between *figure* and *ground* (*ibid.*, pp. 337-339).

The various and different ways of analyzing language that are typical of Talmy's "multiple approach to language", while offering new, interesting and revealing insights into language, do not possess the quality of *generality*, in the sense of being widely and equally applicable to all the various and different aspects of meaning, and usable in all linguistic instances. Taken separately, each of them allows us to understand how a distinct and partial portion of language (for instance, modals, causation, closed-class vs. open-class, etc.) functions, and throws a special, distinct light on language, letting us see and examine language from a new and unexpected point of view (for example, as a system that allows us to distribute attention in various ways, or to build different conceptual perspective points from which to regard and describe objects and events). Taken together, however, these different approaches to language do not produce a coherent and uniform complex of analyses that are linked to each other by a common principle. On the contrary they produce a set of isolated, unrelated and unconnected analyses of language.

What lacks in Talmy's work is a unifying principle capable of relating each specific kind of analysis to the other kinds, and of integrating in a coherent system all the different approaches devised and adopted by him. This does not mean, however, that Talmy does not recognize the importance of, and does not look for, generality and universality in scientific investigation: on the contrary he clearly states that his work presents "no phenomenon in any particular language for its own sake, but only insofar as it illuminates a typological or universalist issue" (*ibid.*, p. 15), and that the long-range goal toward which his study is intended to contribute, is "the determination of the overall character of conceptual structure in human cognition" (*ibid.*, p. 468). This simply means that his work has not fully attained such universality and generality. And this is precisely what he himself more or less explicitly admits when, presenting the five general *parameters* (the relating of one structure to another, relative quantity, degree of differentiation, combinatory structure, and evaluation) that should represent the foundational structural properties common to all the cognitive systems, he recognizes that they constitute the "*initial* outline of conceptual structure in human cognition in general" (Talmy 2000b, p. 446: italics is mine).

Talmy is certainly right in observing that each major cognitive system has its own way of processing information and structuring conceptual content, and provides a specific type of cognition that differs from the types provided by the other cognitive systems: the visual system lets us perceive and make things that reasoning does not. His observations concerning the overlaps across the various major cognitive systems are also true: language *does* have certain commonalities with vision. What he does not seem to realize is that a common factor or structural property can be traced across all the cognitive systems inasmuch as each of them gives rise to (albeit various, specific and different) conscious phenomena. This common factor or structural property is what primarily makes consciousness possible: attention.

Talmy rightly observes that the specific structural properties of each cognitive system determine the specific way each cognitive system organizes and shapes conceptual content.

But it must be added that this shaping of the conceptual content *is* first of all a shaping of our way of consciously experiencing (in its most general sense: perceiving, hearing, seeing, thinking about, imagining, etc.) the world. The fact, for example, that the visual system structures a scene according to certain properties (frontal vision, bilateral symmetry, rotation, dilatation, certain colors, etc.) means primarily: that it makes us consciously perceive the scene in a certain way, and only in that way; that we cannot see what stays behind us as we are looking at what stays in front of us; that we cannot see ultraviolet colors and infrared colors; but that we can perceive depth, moving objects, etc. Every kind of shaping of the conceptual content, caused by whatever kind of cognitive system, results in, and produces, a specific conscious experience in the end. Since consciousness is a product of attention, of how attention interacts with the other organs and systems, of the way its working is modulated by their activity, and of the operations they perform on the products of attentional activity, each specific way of shaping consciousness induced by a specific structuring of the conceptual content implies a specific way of structuring the working of attention.

8.2.2. What Separates Talmy's Cognitive Semantics from Attentional Semantics

Talmy, however, seems to be or come very close to the solution envisaged by Attentional Semantics on more than one occasion, such as when for example he openly admits that cognitive semantics is centred on "content experienced in consciousness". For him (Talmy 2000a, p.4), the main object of study of cognitive semantics is "qualitative mental phenomena as they exist in awareness"; cognitive semantics would then be a branch of phenomenology, and consequently "the only instrumentality that can access the phenomenological content and structure of consciousness is that of introspection". Here, Talmy realizes that the main gate to the study of meaning is consciousness: unfortunately, he does not fully develop and elaborate this idea to its extreme consequences.

Recently, he has recognized (Talmy 2007b) that a very wide range of linguistic phenomena (the relative salience of the "figure" and "ground" in a represented situation; the "windowing" of attention; the attentional backgrounding vs. foregrounding of concepts when expressed by closed-class grammatical form vs. by open-class lexical forms; the "level" of attention set either on the whole of a scene or on its componential makeup; differential attention, in a force-dynamic opposition, on the Agonist and the Antagonist; "fictive motion"; the backgrounding vs. the foregrounding of a concept when it is expressed in the verb complex vs. by a nominal complement; the backgrounding vs. the foregrounding of a proposition when it is expressed by a subordinate clause vs. by a main clause; the conscious as against unconscious processes in the acquisition, manifestation and imparting of cultural patterns; etc.), which he had previously analyzed by means of various and different schematic systems, all pertain to "the same single cognitive system of attention" and can all be placed within this explanatory framework.

In this case, he sees the possibility of unifying under a common analytical principle most of the linguistic phenomena he had separately investigated, described and explained before. However, he does not fully exploit this possibility in order to analyze the meanings of words. When he extensively and accurately describes the various (either automatic or consciously controlled) mechanisms afforded by language to assign different degrees of salience to the parts of an expression (mechanisms that allow the speaker to foreground certain elements while backgrounding the other elements, and to represent the same scene or event from various perspectives and in various ways: Talmy terms the cognitive capacity to construe a

scene in a range of ways the principle of "conceptual alternativity", 2000a, p. 14), he clearly sees that language and words have an important function in directing and modulating the hearer's attention. However, he does not go any further: he simply describes some superficial, *prima facie* effects that certain usages of language have on the hearer's attention, and the mechanisms underlying these usages. Lacking a full awareness of the role played by attention in shaping consciousness, he does not thoroughly investigate the implications that considering language as a means for piloting attention has on the study of meaning. Therefore, he does not see that the use of language entails some deeper and more complex attentional effects than the superficial ones he describes: effects that lead not only to a coarse and general setting of strength of attention, but also to the execution of very fine, sophisticated and articulated mental and physical operations. In brief, he does not envisage the possibility of seeing the meanings of words as condensed, de-contextualized and "frozen" instructions on the attentional (and related non-attentional) operations one has to perform in order to consciously experience what words refer to.

I think that this possibility could be easily envisaged when the following facts are taken into account.

a) Language does not only set different degrees of strength of attention on different parts of an expression, or increases or decreases attention on a certain type of linguistic entity: it also gives instructions to other kinds of attentional operations. For example, it conveys instructions on where to direct one's attention ("look *there*!"), when to direct it ("look at me *now*"), where not to direct it ("*do not* look at her"), how long to sustain it ("look at it *just for a while*"), how to focus it ("if we look at this *from this point of view*…"), how intensively to focus it ("look at it *carefully*"), how widely or narrowly to focus it ("look at *the whole* scene", "look only at *this part* of the scene"), etc. However, what counts more is that the instructions conveyed by words and grammatical constructions often require very complex and structured sequences of attentional operations to be performed: and this, despite the fact that these words and grammatical constructions are very commonly and frequently used. When, for example, an operation of comparison is required ("can you please control if A is high*er than* B?"), one must first focus one's attention on B, then suspend it momentarily from B, but in such a way as to keep or maintain B in the background as the term of reference, for the time necessary to focus on A and measure A against B. The instruction imparted by the plural construction, despite being very common, is also very complex. Indeed, besides requiring an operation of comparison, it needs some additional operations (see the analysis I put forward in this chapter, section 4). Let us finally consider all those cases in which a grammatical instruction is given of referring one thing to another, such as for example when we use the adjective-substantive correlation or the subject-verb correlation (Marchetti, 1993). In these cases, what one perceives, imagines, thinks about, sees, etc. (the adjective, the verb) is produced on the basis of a term or frame or reference (the substantive, the subject) that was previously built (by means of the attentional operations described for the operation of comparison). From all these examples, one can then see how words convey instructions that require the performance of sophisticated and articulated sequences of attentional (and related non-attentional) operations of various kinds.

b) All the basic concepts Talmy uses to perform his semantic analyses (as well as the basic concepts adopted by other linguists: see for example Wierzbicka 1972, 1996), whether in the form of schematic systems or of simpler concepts, such as Figure, Ground, Path, Motion, Manner and Cause (Talmy 2000b, pp. 19-212), can be further analyzed in, and reduced to, attentional (and related non-attentional) operations (see Benedetti 2009): theoretically, there is no word that cannot be analyzed in attentional terms (Ceccato and Zonta 1980), including the words that are used as *definiens*, such as "attention" and "operation" (Vaccarino 1981). For example, the semantics of causation, usually lexicalized by terms such as "because of", "as a result of", and "from", as in: "the vase broke from a ball rolling into it", results from, generally speaking, a specific combination of the attentional operations involved in the operation of comparison described above, that is: i) assuming something, say A, is a term of reference (the unbroken vase); ii) realizing that an instance of A, say A_1 (the broken vase), is different from A; iii) assigning B (a rolling ball) as the subject of the difference between A and A_1, in the sense that the difference would not occur if B were not present (for the analysis of causation, see also the proposals by Ceccato 1974, pp. 132-135, and Benedetti 2009).

c) One of the main (perhaps the main) features of language, which Talmy extensively acknowledges and investigates, that is, the possibility of construing or categorizing a given situation, event or object in various and different ways (the same spatial configuration can be described for example as "X is above Y" or "Y is below X"; a "wood" can also be described as "an area of land covered with growing trees"), is not only a linguistic phenomenon: it is a phenomenon that characterizes and concerns all cognitive systems, and more in general our mental activity. When looking at a certain object (for example, a pencil), we can perceive different things (the whole pencil, a part of it, its color, etc.). When listening to certain music, we can perceive the whole piece, a part of it, only a certain instrument, etc. The possibility of construing, categorizing, perceiving, thinking about, imagining, etc. a certain situation, event or object in various and different ways, is given primarily by the ability we have to voluntarily and intentionally control (i.e., stop, hinder, inhibit, pilot, trigger, change, adapt, etc.) our attentional activity. Indeed, depending on where, when, how, and why we move our attention, we can have different and various conscious experiences of the world we live in. Being able to control our attentional activity at will, we have the fundamental possibility of, firstly, stopping doing what we were doing and starting a new activity, and, secondly, modifying our previous or usual way of doing things. This means that we can: relate things, objects, and events to each other in new and different ways; perceive, see, think about, imagine, describe the same object in different ways; perceive, see, think about, imagine, describe different objects in the same way; produce new products; and more in general, expand our knowledge. What language does through semantic and syntactical means is precisely to implement and realize this ability in a more expanded, structured, systematized and consolidated way than other cognitive systems. The analysis of meanings and grammar, by describing and revealing how language fully exploits and puts this ability into practice, should be the privileged way of showing the attentional operations and mechanisms on which the ability is founded.

9. Some Implications for the other Kinds of Semantics

Attentional Semantics differs considerably from the traditional kinds of semantics in terms of its proposal and aims. This does not mean, however, that the latter cannot benefit from the innovations and proposals of the former, thus receiving new impetus to carry on their research. As an example, and for the sake of brevity, we will consider here the implications that the proposals of Attentional Semantics have for Logical-philosophical Semantics and Structural Semantics.

The name Logical-philosophical Semantics includes all those kinds of semantics (truth-conditional semantics, model-theoretic semantics, intensional semantics) that, originating from the analytic philosophy of language, were developed thanks to the works of authors such as Frege, Carnap, Tarski and Montague, who devoted special attention to the logical structure of language. The main aim of Logical-philosophical Semantics is to describe in logical or set-theoretical terms the relationship between the component parts of a sentence or phrase, regardless of the specific content of each component part. It differs radically then from Attentional Semantics, which aims at firstly analyzing the meanings of the single words in order to be able to explain subsequently how these meanings determine the general meaning of a sentence or phrase. It is well known that Logical-philosophical Semantics encounters unsolvable problems when it tries to account for those aspects of language that have to do with the subjective interpretation or description of a scene, and with the specific criteria and procedures that speakers may adopt. It is not able, for example, to explain in truth-conditional terms the difference in meaning between two sentences which, despite referring to the same referent, express different, subjective points of view on it ("the glass is half full" vs. "the glass is half empty"), or describe it with the same words, but using a different linear order ("the candidate is untidy, but competent" vs. "the candidate is competent, but untidy") (Violi 1997). More in general, as Frixione (1994) observes, this kind of semantics is not able to represent the meaning of extra-logical symbols, and account for the referential component of lexical meaning (a problem that is known in AI as the symbol grounding problem: see Harnad 1990). The reason for these drawbacks of Logical-philosophical Semantics lies precisely in its upheld contentlessness, that is, in disregarding the importance of the content or lexical meaning of the single words. This derives principally from the fact that Logical-philosophical Semantics conceives of the meaning of the single word as an objective entity, existing in itself, given to us as a *prius*: an entity for whose existence we are not responsible at all and that we can only accept as it is. Among the negative consequences of its contentlessness, the most straightforward is that Logical-philosophical Semantics is not able to provide content for the distinction between the meaning of sentences like "the cat in on the mat" and "the book is on the table" (Marconi 1992). Conceiving meanings as objective entities, moreover, brings with it conceiving the relationship between meanings as already fixed and determined - that is, independent of the activity of those who, by thinking, relate one meaning to another - and disregarding the possibility that new, different and unforeseen ways of relating meanings exist. Hence, the exclusive interest of Logical-philosophical Semantics for the logical kind of relationship, and its indifference for the other possible kinds of relationship.

The project and proposals of Attentional Semantics can provide not only a solution to the drawbacks of Logical-philosophical Semantics, but also a new basis on which to found the analysis of the relationships between the component parts of sentences and phrases. Indeed,

Attentional Semantics conceives meaning as being a product of our mental activity and not as something existing in itself and independent of our activity. Viewing meaning in this way, implies for Attentional Semantics: a) analyzing the meanings of *all* the words, and b) performing the analyses in terms of the invariable attentional operations that, independently of any individual, specific occurrence of a given conscious experience, are at the core, and are responsible for the production, of any instance of that conscious experience. By aiming at analyzing the meanings of *all* the words, Attentional Semantics overcomes the problems that Logical-philosophical Semantics poses by limiting its analyses only to the relationship between the components of a sentence or phrase, and disregarding the possibility of analyzing the lexical meaning of the single words. By aiming at performing its analyses in terms of attentional operations, Attentional Semantics overcomes the problems that Logical-philosophical Semantics poses by limiting its analyses to a sole kind of relationship, that is, the logical one, and disregarding the possibility of analyzing other kinds of relationships between the component parts of sentences or phrases. As we have seen, the main property of mental activity is represented by the possibility it gives of acting on and dealing with the same object or event in different ways, and of acting on and dealing with different objects and events in the same way. In brief, of relating oneself to the same object or event in different ways, and to different objects or events in the same way. Consequently, analyzing meanings in terms of attentional operations implies conceiving the possibility that meanings can be related to each other in various, different and new ways, and not only in a logical way. Attentional Semantics offers then a new basis on which to analyze the relationships between meanings: a basis that envisages not only one kind of relationship (the logical one) but many, different and new ways of relating meanings: grammatically, pragmatically, socially, aesthetically, etc. In this regard, Vaccarino's attempt (1981) at building an *intra-propositional logic* as opposed to symbolic logic or *inter-propositional logic* represents a first example of how an analysis of meanings in terms of mental operations can allow researchers to investigate grammatical relationships. Finally, by analyzing the meanings of words in terms of the elements that are responsible for the conscious experience referred to by the meanings, Attentional Semantics provides the way of linking language to the conscious experience we have of ourselves, of other human beings, and of the world in which we live. Since conscious experience contains all the kinds of experiences we can have – physical, perceptual, psychological, mental, etc. - the link provided by Attentional Semantics allows us to have an experiential basis on which to ground semantic analyses.

Similarly, Structural Semantics can also benefit from the innovations of Attentional Semantics. The main hypothesis of Structural Semantics is that language is an autonomous system, whose elements exist by virtue of each other, independently of any determination from outside the system. Saussure, one of the most important representatives of Structural Linguistics along with Hjelmslev, Matinet, and Greimas, claimed that language includes neither ideas nor sounds existing prior to the linguistic system, and that concepts are values that emerge from relations with other values of a similar kind. Therefore, meanings are completely built on and derive entirely from the internal relations of the linguistic system: they are freed from both any reference to extra-linguistic reality and any conceptual and mentalist determination. Structural Semantics bases its semantic analyses mainly on a principle of *componentiality*. According to this principle, the meaning of every word is made up of a combination of simpler, more basic and general components called "primitives". Since for Structural Semantics language is independent of any kind of extra-linguistic reality,

whether conceptual, mental, perceptual, physical or other, primitives cannot be but of a linguistic type.

Many authors have pointed out that the main problem with the approach of Structural Semantics is its intrinsic circularity. If meanings can only be defined on the basis of the relations between them, how can these relations be identified without referring to meanings themselves? Knowing the set of semantic relations that exist between meaning *a* and the meanings *b, c, d, e, f, etc.* does not mean knowing meaning *a*. Neither does it help us knowing that meaning *a* is made up of the semantic components *y, x*, and *z*. Indeed, despite being called "primitives", *y, x* and *z* are in turn linguistic entities. Words are explained by means of other words, in an endless circularity.

In order to explain and analyze linguistic meanings, it is necessary to go beyond purely linguistic relations. Language needs an a-linguistic counterpart. This is precisely what Attentional Semantics offers: in fact, Attentional Semantics analyzes meanings in terms of mental operations. It neither ignores nor rejects the main contributions of Structural Semantics, such as for instance the ideas that meanings can be analyzed in simpler components, or the analytical procedure based on the comparison of words belonging to the same semantic field. However, by resorting not so much to linguistic concepts, as to mental operations and activities, such as attention, it overcomes the main problem of Structural Semantics, i.e. circularity.

Chapter 3

TIME

1. CIRCULARITY

As we have seen in the first chapter, one of the main problems that arises when studying consciousness and conscious phenomena from a third-person perspective is circularity. Circularity is the fallacy that occurs when one uses in one's analysis, explanation or definition of an object or event, concepts or notions that directly or indirectly derive from, are produced by, presuppose or imply the existence or experience of the object or event itself: that is, when the *definiens* includes the *definiendum*. When one approaches consciousness from a third-person perspective, one typically assigns it some characteristics that are (also) the result of one's own and others' conscious activity. Consequently, when analyzing conscious phenomena, these characteristics re-appear as a-priori, intrinsic characteristics of consciousness, whereas on the contrary they are (a-posteriori) duplications of the products of one's conscious activity. This gives rise to typical problems of circularity: what is a result of one's activity is taken to be a basic constituent of that very activity.

1.1. Circularity in Studies of Time

Among the conscious phenomena, time seems to be one that most easily induces those who deal with it scientifically to circularity. Two different reasons contribute to make time a research object that is so easily affected by circularity.

The first reason is a very general one, and does not affect only time but many other phenomena as well: it is our lack of awareness of the fundamental role played by our mind in shaping and giving form to the events, objects and concepts that we perceive, see, conceive of, and more in general know and experience. This lack of awareness is aided by the fact that human knowledge develops and is made possible thanks to processes such as perception, learning, reasoning, motor control, understanding and memorization that largely rely on, and are regulated by, unconscious mental operations. Moreover, these processes, even when they initially occurred under the supervision of consciousness, tend to progressively become unconscious with practice. Therefore, our knowledge unavoidably and to a great extent assumes the character of being implicit. This implies that we know that we are able to do

things (by "to do things", I mean the general capacity to exercise one's mental, psychological and physical abilities and faculties: acting, moving, thinking, conceiving of, perceiving, etc.), but that sometimes we do not know how we do them, and what it is that allows us to do them: that is, we are not conscious of the processes and mechanisms that allow us to do them. We all know that we can add three to two and get five, but we are not conscious of the processes that allow us to do so. We are able to walk and tell the time, but not all of us can remember the original sensations we had, and how we reacted to them when first performing those activities. It is this very lack or loss of awareness that made Saint Augustine say: "What, then, is time? If no one asks of me, I know; if I wish to explain to him who asks, I know not".

One of the consequences of the lack of awareness of the role played by our mind in building and shaping phenomena is that whatever we build and shape (whether it is a physical object, a mental construct, or something else) tends to acquire an autonomous and independent life for us, that is, it becomes an object whose own existence is independent from us: a wall, once built, has its own life and destiny. This also applies to the abstract products of our mind, such as words, concepts, ideas and symbols. Moreover, once we have built something, we can use that something instrumentally to build other things: we use bricks to build houses, words to build sentences, ideas to build theories, etc. Time is no exception. The construct of time has been used to build, or has contributed to characterize, in specific ways the various fields of our knowledge and experience. For example, Fraser (1987) identifies six different and increasingly complex ways of using time to characterize and shape our experience: atemporality, prototemporality, eotemporality, biotemporality, nootemporality, and sociotemporality. Eotemporality, for example, is the linear time of mechanical clocks: it is the simplest form of continuous time, but it does not flow, and the notions of past, present and future cannot be applied to it. On the contrary, nootemporality, which characterizes the mature human mind, clearly distinguishes between past, present and future.

Another consequence of the loss or lack of awareness of the role played by our mind in shaping objects, events and concepts is the fact that when we try to explain or analyze them, we do not look for the answer where they actually originate, that is, the set of our abilities and faculties, of which the mental ones represent the most fundamental and central ones, but in other places: typically those worlds or fields of knowledge that we have built by means of, or with the contribution of, the very objects, events and concepts we want to explain and analyze. In other words, we do not realize that these other places are nothing but a product of our abilities, of the conceptual and physical tools with which we equipped ourselves, and that these places are full of the products of such abilities. For example, we tend to explain time (a construct we shaped and built with our mind) by resorting to the field of physics (a field that was also built thanks to the construct of time) and to its products (clocks and timers). Therefore, lack of awareness makes us sometimes explain our conceptual and physical tools and their origin by resorting to the concepts, ideas, objects, etc. that result from these very same conceptual and physical tools: circularity is thus brought about by lack of awareness.

The second reason why the notion of time easily induces researchers and scientists to circularity is its pervasiveness: a pervasiveness that undoubtedly testifies to its usefulness and "viability" (von Glasersfeld 1989, 1998) as a cognitive tool. Indeed, there seem to be no or very few realms of our knowledge and experience that are not characterized by time. Time pervades almost every aspect and dimension of our life. Time seems to be a universal, unquestionable reality. As such, time does not seem to be something that is produced and shaped by our mind, but something really independent from us, a prius given to us in a pre-

constituted and inalterable way. Obviously, this fact can influence the researcher's attitude toward time so as to lead him/her to analyze and deal with it precisely as a pre-constituted, independent reality, assigning it those properties which, on the contrary, derive from our own mental and physical activity.

Given this characteristic of the notion of time, I will devote this chapter to it, in order to exemplify how circularity can be brought about when dealing with conscious phenomena. The examples of circularity will be mainly drawn from linguistic and psychological studies (even though circularity can be found in other disciplines as well), because circularity occurs especially in those research fields – such as linguistics and psychology - that have conscious phenomena as their research object.

In the final part of the chapter I will show how it is possible to avoid circularity when studying time by adopting the analytical tools of a first-person approach, that is, Attentional Semantics.

2. CIRCULARITY IN LINGUISTICS

In this section, I will deal primarily and extensively with a work by a cognitive linguist, Vyvyan Evans, because it is specifically devoted to the semantic analysis of the lexical item "time", and is a relatively recent, detailed and informative study of time. Moreover, Evan's work offers a clear picture of the current research of Cognitive Linguistics into time, that is, of the only kind of linguistics which, to my knowledge, has seriously tackled the problem of time until now. I will then briefly deal with Lakoff' and Johnson's analysis of time. Finally, I will consider what has been, to my knowledge, the first serious attempt to avoid circularity in linguistic studies: Silvio Ceccato's work.

2.1. Evans' Analysis of Time

Evans's work (2004) is a relatively recent, in-depth study devoted to the semantic analysis of the word *time*. Evan's central thesis is that temporality is fundamentally subjective in nature and phenomenological in origin: "temporality is a real and directly perceived subjective experience" (*ibid.*, p. 31). Time is ultimately neither an empirical primitive, that is, a physical feature of an objective world, nor a mental achievement, an abstraction derived from relations between external events, but an internal, subjective phenomenon related to the perceptual mechanisms that process sensory experience. Our awareness of time would be a consequence of the various "timing mechanisms" in the brain, such as the "perceptual moments" (*ibid.*, pp. 22-27), which are necessary for, and underpin, perceptual processing. As such, time enters into our experience of everything since it is fundamental to the way in which perceptual processes operate: it is "a pre-requisite for abilities such as event perception and comparison, rather than being an abstraction based on such phenomena" (*ibid.*, p. 9).

That time is not an abstraction based on phenomena such as event comparison - a theory put forward by Gibson (1975, 1979), who argued that while events are perceivable, time is not, and by Lakoff and Johnson (1999), who argued that the concept of time results from an antecedent awareness of ongoing change exhibited by events in the world - is clearly shown

by the fact that (i) "we actually experience the 'passage' of time whether there has been a change in the world-state or not" (Evans 2004, p. 64) as evidenced by situations of relative sensory-deprivation (such as windowless, sound-proofed cells) in which subjects are still aware of the passage of time, and (ii) our experience of time appears to be independent of the nature of the external events we are exposed to, that is, the way they change and move.

The hypotheses that time is fundamentally subjective in nature and that there is a basic bifurcation in the conceptual system between concepts of subjective origin and concepts of external origin, explain what Evans calls the metaphysical and the linguistic problems of time. We are aware of time even if there seems to be nothing tangible in the world which can be pointed to and identified as time (the metaphysical problem of time), because time is subjective in essence and of internal provenance - temporality being "traceable to specific cognitive apparatus and processes" (*ibid.*, p. 256) such as the neurologically instantiated temporal codes or rhythms that underpin perceptual processing - and because we can experience and perceive it directly. We use language pertaining to motion through three-dimensional space in order to think and talk about time (the linguistic problem of time) because subjective information is difficult to conceptualize and verbalize. In order to conceptualize and verbalize it, we have to elaborate it in terms of an external, inter-subjective sensory experience, such as the visual-spatial one.

According to Evans, the subjective experience of temporality is fundamentally durational in nature, and duration is what he calls the "sanctioning" sense associated with the lexical item *time*, that is, it constitutes the "citation" sense that language users would be most likely to produce in response to the question: "What does the word X mean?". As such, the durational aspect of temporality represents a prerequisite for the development (and not a consequence, as instead many authors claim) of the other important experiences that are usually conceived as being strictly linked to time, such as the awareness of change, the experience of succession, and the possibility of distinguishing past from present and from future. A number of reasons lead Evans to hypothesize that the experience of time is primarily durational in nature. Firstly, we can experience the "passage" of time whether there has actually been a change in the world-state or not. Secondly, the experience of duration is independent of the nature of external events: the experience of protracted duration can result from both states in which the stimulus array is impoverished and events that, on the contrary, are extremely rich in sense-perceptory terms. Thirdly, "it is our awareness of and ability to assess magnitude of duration which first and foremost allows us to distinguish past from present, and thus allows us to experience events as successive" (*ibid.*, p. 112). Fourthly, the neurologically instantiated temporal codes that provide the basis for perceptual processing, and hence for our subjective awareness of time, are durational in nature. Fifthly, etymological evidence from linguistics suggests that it is "duration" which may constitute the historically earliest sense associated with the lexical item *time*.

Despite referring primarily to the durational aspect, "the lexical item *time* is conventionally associated with a range of distinct temporal lexical concepts" (*ibid.*, p. 72). Evans, on the basis of three criteria or decision principles devised by himself (the meaning criterion, the concept elaboration criterion, and the grammatical criterion), is able to distinguish eight different lexical concepts (or "senses") associated with the lexical item *time*: 1) the sanctioning sense of duration, from which the other senses appear to be derived. The duration sense is exemplified by sentences such as: "The relationship lasted a long/short time" or "It was some/a short/a long time ago that they met"; 2) the moment sense: "The time

for a decision has arrived/come"; "What size was she at the time he was fourteen?"; 3) the instance sense: "Devine improved for the fourth time this winter when he reached 64.40 meters at a meeting in Melbourne"; "This time, it was a bit more serious because I got a registered letter"; 4) the event sense: "The young woman's time (=labor) approached"; "His time (=death) has come/arrived"; 5) the matrix sense: "Time flows/runs/goes on forever"; "Time has no end"; "We live in time"; 6) the agentive sense: "Time is the great physician"; "Time, the avenger"; "Time has aged me"; "Time reveals all"; 7) the measurement-system sense: "In the 1850s Railway time was introduced as standard"; "Eastern Standard Time is five hours behind Greenwich Mean Time"; 8) the commodity sense: "Time is money"; "Time has become a scarce commodity"; "She has invested a lot of time in that relationship".

From the synchronic level, the range of distinct senses can be modelled in terms of a semantic network where the more peripheral members are less-related to the central sanctioning sense than the more central senses. Figure 8 presents a diagram of the semantic network for *time*, where each node represents a distinct sense and the arrows represent the degree of relatedness between distinct senses.

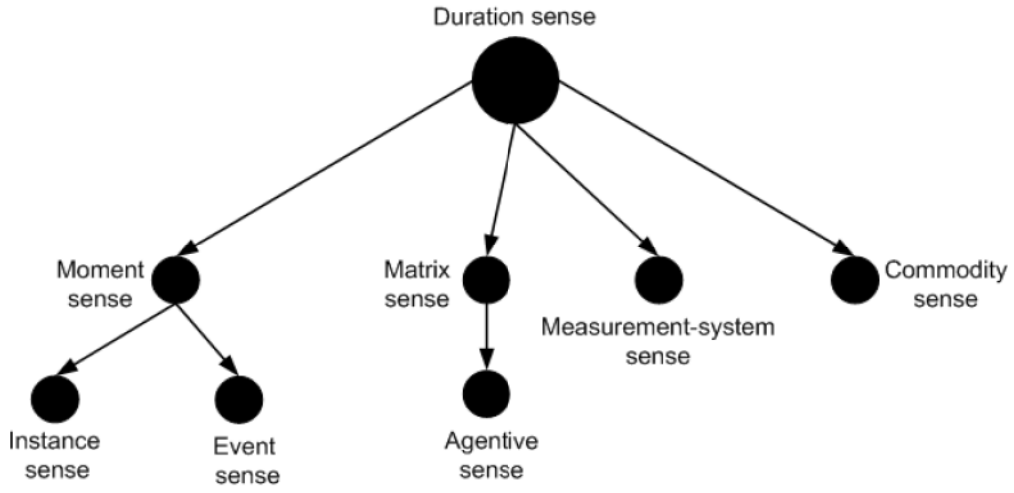


Figure 8. The semantic network for "time" according to Evans.

The fact that a word such as "time" has so many distinct senses can be easily accounted for if one adopts what Evans calls the "principled polysemy approach". This approach "seeks to account for the meanings associated with words as not being absolute and fixed, but rather as being capable of changing over time" (*ibid.*, p. 79). According to the principled polysemy approach, lexical concepts are mutable and dynamic in nature; hence, through word-use, new lexical concepts or senses can be generated and associated with a particular word, thus extending the range of meanings associated with it. This process results in new lexical concepts becoming conventionalized, in such a way that they achieve a mental representation that is independent of the antecedent lexical concept which motivated their occurrence. The resulting distinct senses are the outcome of a dynamic process of meaning-extension, which is a function of language-use and socio-physical experience. An important role in this process is played by the mechanisms of "experiential correlation" and "perceptual resemblance" (*ibid.*,

pp. 46-49), the former giving rise to associations at the conceptual level due to close and recurring correlations between two different kinds of experience, and the latter establishing connections between concepts on the basis of perceived similarities and shared characteristics. The mechanisms of experiential correlation and perceptual resemblances often give rise to implicatures or situated inferences, that is, contextually-derived meanings, which, through recurrence, can become conventionally associated with a particular lexical form associated with the context of use. Once an implicature has become conventionally associated with a particular form, this derived sense can, via "pragmatic strengthening" (*ibid.*, p. 99-101), be employed in contexts of use that are unrelated to the original context which gave rise to the implicature in the first place.

Evans' analysis of time does not escape circularity. For Evans, the experience of time is primarily "durational" in nature: in fact, duration constitutes the sanctioning sense associated with the lexical item *time*. Duration, in turn, is defined as an "interval": "I will define duration as the INTERVAL holding or extending between the two boundary (beginning and ending) events" (*ibid.*, p. 108). An interval, in turn, results from "succession": "Put another way, an interval of duration results from SUCCESSION. After all, if two events are not experienced as being successive we cannot experience duration" (*ibid.*, p. 108). But "the notion of succession (…) derives from the phenomenon of duration" (*ibid.*, p. 109): an observation, this, that is repeated in the following statement: "It is our awareness of and ability to assess magnitude of duration which first and foremost allows us to distinguish past from present, and thus allows us to experience events as successive. Hence, succession is a consequence of our awareness of duration" (*ibid.*, p. 112). Circularity is thus assured (Figure 9).

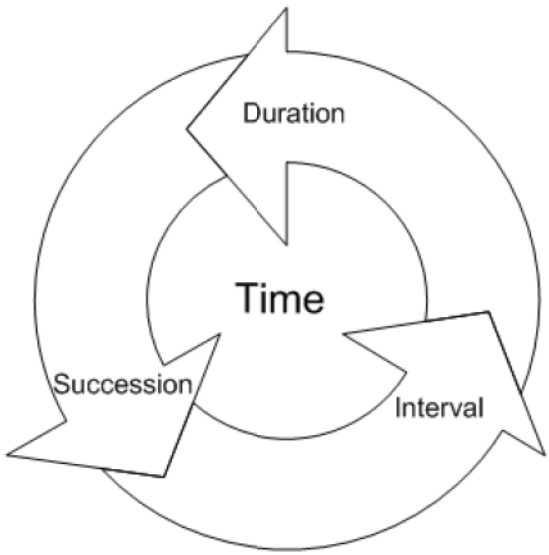


Figure 9. The circularity in Evan's definition of time.

There is no way to avoid circularity in Evans' definition of time. Time is duration, duration is an interval, an interval derives from succession, and succession derives from duration: the circle is closed. In Evans' formulation, all these concepts are so tightly entangled that is impossible to tell which one of them generates the others.

Duration is certainly a very important aspect of the experience of time. But if one defines time as duration, one should be expected to be able to define duration independently of time. In order to define duration, Evans, on the contrary, resorts to concepts that already contain time as their constituent. The notion of "interval", for example, denotes a portion of time, something that has a "beginning" and an "end" (or an onset and an offset, in Evans' terms). But "beginning" and "end" are concepts that imply and presuppose the experience of time: in fact, to be able to speak about "beginning" and "end", one must have already experienced time.

Likewise, we cannot have an experience of "succession" or "sequence" without having had a more primitive experience like that of time (but also the experience of space could serve as the basis for the experiences of succession and sequence). Indeed, one can experience a succession or sequence of events only after having experienced the fact that an event follows another in time (or in space), or that events are present at different times (or places). Therefore, we can experience succession and sequence only after having had that particular experience known as "time" (or that particular experience known as "space").

Moreover, the notion of duration, which Evans considers to be the sanctioning sense associated with the lexical item *time*, is not, strictly speaking, completely independent of the experience of time either. Indeed, if it is certainly plausible to define time in terms of duration, it is equally plausible to define duration in terms of time. In fact, the experience of duration entails the experience of something that "lasts", "endures", "goes on", "continues" or "develops", and this experience necessarily requires a "beginning" event, and sometimes also an "ending" event, that is, events which have a boundary nature. But an event can assume a boundary nature only when it is seen through the eyes of temporal experience.

Evans is not able to provide an independent definition of time, that is, a definition that does not refer to experiences, concepts and notions which, in turn, are based on temporal experience. He defines time by using concepts such as duration, interval, and succession that presuppose and imply the experience of time: the *definiens* includes the *definiendum*, in an unavoidable circularity.

There is, however, one occasion in which he seems to realize the necessity to use an independent level of explanation: when he hypothesizes that our conception of temporality may ultimately be traceable to neurologically instantiated "temporal codes" underlying perceptual processing. An instance of temporal code is the "perceptual moment". A perceptual moment is a temporal interval characterized by the synchronized oscillations of neurons, which lasts for a short period of time, and is bounded by a silent interval before re-occurring. These synchronized oscillations allow information which is spatially-distributed in our brain to be correlated, thus giving rise to the correlation of sensory qualities, i.e., object perception. Therefore, the perceptual moment underpins perceptual processing and enables us to perceive. But the perceptual moment is not only necessary for perceptual experience: it also constitutes "the cognitive antecedent of the concept of the present or now" (*ibid.*, p. 26). Moreover, according to Evans (*ibid.,* p. 26), it would be the succession between a perceptual moment held in memory and the current perceptual moment that gives rise to the experience of duration. Therefore, the experience of temporality would naturally emerge from perceptual processing, with which it is so deeply entangled.

Also in this case, however, Evans is not able to avoid circularity. Ascribing - even if indirectly (*ibid.*, p. 256) - the origin of the experience of time to a neurologically instantiated temporal code or mechanism, Evans simply eludes the problem of giving a positive, non-

linguistic definition of time, putting off its solution. What he does, actually, is to explain time through time itself. He explains temporal experience by using terms and concepts – such as neurologically instantiated "temporal" codes; "temporal" intervals; "synchronized" oscillations - that are already temporal categories, in that they contain and are built on time. Indeed, how could you explain "temporal" codes, "temporal" intervals, and "synchronized" oscillations without resorting to the concept, or the experience, of time? Instead of providing an explanation of time that is independent of what we already know about time, and of the (conceptual and physical) tools humankind built precisely thanks to the notion of time, he bases his identification of the origin of the experience of time precisely on his knowledge of time: in fact, one can properly speak of "synchronization", "temporal" code and perceptual "moment" only when one already knows what time is.

Neither does Evans seem to offer or find a way out of circularity when he defines time in terms of the other lexical concepts: the moment sense, the instance sense, the event sense, the matrix sense, the agentive sense, the measurement-system sense and the commodity sense. Indeed, he performs his analyses only by comparing the different senses, without resorting to any independent, non-linguistic level of analysis. One sense is defined by comparing it or referring it to the others, in a recursive way. Inevitably, these comparisons are always based on notions and concepts, such as "temporal", "duration", "interval", "moment", "sequence" and "event", which are not themselves defined in positive, non-linguistic terms, but which on the contrary refer circularly to each other.

Most probably, the pervasive presence of circularity in Evans' work is due to the strong relevance he gives to the notion of "concept" when analyzing the meaning of the lexical item *time*. Evans equates meanings with concepts: "to study linguistic meaning constitutes a study of the conceptual system" (*ibid.*, p. 6). Evans further specifies that concepts are mental representations, that is, information referring to experience that can be represented, modelled and recalled for purposes of reasoning, abstraction, projection, etc. even when the experience is no longer accessible to focal consciousness (*ibid.*, p. 39). However, the move of reducing the semantic level to a purely conceptual one (a move that is also made by some other cognitive linguists: see for example Jackendoff 1983, 1992, and by cognitive psychologists: see Bloom 2000) involves one major problem: if the notion of concept is not accompanied by an explanation of how a concept originates, what kinds of mechanisms determine it, how it works, and so on, the notion is completely useless. It is simply another linguistic way of representing and defining the meanings of words, an illusion of getting out of the linguistic level. It is true that Evans tries to generally motivate the development of conceptual structure and concept formation by means of mechanisms such as "perceptual analysis" (Evans 2004, pp. 51-52), and to ground this development on our experiential and bodily basis. It is also true that he himself openly admits that while language is symbolic (it pairs a physical symbol with a meaning), meanings and concepts are sub-symbolic, that is, they are not linguistic: "meanings (or lexical concepts) are not primarily linguistic, but rather derive from perceptual analysis and are hence redescribed perceptions (i.e. they are embodied). In addition, they are informed by our interaction and experience with the entities they represent, and a whole welter of other background knowledge, such as knowledge gleaned through cultural transmission" (*ibid.*, p. 53). But it does not go any further than that. For example, he does not investigate, or propose any hypothesis about what it means to build perceptual-visual information, how it is or can be built, and how it can be redescribed in "conceptual" terms; more in general, what it means to say that concepts and meanings are not linguistic, what it

means, and how it is possible, to redescribe something in non-linguistic terms, which kinds of operations (mental, physical, psychological?) and which combination of these operations produce a given concept, and so on. In brief, he does not provide any a-linguistic counterpart to language and concepts. On the contrary, he remains inside a purely linguistic level of analysis and description. Consequently, his analyses cannot escape circularity.

Reducing the semantic level to a purely conceptual one also involves some other kinds of problems. Concepts are not meanings: the former differ from the latter for some important reasons. Firstly, the meaning of a word is univocal: it is valid for, and shared by, everybody, and it has to be so to safeguard the communicative function of language. On the contrary, concepts are individual: everybody can have a different concept of what the word refers to (everyone understands what the word "freedom" means, despite the fact that everyone can have a different concept of "freedom"). Secondly, the phenomenal, conscious experience of the meaning of a word is very different from that of the concept expressed by the word. To be conscious of the meaning of a word is to be able to differentiate it from the meaning of other words: we understand the meaning of the word dog because we know that the word "dog" does not mean the same as, for instance, the words "cat" or "table". On the contrary, to be conscious of the concept that is expressed through a word is to be able to differentiate it from the other concepts that may be expressed through the same word. Even when I say "dog" and you understand what I mean, the concept I have of a "dog" may be very different from your concept of "dog": for me a dog can be a nasty animal, whereas for you it can be a lovely one. Thirdly, while all words have a meaning, not all words necessarily have an associated concept. While it seems reasonable to have concepts for words like "dog" and "cat", it does not seem plausible, or anyway necessary, to have concepts for other words such as "and", "or", and "to". What is the concept of "and", "or", and "to"? Usually concepts influence or govern our behavior: my concept of dogs, for instance, may lead me to avoid dogs and to prefer cats. May we find a parallel influence of a supposed concept of "and" in our use of this word? Apparently, we cannot, which would be indirect evidence of the fact that concepts for words like "and" and "or" do not exist.

Equating meanings with concepts, as Evans does, involves assigning the former the properties of the latter (and vice-versa). One of the direct consequences of this operation is that of confusing the semantic level of analysis with other levels of analysis, such as the conceptual or the pragmatic ones – a confusion which seems to be implied by the encyclopedic view put forward by Evans (*ibid.,* pp. 53-54). It is certainly true that words represent a point of access to a kind of knowledge that is usually more general and wider than that specifically and immediately transmitted by their meanings. It should be noted, however, that one needs some time to pass from the moment in which one understands the meaning of a given word to the moment in which one can imagine, remember or think about what that meaning may refer to. When we hear a certain word, such as "dog", we understand the meaning of the word almost immediately. However, we need some more time to pass from the meaning to the concepts, images, thoughts, memories or emotions that may be associated with it (that is, what constitutes our personal experience and concept we have of dogs). Usually, in normal, daily speech, we do not pass from the meaning of every word we hear to the concept or the bulk of our personal experiences it may elicit, but only for some of the words we hear. This means that meanings are processed at a different stage from that at which concepts and more in general past experiences are processed. If this is so, it seems useless and

out of place to call for "the totality of knowledge we possess concerning a particular entity or experience" (*ibid.*, p. 54) in order to analyze the meanings of words.

2.2. Lakoff and Johnson's Analysis of Time

According to Lakoff and Johnson (1999), time is something created via our bodies and brains: it is a human concept that is cognitively constructed by two processes, one metonymic, based on correlations with events, and one metaphoric, based on motion and resources. While the cognitive mechanism of metonymy allows us to have a sense and an experience of time, the metaphoric one allows us to conceptualize time in terms of motion and space.

Our direct sense and experiences of time, what Lakoff and Johnson call the "literal" aspects of time, such as its directionality and irreversibility, arise from, and are grounded in, other experiences: the experiences of events and their comparison. This derives from the fact that we cannot observe time itself; we can only observe events and compare them: "Literal time is a matter of event comparison" (*ibid.*, p. 139). Our real experience of time is always relative to our real experience of events. Saying that an event lasts a certain time is saying that it is compared with other events that have a regular and iterative occurrence, such as the motion of a pendulum, the movement of the sun, or our bodily rhythms: "The sense of time in us is created by such internal regular, iterative events as neural firings" (*ibid.*, p. 138). In other words, there are iterative events against which other events are compared: "We define time by metonymy: successive iterations of a type of event stands for intervals of 'time' " (*ibid.*, p. 138).

According to Lakoff and Johnson, literal time is only the beginning of our concept of time. We use a number of metaphors in conceptualizing time – time as a flow, time as a continuous unbounded line, time as a linear sequence of points, etc. – and it seems unlikely that we can think and talk about time without those metaphors: "such a metaphorical conceptualization of time is constitutive, at least in significant part, of our concept of time" (*ibid.*, p. 166). Very little of our understanding of time is purely temporal: "Most of our understanding of time is a metaphorical version of our understanding of motion in space" (*ibid.*, p. 139). This is due to the fact that motion is a more primitive concept than time. Time metaphors are so pervasive, occur so frequently, and are present in so many different languages around the world because they arise from our most common everyday embodied experience of functioning in the world:

> Every day we take part in 'motion-situations' - that is, we move relative to others and others move relative to us. We automatically correlate that motion (whether by us or by others) with those events that provide us with our sense of time, what we call 'time-defining events'. In short, we correlate time-defining events with motion (…). Thus, in a motion-situation, motion is correlated with time-defining events (*ibid.*, p. 151).

The spatial metaphors for time are an automatic part of our cognitive unconscious that structures the very way we experience time.

As we have seen when dealing with Evans' (2004) work, Lakoff and Johnson's position that the concept of time results from the comparison of events which inhere in the world

raises some reasonable and legitimate doubts, especially because the experience of time appears to be independent of the *nature* of the external events we are exposed to, that is, how much change is occurring. As shown for example by Flaherty (1999), the experience that time is passing slowly, a phenomenon which Flaherty labels "protracted duration", can be brought about by opposite situations: indeed, it can result from events that are extremely rich in sense-perception terms – such as when situations explode suddenly into violence and danger, in shocking circumstances, when unexpected events occur, and so on – but also from events in which the stimulus array is impoverished as in boredom, waiting periods, etc. Moreover, "uneventful" situations such as solitary confinement in prison do not at all prevent who lives them from perceiving the passage of time.

Here, some people could raise at least two objections, in particular, against the validity of the kinds of evidences put forward by Flaherty, and more in general, against the idea of the independence of time experience from external events.

The first objection is that even in the most "uneventful" situation some events take place all the same and, therefore, it is not completely correct to affirm that the experience of time is independent of external events. For example, Flaherty (1999) observes that, during their solitary confinement, prisoners tend to "kill time" by filling it "with attention to all manner of subjective and objective experiences" (*ibid.*,, p. 27), such as staring at their watch, making chalk marks on the walls of the cell, thinking, and so on.

The second objection is that the experience of timelessness or "protracted duration", which as we have seen can be brought about by either extremely high or low levels of stimulus complexity, can be explained by a model that also resorts to external events. For example, Glicksohn (2001) proposes a model that is based on the notion of a single pool of attention, part of which can be directed at external events and the other to internal events: externally-oriented attention would be reflective of instrumental processing, while internally-oriented attention would be reflective of absorbed involvement in ongoing experience. Assuming the existence of a common pool of attention, there is a necessary trade-off between externally-oriented and internally-oriented attention: the more absorbed the subject becomes in his or her subjective experience, the slower time appears to be. In Glicksohn's model, the consciousness of time derives from the discrete pulses of mentality the subject subjectively experiences thanks to his or her internally oriented attention. More precisely, apparent duration is the result of a multiplicative function of the size of these pulses and their number:

apparent duration = size of subjective time units (S) x number (n)

Both (S) and (n) are determined by the level of internally-oriented attention (or level of absorption), which in turn is determined by the level of externally-oriented attention. Therefore, according to Glicksohn, time experience is a phenomenon that is strictly and directly linked to both externally -riented attention to external events, and internally-oriented attention to internal states. The fact that "protracted duration" can be brought about by opposite situations (for example, intense emotions or danger vs. meditation or boredom) is explained by Glicksohn as:

> the limit for the functioning of the cognitive timer, achieved by the same multiplicative function (number of subjective time units x size of subjective time units), as one constituent of this relationship progressively increases while the other progressively decreases (*ibid.*, p. 13).

In other words, the state of timelessness can be achieved either by inducing a longer and longer subjective time unit (for example, through meditation), in which case all attentional resources are allocated in inward reflection, or by inducing smaller and smaller subjective time units (for example, in situations of extreme stress), in which case all attentional resources are allocated to the perception of external events.

Actually, what the first objection shows is that the experience of time is dependent not so much on the *nature* of the external event, as on the way subjects *live or perceive* (or as I prefer to say, mentally and attentionally construct) events. In Flaherty's examples what counts more is not the events *per se*, as how much *attention* the subject pays to events, and how he or she deploys his or her attention. The number of "changes" the subject can perceive depends on the amount of attention he or she devotes to events. As we will see later on, the perception of time can be said to be primarily dependent on the way we attentionally and subjectively construct events. In this sense, our experience of time ultimately depends not on the changes exhibited by events, but on the changes we subjectively introduce through deploying and using our attention in a certain way rather than in another one.

As to the second objection, and more specifically to Glicksohn's model, I think that it is certainly valid so long as it shows there is a certain kind of relationship between time perception and external events. In my opinion however, it introduces an overly rigid and direct link between the two that can hardly account for those cases in which the same activity can bring about diametrically opposed experiences of time. Consider for example the case in which the same journey or trip can be judged to have passed either slowly or quickly depending on whether it is, respectively, the first time or the umpteenth time we made it. According to Glicksohn's model, when we pay little attention to external events, we can devote more attention to internal states, and consequently experience an expansion of time. However, precisely the opposite happens when we make the same journey for the umpteenth time. In this case we usually pay little or no attention to what externally occurs, because we already know the road, where to turn, how long a given traffic light lasts, and so on, and can therefore devote more attention to our own thoughts, memories, plans, etc.: despite this, the journey seems to be very short in comparison to the first time we made it. In my opinion, Glicksohn's model can also hardly account for those cases in which the subject decides to change his or her attitude toward the activities he or she performs daily, for example by practicing mindfulness. In mindful states, we become much more aware of details and experience much more sensations than in "usual" states; consequently, we experience daily activities in a richer and more in-depth way than usual, and perceive an expansion of time compared to the way we perceive time in usual states. Steve Taylor (2007) reports, for example, that when he asks his students to guess how much time has passed during some mindfulness exercises he asked them to do (such as: "Look at your hands, paying attention to the different lines and the different textures and shades" or "Eat a sweet carefully and slowly, paying attention to the different sensations and flavours"), "most of them overestimate it, suggesting that it's been moving slowly for them" (*ibid.*, p. 214). In Glicksohn's model, paying more attention to external events implies paying less attention to internal states, which entails a contraction of time (unless a condition of extreme stress is reached, in which case timelessness is achieved). In reality, what happens in mindfulness (which by the way is usually characterized by relaxation and serenity) is that paying more attention to external events brings about an expansion of time; vice versa, performing daily activities in a usual, automatic way, that is, with a low level of attention, brings about a contraction of time. As we

can see, therefore, what counts more is not so much the external event in itself as how much attention the subject decides, or is led, to allocate to it. The relationship between the external event and time perception is not a rigid and inflexible one, but it is mediated by factors such the subject's attitude or habits. I think that if Glicksohn's model was based on the notion of multiple attentional resources (McLeod 1977, 1978, Duncan 1984, Fagot and Pashler 1992, Pashler 1989) rather than on a single pool of attention, it could easily account for the flexibility and variability of the relationship between external events and time perception. Indeed, the cases reported before, in which we perform usual, daily activities, or make a certain action for the umpteenth time, are representative of our ability to divide our attention between different (both internal and external) tasks. When we perform a daily, usual activity X (for example, make a usual journey), we can allocate little attention to it and pay more attention to some other activity Y (such as, listening to music, speaking with other people, and so on). In this case, we also split that portion of attention that we allocate to the evaluation of duration, assigning part of it to X and part to Y. The result is that the attention we allocate to the evaluation of the duration of X is less than the attention we allocated to the same purpose the first time we performed X (when we perform a certain activity for the first time, usually our *whole* attention is absorbed by it, including the attention allocated to time perception). Consequently, having allocated less attention to the estimation of the duration of X, we perceive X as lasting shorter than the first time we performed it.

In addition to Evans' (2004) objections reported above, Lakoff and Johnson's (1999) position raises some other relevant ones. Claiming that the sense of time is created by "such internal *regular, iterative* events as neural firings", and that the sense of duration of an event results from comparing the event "with some *iteration* of such events as the motion of a pendulum or the spinning of the wheels of the clock" (*ibid.*, p. 138; the italics are mine), is clearly putting forward a circular definition of time. Concepts such as "iteration" and "regular", let alone "clock", can only be obtained and built up by means of a more basic and primitive conceptual tool such as time. Indeed, how can you judge or estimate an event as "iterative" or "regular" without an independent parameter against which you can compare the event itself? How can you say that something is repeated "regularly" if you do not have an independent criterion or scale to measure and ascertain the "regularity" of the repetition? How could you even speak and conceive of "regularity" and "iteration" without having previously adopted a principle on, and by means of which you, can build it? And where does this criterion, parameter or principle lie if not in a basic concept such as that of time (or in some other abstract scale derived from time)?

The regularity of perceived successive events is still not the perception of the regularity of events. Tha fact that event X *regularly follows* event Y is given neither in X nor in Y, but is added by us, by one or more of our supplementary mental acts. And there is no doubt that these acts consist, at least partly, in: a) correlating X with Y by means, and on the grounds, of an irreversible – i.e. "temporal" – scale; b) determining the order of the events in the sequence (i.e., X comes after Y); c) determining, on the basis of the temporal scale, the distance between X and Y; d) adopting such a distance as a basic, reference unit against which the distance between the events in each further repetition of the sequence Y→X is compared (as a consequence of the comparison, the repetition of the sequence Y→X can turn out to be either "regular", if the distance between the events of the repeated sequence is equal to the reference unit, or "irregular", if it is not). Only after having performed such operations can one speak of, conceive of, and perceive the regularity with which events repeat and occur.

Lakoff and Johnson's statement that: "The sense of time in us is created by such internal regular, iterative events as neural firings" (*ibid.*, p. 138), reminds me of the evolutionary proposal put forward by the psychologist Goodson (2003). According to Goodson, time is the outcome of the organizing processes of perception, which in turn express and reflect the perpetual interaction between the organism and its ever-changing environment. Rhythm marks the fluctuations of energy and the movement of things in the natural environment: winter turns into summer, the moon waxes and wanes, and so on. "Organisms evolved in a context of such rhythms, and they reflect them in their processes" (*ibid.*, p. 137). There are rhythms in the homeostatic activities of the cell, in the beating of the heart, in the elimination of waste, in the menstrual cycle of the human female, and so on. All these internal rhythms or biological clocks reflect recurrent changes in the environment, and each determines the tempo of some critical activity performed by the organism.

The cadence of events that are important for survival is thus internalized into the organism in various ways. In Goodson's view, the rhythm of responses triggered and sustained by cyclical stimuli becomes the basis on which the experience and perception of time is built: "Where Kant believed that time was an inherited subjective intuition imposed upon by experience, I believe that our perception of time is derived from repeated tempos given in experience" (*ibid.*, p. 139). More precisely, the human being's experience of time is a learned perceptual structure built up in much the same way as those representing size and shape constancy. That is, the individual's multiple and recurring experiences become fused and summarized into a *subjective frame of reference* (or chronocept) which the individual uses each time he or she thinks about time in an abstract way or makes a judgment of how much time has passed:

> In the human being, the internal rhythms of breathing, heartbeat, and other biological processes combine with such recurrent and systematic external changes as the alternation of night and day, the arrival of the postman, the movement of hands on a clock, and so on to become subsumed into the time constancy subjective frame, which then provides the basis for time judgments thereafter. This time constancy frame of reference is automatically imposed, and provides a functional background relative to which all tempos and events are automatically evaluated (*ibid.*, p. 138).

In other words, this time constancy subjective frame (or chronocept) provides an enduring basis for the judgment of tempo, and it is what we are referring to when we use the word time.

In my opinion, there can be no doubt about the evolutionistic origin of the notion of time, as well as for most of, if not all, the notions and concepts produced by the human being. We are what we are (at least, to a considerable extent) because of the continuous selective pressure exerted on us by the environment and other creatures: we represent within our processes and structures the shaping conditions that determined our evolution. Likewise, there is little doubt about the specifically human nature of our experience of time (and space), because we have developed in such a specific way and environment.

However, describing the circumstances that favoured the appearance and development of something is not explaining how that something works and what it consists of. A pure evolutionary description can certainly account for the reasons that brought human beings to consciously experience time, and perhaps also for the fact that their experience of time is

characterized by certain specific features. But this evolutionary description is not yet an explanation of the mechanisms that underlie the experience of time, and make it possible. Describing the evolutionary "why" is not yet explaining the functional "how": one cannot mistake one level of analysis and explanation for the other.

Moreover, the idea that: "our perception of time is derived from repeated tempos given in experience" (*ibid.*, p. 139), and that the chronocept reflects, in a summarized way, the rhythms in which the events of the external environment and of our organism occur and are repeated, has some fundamental drawbacks.

Firstly, it cannot account for the fact that psychological time, that is, time as it is experienced subjectively, does not reflect, and is different from, physical time, that is, the time of physics. As we will see more extensively in a following paragraph devoted to the relationship between physical time and psychological time, phenomenal, subjective time cannot be reduced to the time of physics. If our experience of time really reflected, albeit in a summarized way, the rhythms of the external environment and of our organism, there would not be all the differences and discrepancies between phenomenal time and physical time that psychological experiments have highlighted (Vicario, 2005).

Secondly, the various rhythms of the environment and of the organism are so different both in degree and type that it is not at all easy to understand how they can be "summarized" and what this summarization consists of. How can one combine and reconcile such different rhythms as the rate of breathing and the lunar phases? How can a summarized, mean rhythm account for as irregular rhythms as the menstrual cycle and a heartbeat? (By the way, should the fact the women have a menstrual cycle imply that their chronocept differs from men's?)

Thirdly, it seems to overlook the fact that explaining subjective time by resorting to physical time, whether under the form of the rhythms of the environment or the internal rhythms of the organism, does not explain time at all, but simply postpones its explanation. Calling external rhythms or changes such as the alternation of day and night into question does not clear up the mystery of time any more. What is a "rhythm"? What is an "alternation of day and night"? What do they consist of? How do you explain them? Are they self-explaining phenomena and notions? Or do they need someone else (such as a human being) to perceive, conceive of and explain them?

In my opinion, the latter solution is the only possible one: someone is required to bring them about. Indeed, in order to be able to speak and conceive of - let alone explain - "alternation", one must at least perceive that there are two phenomena ("day" and "night"), that they are different, to think of them as being related to each other, that their relationship involves a given order of occurrence (night comes first, then comes day: that is, they cannot come together simultaneously), and that they are repeated in accordance with the order of occurrence. Without the contribution of such additional operations, and, consequently, without the existence of an operating subject performing them, there could not be any "alternation" between events, or any other kind of relationship between them, or even the events themselves. Evidence of this is also given by the fact that what someone describes as an "alternation", someone else could just as well describe in some other ways, such as a "substitution" (of day for night), a "change" (from night into day), a "progression" (from night to day) or a "sequence" (of night and day), simply by slightly changing one or more of the additional operations. In conclusion, physical time is not given once and for all as a fixed reality either, but in order to come into reality, be seen, conceived of, and explained, it needs a perceiving and cognizing subject able to perform some additional (mental) operations.

2.3. Ceccato's Analysis of Time

To my knowledge, the first serious attempt in linguistic studies to avoid circular definitions was made by Ceccato (Ceccato, 1969, 1972, Ceccato & Zonta, 1980), who always insisted on the necessity of looking for an a-linguistic counterpart of language. Indeed, Ceccato strived to provide definitions of the meanings of words that were not *linguistic* but *operational*, that is, definitions deriving from analyses carried out in terms of operations, namely, mental operations. In this view, he carried out many analyses of meanings in terms of attentional operations, including those of space and time. He used the symbol S for the single attentional state, and used the sign ‾ above the attentional states to indicate their combination and the order in which they are combined. These are Ceccato's analyses of space and time (my translation into English):

> Take a very small object, such as the ball of a ballpoint pen, and try to consider it as being 'spatial'. You notice that, at least for a moment, you have to mentally break it down and articulate it into two pieces, feeling between them a kind of interval and continuing at the same time to sense the unity of the ball. If we were to translate these impressions into operational terms, we would describe the category of space as being composed of a thing ($\overline{SS}$) and a plurality ($\overline{SS}\overline{SS}\overline{SS}$), and it is the state of central attention, of the plural, which generates the sensation of an interval. In other words we would say that the category of space corresponds to articulating pluralistically 'thing'. (…) The category of 'time' inverts the situation: that is, we start off with a plurality (ball at time 1, ball at time 2) and we 'narrow down', unify, condense this plurality into 'thing' (Ceccato & Zonta, 1980, pp. 209-210).

As we can see, for Ceccato, the experience of time is opposed to that of space: it is an experience in which a situation that is composed of a plurality of events or objects - that is, where an event or object is mentally constructed (whether in the form of a perception, an idea or something else) more than once - turns into a situation composed of a single event or object. Ceccato's analysis rightly points out one of the fundamental features of the time experience: the fact that when we see an object from the temporal point of view, or when we live a situation as unrolling or evolving in time, we *repeatedly* experience that object or situation, we perceive, see, imagine, consider or think about it more times.

His analysis however, while representing a first important attempt at describing time experience without using elements which in turn derive from and are built on time experience, is unable to account for at least three fundamental features of the time experience:

a) the fact that by means of time experience we are able to order events, that is, to establish that a certain event A comes before event B. Ceccato leaves the explanation of our capacity to order events completely to the intrinsic *succession* or *sequence* of the two categories of "thing" ($\overline{SS}$) composing the category of "plural" ($\overline{SS}\overline{SS}\overline{SS}$): the order in which events occur is then determined by the bare succession or sequence of the categories of "thing". In fact, he mentions: "ballpoint at time 1, ballpoint at time 2", without explaining how it is possible for us to determine "time 1" and "time 2", that is, how we can construct, perceive or conceive of a given event or object as occurring at "time 1" instead of at "time 2". But how can a succession or sequence explain time order? To have a succession or sequence of things or events we must

have a "before" and an "after", or a "now" and a "then", or a "here", and a "there": one thing or event must follow another in time (or space), and we must know what "to follow" means and implies, otherwise we could neither see, perceive or conceive of a temporal (or spatial) succession or a sequence of things or events, nor a bare a-temporal and a-spatial one ("first", "second", third", and so on), but only have a kind of experience such as "one thing, another thing, still another thing, and so on": an updated now without any awareness of succession or sequence. The very notions and experiences of succession and sequence rely on the more basic experiences of time and space;

b) the fact that our evaluation of the duration of a given period – such as an hour – depends on how much attention we have spent either to perform a given activity during that period (as one can easily notice, for instance, during a strong effort of attention time is long for us, during easy employment it is short), or to focus on or evaluate time itself (as James observes: "a day full of waiting, of unsatisfied desire for change, will seem a small eternity […] It comes about whenever, from the relative emptiness of content of a tract of time, we grow attentive to the passage of the time itself", James 1890, Vol. I p. 626). This latter kind of duration judgement, also known as "prospective duration judgment" or "experienced duration", depends highly on attention (Block and Zakay 2001, and Tse et al. 2004). As Block and Zakay point out: "most theorists propose attention-based models of experienced duration (…) In these models, experienced duration increases to the extent that a person allocates more attentional resources to processing temporal information" (Block and Zakay 2001, pp. 68-69).

c) the fact that psychological time moves only in one direction, that is, it is irreversible.

3. CIRCULARITY IN PSYCHOLOGY

3.1. Circularity in Psychology

The problem of circularity is certainly not new to psychology. William James (1890) observed that the explanations put forward by many authors (for example, Drobisch, Guyau, Herbart, Lipps, Volkmann and Waitz) who had tried to account for which cerebral processes cause the sense of time, simply begged the question: indeed, their explanations, using explanatory notions (such as "elapsed", German, "durchlaufene") that already contained within themselves, and were based on, the experience of time, did not explain time experience at all, but simply *described* it. He also pointed out the fallacy implied in one of the most common and instinctive ways of accounting for the sense of time, namely, the explanation based on the observation that phenomena succeed one after the other. The line of reasoning followed by those who use this kind of observation is more or less the following. 1) Outer forces smite upon the brain first, and then upon our mind: consequently, our perceptions correspond with, and mirror outer reality; 2) Events take place in time; therefore, our perception of events also takes place in time: the time-relations of our perceptions then furnish a copy of the time-relations of the perceived events; 3) The mind, which can feel its own states, also feels the time-relations of its states: therefore, time, sequences and durations

become known by the mind. In other words, the mere existence of time in those changes outside of the mind which affect the mind is a sufficient cause of why time is perceived by the mind. As James observes, the fallacy of this line of reasoning lies in the fact that:

> even though we *were* to conceive the outer succession as forces stamping their image on the brain, and the brain's successions as forces stamping their image on the mind, still, between the mind's own changes *being* successive, and *knowing their own succession*, lies as broad a chasm as between the object and subject of any case of cognition in the world. *A succession of feelings, in and of itself, is not a feeling of succession. And since, to our successive feelings, a feeling of their own succession is added, that must be treated as an additional fact requiring its own special elucidation*, which this talk about outer time-relations stamping copies of themselves within, leaves all untouched (James, 1890, Vol. I, p. 629).

Successive perceptions or ideas are not yet the perception or idea of succession: succession in thought is not the thought of succession. If idea or perception A follows idea or perception B, consciousness simply exchanges one for another. That B comes *after* A is given and implicit neither in B nor in A: it is a *third* kind of conscious experience that is brought forth by us, that is, the product of some additional mental operations we perform and through which we correlate A and B.

3.2. The Internal-Clock Models

Another very popular but, in my opinion, problematic way of explaining time in psychology is that of using the metaphor of an internal or inner clock, whether its workings are occasioned by chemical, neurological or physiological processes.

Hoagland (1933, 1935), for example, hypothesized the existence of a specific chemical clock located in the nervous system that furnishes its possessors with a subjective time scale. He based his hypothesis on the observation that various physical changes taking place in the environment, such as variations in body temperature, modify time-related behaviors and judgments: which makes it plausible to believe that the latter are determined by the working of a chemical clock.

Wiener (1948) suggested that the alpha waves of the EEG could act as the "ticks" of a biological clock and that the alpha rhythm might provide the physiological mechanism underlying our "organ" of time.

Treisman (1963) proposed a model of the internal clock composed of a pacemaker producing a regular series of pulses, a counter recording the number of pulses that arrive at a given point, a store and a comparator, into which the result of the activity of the recorder is entered. He also attempted to determine whether the frequency of this hypothetical pacemaker is related to the alpha-rhythm, but his data failed to support the notion of a correlation between the two (Treisman, 1984).

More recent models (for a review, see Wearden 2001), such as the pacemaker-accumulator clock or the model suggested by the "scalar expectancy theory" (SET), represent a refined elaboration of Treisman's proposal. Let us examine, for instance, the SET model, of which Figure 10 provides a diagram.

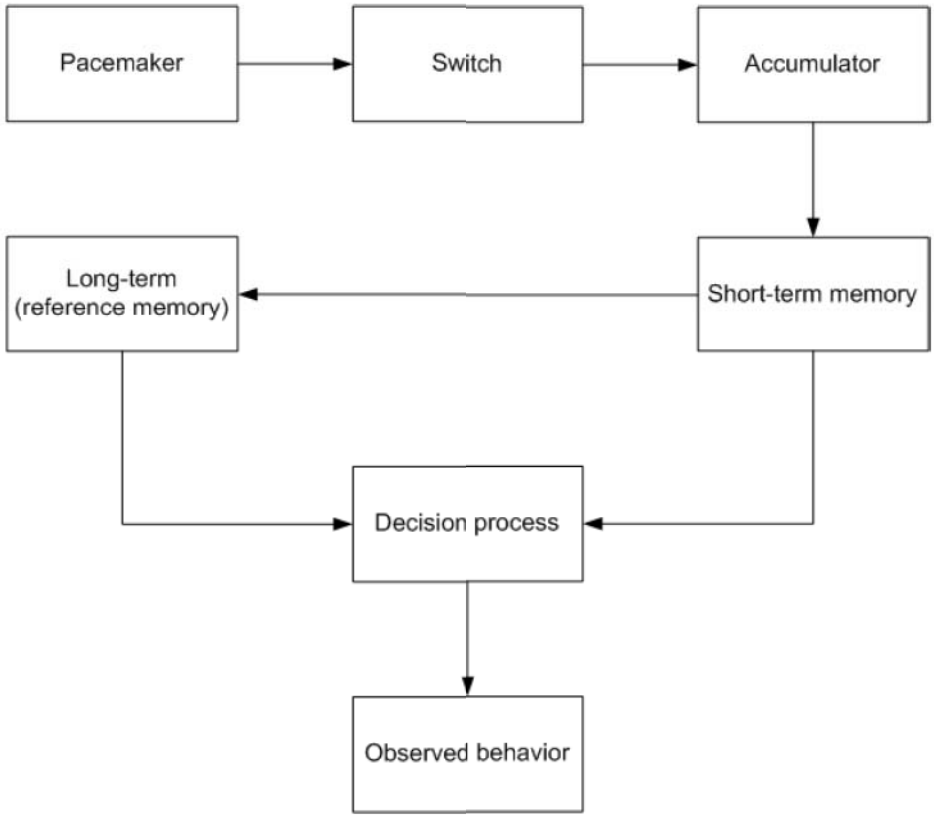


Figure 10. The temporal information processing system proposed by the Scalar Expectancy Theory.

The SET model is composed of three parts: a pacemaker-accumulator, a memory system, and a comparison or decision process. To understand the operation of such a model, consider the problem of timing the duration of a stimulus t_1 through comparison with the duration of another stimulus, t_2 (whether, for example, they are equal or different in length). Onset of stimulus t_1 causes the switch connecting the pacemaker and accumulator to close, allowing pulses, that is, the "ticks" of the inner clock, to flow. Offset of stimulus causes the switch to open, cutting the connection: the accumulation of pulses by the accumulator is then stopped. The memory system allows duration representations to be stored either in a long-term memory or in a short-term memory. Thanks to the memory system, the duration of the first stimulus t_1 can be stored until after the second one, t_2, has been presented: a comparison between the two stimuli is then possible. Finally, t_1 and t_2 are compared and a response can be delivered.

Internal-clock models can account for some phenomena, such as the differences in judging the duration of auditory stimuli versus visual ones. It has been known since the nineteenth century that with the same real-time duration, auditory stimuli appear longer than visual ones. Wearden et al. (1998) showed that the difference in duration judgments between auditory stimuli and visual ones can be modelled in terms of a difference in pacemaker speed for the two modalities. Internal-clock models also account for the differences in duration estimates occasioned by techniques that apparently change pacemaker speed: Penton-Voak et al. (1996) showed that brief trains of clicks (from 1 to 5 seconds long) changed the subjective

duration of auditory and visual stimuli, in a manner consistent with the idea that pacemaker speed had been increased by the clicks.

However, internal-clock models cannot account for everything. As Wearden observes: "not all the timed behaviors of humans are explainable by internal clocks" (Wearden 2001, p. 38). While internal-clock models are used to account for prospective timing tasks, where subjects are alerted in advance that time judgments will be required, they cannot be used, for example, to account for retrospective timing tasks, where subjects do not know in advance that they will later be asked to judge the duration of a time period. Retrospective timing tasks, on the contrary, are explained using models involving the number of contextual changes which occurred during the period whose duration has to be judged (Block and Zakay 2001), or the amount of information processed (Ornstein 1969).

Moreover, various kinds of criticisms have been raised against the models based on the idea of an internal clock. According to Block (1990), for example, internal-clock models are certainly suited to handling relatively simple relationships such as that between body temperature, arousal, and response rate; however, they seem unable to explain why cognitive kinds of factors, such as strategies, influence temporal behavior and experience. Furthermore, he observes that internal-clock models seem inadequate to explain the inherent inaccuracy of human duration judgments, that is, the fact that organisms provided with such a precise mechanism as an internal clock very often exhibit inaccurate timing behaviors. Block (2003) also points out that internal-clock models have some more specifically technical and methodological drawbacks: 1) no constant-rate pacemaker has been identified in the brain; 2) researchers advocating internal-clock models have mainly studied rats and pigeons; 3) most of the evidence comes from a few relatively simple paradigms (such as the peak procedure and the bisection task), from studies in which animals estimate the duration of a single stimulus or an interval between two stimuli, and from experiments during which no external stimuli are presented; 4) internal-clock models are not easily able to explain the effects of attention on psychological time; 5) many of the findings that internal-clock models explain are generic, that is, they are not unique to the time dimension. The same findings of internal-clock models could be explained by models composed of very basic modules, such as a perceptual system, without needing to resort to an additional component such as the pacemaker. As Block states: "With only slight modification (e.g., substituting external stimulus information for the pacemaker), scalar-timing models could easily become scalar-perceiving models" (Block 2003, p. 44); 6) the typical internal-clock assumption that time estimates are a linear function of physical duration is not widely supported.

Ornstein (1969) raises some other interesting questions concerning the individuation of the internal clock. Apparently, human beings, as well as other animals, are provided with a number of different mechanisms that could all equally and finely act as internal clocks: heart rate, breathing rate, cellular metabolism, toe-nail growth, alpha rhythm, etc. What are the criteria for judging a given physiological process to be an internal "chronometer"? Why could hair growth or toe-nail growth rather than alpha rhythm not be designated as the internal time keeper? Moreover, as Ornstein observes, these different mechanisms do not always run at the same rate: the breathing rate, for example, is different from the brain cell metabolism. Therefore, which could be the "biological clock"? Is there a rate or rhythm that could be considered more basic than the others? Or is it a combination of some or all of these internal periodic rhythms that must be considered as the internal time keeper?

In this regard, Richelle et al. (1985, p. 90) go so far as to pose the provocative question: "Why not admit that there are as many clocks as there are behaviors exhibiting timing properties?". This nasty admission definitely confirms the uselessness and lack of parsimony of the notion of the internal clock for a general analysis and explanation of time experience. If there are as many internal clocks as time behaviors and experiences, what is the epistemological and practical usefulness of the notion of internal clock, given the wide variety and complexity of the experiences of time? Not only can we have various conscious experiences of time, such as short and long durationas, simultaneity, succession, etc. but also perceive each of them in different ways, according to how many different conditions such as body temperature, contextual changes, information load, fatigue, etc. vary. If we suppose that every behavior exhibiting timing properties requires its own internal clock, then what we can expect is only an incontrollable expansion of the number of these clocks. To reiterate a well-worn dictum, in science we strive to explain the most with the least: any explicative model that increases complexity instead of reducing it must be rejected.

Obviously, as it has been observed (Ornstein 1969, Block 1990, Vicario 2005), the notions of internal clock or biological clock may have some relevance in the explanation of periodic physiological rhythms *per se*. Undoubtedly, such notions seem to be necessary if one wants to explain, for example, human movement timing and motor programs, and, to a certain extent, also prospective timing (Block and Zakay 1996, 2001, Zakay and Block 1997). Indeed, as I will show later, it seems reasonable to suppose that some kind of mechanism - akin to, *but anyway different from*, a clock or a pacemaker - supplying in a more or less regular way the basic material on which to build and perform temporal processing, is involved in time experience in general.

However, this is not sufficient. What seems to me highly implausible is the belief that merely naming a given process as a "time keeper" automatically suffices to appoint it as the mechanism responsible for time experience. A counter or a timer, like any clock, can only provide the raw material necessary for counting. But there must be someone who performs the counting. As Vicario argues: "*The clock says the hour only when we look at it*" (Vicario 2005, p. 165). It is we who assign the physical mechanism - whether it is a pendulum, the sun, a clock, or something else - the capacity to trace the flowing of our conscious experiences and to estimate their duration. To realize this, just consider the fact that a clock which has stopped or is not working, despite not measuring any actual time, can still be interpreted by an observer as telling the time!

The big problem with explaining time experience in terms of an internal or inner clock lies in the circularity it implies. Clocks, as well as chronometers, watches, sand-glasses and the like, were developed on, and thanks to, the original capacity human beings have to subjectively experience time: they are the product of our mental, physical and psychological capacities. Well, by explaining temporal experience through the notion of an internal clock, one simply begs the question, because one uses the result of an activity - that is, what can be done and developed thanks to that activity - to account for the activity itself: it would be tantamount to using the notion of flour to explain how a mill grind grains, what machinery performs the grinding, on what physical principles, and so on!

Moreover, the limitation of of the internal clock hypothesis is further highlighted by the consideration that clocks are just one of the possible products that were developed out of the various kinds of temporal experiences human beings can have. Indeed, clocks are products based on one specific (albeit very basic) kind of temporal experience: the continuous flowing

of our conscious experiences. However, we can have other kinds of temporal experiences as well: the experience of their succession, simultaneity, rhythm, duration, instantaneity, irreversibility, and so on. While clocks and watches were developed in order to account, as precisely as possible, for the continuous flow of our conscious experiences, chronometers were developed in order to measure their (typically short) duration, metronomes to beat time, synchronization systems - such as those used in telecommunications - to maintain simultaneity, calendars were developed to account for irreversibility (of days, weeks, seasons, years, etc.). Each one of these instruments has its own specific function, and cannot (or can hardly) be used to perform any of the functions performed by the other instruments. You cannot use a calendar or a pocket diary to measure what a watch measures (a pocket diary cannot tell you what time it is now); conversely, you cannot use a watch to account for what a calendar or a pocket diary accounts (if you are alone on an island, and you forget what day of what month of what year it is today, you cannot count on your watch to give you this information - unless of course your watch is provided with some kind of calendar). When one of these instruments can be used instead of one of the others (such as when you use a watch to beat time), you must intentionally change your usual attitude towards it (when beating time, you will pay attention not to what time it is, but to the number of elapsed beats, and to the fact that they have to be repeated after a certain number of them has elapsed). Clocks therefore can account only for the continuous flowing of our experiences, but not for the other temporal experiences. Consequently, using clocks to also account for the other kinds of temporal experiences would prove to be inadequate.

3.3. Models Alternative to the Internal-Clock Model: the Storage-Size Model

As stated at the beginning of this chapter, one of the main negative impacts and perverse effects of circularity in scientific explanation, and on knowledge development in general, is that of diverting the scientists' attention from taking into due consideration the fundamental importance played by their mind in constructing and shaping the phenomena they are investigating. The notion, or metaphor, of an internal clock has precisely this very property: giving an intuitive, apparently easy, immediate and appealing, but illusionary, solution to (at least some of) the problems related to how we humans, as well as some other species, can estimate time and coordinate motor programs, and how periodic physiological rhythms can occur, and so on, it distracts the researchers' attention from taking into due consideration the mental processes that contribute to shape, give form to, and produce the experience of time, thus blocking the advance and growth of human knowledge.

Ornstein was well aware of the treacherous mechanism of the internal-clock model, and of its fatal consequences for the study of mind and human cognition. According to him, this model was based on the idea that "there would exist a 'real' time independent of us" (Ornstein 1969, p. 34), that is, an external time existing outside the organism, and that we are provided with an "organ" of time experience (namely, the internal-clock) capable of measuring the real, external time. According to this idea of an "external time", our role in time experience would be a very limited and restricted one: we would be relegated to acting as a passive tool which can only mechanically and automatically register and measure what is going on "out there".

As Ornstein argues, this is a very unrealistic picture of time experience: a picture which cannot account for the fact that our experience of time is strongly influenced by cognitive factors such as the amount of information processed during the interval whose duration has to be estimated, the complexity of the processed stimuli, the way stimuli are stored in memory, memory load, the observer's level of attention, and so on. In a series of experiments on remembered duration, or retrospective timing task, in which subjects were kept unaware that their experience of time was being studied, Ornstein (1969) found that either storing more stimuli during a time period, storing more complex stimuli, or storing them in a more complex way, lengthens the subject's experience of duration. In Experiment I, for example, subjects had to listen to three tape recordings, each of the same clock length (9 min. and 20 sec.), on which events (tones of 0.2 sec.) appeared at three different rates: on one tape, events appeared at the rate of 40 per min., on another tape at 80 per min., and on still another tape at 120 per min. Subjects judged the 80 per min. condition to be longer than the 40 per min. condition, and the 120 per min. condition to be the longest. He found that some other cognitive factors, such as familiarity with stimuli, learnt coding schemes, the pleasantness of stimuli and their propensity for being retained in memory, are brought to bear on duration judgment. When for example subjects were taught different schemes to code the same event, they tended to judge the event in which more was construed to have occurred as being longer (Experiment VI). Likewise, when conditions were arranged so that subjects in one condition forgot more than subjects in another, the experiences co-varied with the amount in storage (Experiment VII). Ornstein also showed that when the information stored in memory is somewhat manipulated and altered, the experience of duration is altered correspondingly: by having subjects recode a "random" or complex stimulus into a simpler one after the interval was completed, their experience of duration was shortened relative to those who did not recode the stimulus (Experiment VIII).

On the basis of all this evidence, Ornstein inferred that time experience can be best accounted for by the "storage size" metaphor, which explains duration as a mental construction formed from the size of storage of the information in a given interval: that is, it is the information remaining in storage that determines duration experience. According to this metaphor, anything which alters the size of storage of the information in a given interval will also affect the experience of duration of that interval: an increase in the number of intervals occurring within a given interval, or an increase in the complexity of these events, or a reduction in the efficiency in the way events are coded and stored, would each lengthen the experience of duration of that interval. As Ornstein conclusively observes: "We then *create* our own duration experience from our memories" (*ibid.*,, p. 110).

Ornstein's storage size model has its own limits, as Ornstein himself admits. It accounts primarily for one mode of time experience, duration, and cannot be used to account for all the other modes of experiential time (irreversibility, continuity, simultaneity, and so on). Moreover, even as far as the pure experience of duration is concerned, his model does not always hold.

Firstly, it accounts only for one kind of duration judgment: retrospective duration judgments (that is, when subjects do not know in advance that they will later be asked to judge the duration of a time period). It cannot account for what is found when the opposite paradigm is used: prospective duration judgments (that is, when subjects do know in advance that they will later be asked to judge the duration of a time period). While Ornstein's model predicts that an increase in the number of stimuli occurring within a given interval lengthens

the experience of duration of that interval, experiments in which subjects are required to make prospective judgments show that the experience of duration shortens when more information is processed. In a typical experiment on duration judgment (Hicks, Miller and Kinsbourne 1976, Hicks et al. 1977), subjects were asked to prospectively judge the duration of the time period in which they had to perform a certain task: sorting a stack of playing cards following the instructions the experimenter had given to them. The instructions required the subjects to allocate resources to processing non-durational information according to three different levels of increasing difficulty: in the 0-bit condition, subjects were told to hold the cards face up and deal the cards into a single stack as fast as possible during the interval to be judged; in the 1-bit condition, they were told to deal the cards into two stacks, one for red and one for black, as fast as possible; in the 2-bit condition, they were told to deal the cards into four stacks on the basis of suit. The experiment showed that judged time decreased linearly with the increased processing demands of the non-durational information. Therefore, experiments using the prospective time paradigm, in which subjects must not only judge the duration of a time period but also perform a concurrent task occurring during the same interval, or process non-durational information about stimuli during the interval to be estimated, show that perceived time generally contracts as a function of the amount of non-durational information to be processed, or the difficulty of the concurrent task (see also Block and Zakay 2001, Brown 1985, Zakay and Tsal 1989).

Secondly, Ornstein's model cannot even account for all the factors influencing retrospective duration judgments, that is, precisely the kind of duration judgment for which the storage size model was explicitly developed. As Block and Zakay observe (Block 1990, Block and Zakay 2001), people do not simply base retrospective duration judgments on the degree of recallability of events from the time period: other factors are involved as well. For example, people do not attempt to retrieve *all* available memories from the time period: instead they probably rely on an availability heuristic by means of which they remember a duration as being longer to the extent that they can easily retrieve *some* of the events that occurred during the time period. Another factor that strongly influences retrospective duration judgments is contextual changes. Block and Reed (1978) found that people judged a time period as being longer in duration to the extent that there were greater process context changes: this finding cannot be easily handled by the storage size model.

Thirdly, the storage-size model is seriously flawed by the fact that it is based on an implausible metaphor of memory as a process running in a digital computer. As Block observes (Block 1990, p. 23): "Compared to memory processes in digital computers, human memory functions in a more interconnected way, reflecting a continual reorganization of previously encoded information".

Apart from these undeniable limits, Ornstein's work has at least two important merits. The first, is that of having clearly evidenced and stressed the perfidious influences that the internal-clock model brings to bear on the study of mind and human cognition: the adoption of the internal-clock model, implying the idea of or belief in the existence of an external time, independent of ourselves, unjustifiably minimizes the function and importance of mental processes in producing and forming the experience of time, and consequently distracts the attention of researchers from duly investigating and taking them into consideration. Ornstein's second merit is that of having contrived some of the experiments by means of which it is possible to empirically ascertain the role and level of involvement of mental processes in building the subjective experience of time.

3.4. Attention-Based Models

As we have seen, experiments on duration judgments in which subjects were asked to prospectively judge the duration of the time period in which they had to perform a certain task, revealed that judged time decreased linearly with the increased processing demands of the non-durational information, and that experienced duration increased to the extent that subjects could allocate more attentional resources to the flow of time itself (Brown 1985, Hicks, Miller and Kinsbourne 1976, Hicks et al. 1977, Coull et al. 2004). In short, a heightened awareness of the passage of time itself produces a lengthening of the experienced duration. As William James observed:

> Tracts of time (…) shorten *in passing* whenever we are so fully occupied with their content as not to note the actual time itself. A day full of excitement, with no pause, is said to pass 'ere we know it'. On the contrary, a day full of waiting, of unsatisfied desire for change, will seem a small eternity. (…) It comes about whenever, from the relative emptiness of content of a tract of time, we grow attentive to the passage of the time itself (James 1890, Vol. I, p. 626).

Thus, a prospective duration judgment can be assimilated to a dual-task condition in which attention must be divided between temporal and non-temporal information processing (Block and Zakay 2001, Zakay and Block 2004). For this reason, some theorists have proposed an attention-based model to explain prospective duration judgements or experienced duration. According to Thomas' model (Thomas & Brown 1974, Thomas & Weaver 1975), for example, in prospective duration judgments, subjects are faced with a dual task in which they have to share their attention between temporal and non-temporal processing. As non-temporal task demands increase, less attentional capacity is allocated to temporal processing, and perceived duration generally shortens in comparison to judgments of intervals in which the only task is to keep track of time.

The attentional-gate model proposed by Block and Zakay (Block and Zakay 1996, Zakay and Block 1997) is an evolved and more refined version of the models previously designed within the internal-clock paradigm (such as, for example, the pacemaker-accumulator clock or the model proposed by the "scalar expectancy theory", shown in Figure 10). It contains not only the same modules as those characterizing the previous models, such as a pacemaker, a switch, an accumulator or counter, a memory system, and a comparator, but also an attentional source and an attentional gate. Moreover, it accounts for the possibility that the pacemaker increases the number of produced pulses per unit of time with higher levels of arousal.

According to the attentional-gate model, a subject can divide his or her attentional resources between a temporal task and a non-temporal task. Attending to the temporal task opens the attentional gate, allowing pulses produced by the pacemaker to pass to the counter. Compared to traditional attentional models (such as Thomas's, for example), the attentional-gate model accounts for the facts that:

i) prospective judgments depend not only on the amount of attention allocated to time, but also on the arousal level. Traditional attentional models, assuming a constant pool of attentional resources, cannot explain why reproduced durations (that is, durations estimated by means of the method of reproduction, in which subjects are

asked to delimit a second time period corresponding to their previous experience of the duration to be estimated) are shorter when the duration to be estimated (or target duration) is filled with events (e.g. the flickering of a bulb) occurring at a slower rate (e.g. 0.5 flashes per sec.: slow external tempo) than when it is filled with events occurring at a higher rate (e.g. 2 flashes per sec.: fast external tempo). On the contrary, the phenomenon can easily be explained if one assumes that the faster external tempo leads to increased arousal. Indeed, increasing the arousal level leads the pacemaker to produce more pulses per unit of time, making the subject reproduce lengthened durations with increased external tempo. The attentional-gate model, incorporating the notion of arousal, and linking the working of the pacemaker to the arousal level, can account for the phenomenon;

ii) prospective reproductions are typically shorter than target durations. While traditional attentional models cannot explain this phenomenon either, the attentional-gate model is able to account for it. According to the attentional-gate model, during a reproduction all attentional resources are allocated to timing: the gate is opened more widely than during the target duration, when attention is divided between timing and a concurrent non-temporal task. Therefore, during the reproduction, the pulse stream transmitted through the gate is greater than it is during target duration. A reproduction ends when a match is achieved between the current pulse count and the count representing the target duration. The wider gate during the reproduction means that this match occurs after a shorter duration than the duration during which the target count is accumulated.

Evidence supporting the hypothesis that prospective duration judgments can be considered equivalent to divided-attention tasks also comes from studies that show how attentional resources can be allocated to processing temporal information not only implicitly, by modifying the difficulty of the secondary task as in Hicks, Miller and Kinsbourne's experiment (1976), but also explicitly, by prior instruction on how much attention to allocate for non-temporal stimulus features and how much to allocate for temporal features (Macar, Grondin and Casini 1994, Zakay 1998). Zakay (1998), for example, using a dual task paradigm, showed that the magnitude of prospective duration judgments increased when subjects were told that the temporal task was the primary task and that a simultaneous non-temporal task was the secondary task.

In my opinion, the main problem with attention-based models, as they have been designed up until now, lies in the circularity intrinsic to their main statement: that in prospective duration judgments, experienced duration increases to the extent that more attentional resources are allocated to the *flow of time itself*. Attention-based models explain temporal experience by resorting to the very notion of time. According to attention-based models, the experience of duration depends on, and is determined by, the amount of attention allocated to *time itself*: which is tantamount to explaining one of the dimensions of time, duration, by means of time itself. By pointing out the circularity intrinsic to their main statement, I do not intend to claim that they did not make any contribution to expanding our knowledge of the phenomenology of temporal experience: I believe, on the contrary, that they certainly contributed to empirically confirming what psychologists like James had only intuited, giving full details of the circumstances that bring about the phenomenon. What I intend to say is that their proposal adds nothing to the explanation of where our experiences

of time and duration come from, and which mechanisms are responsible for their production: they simply describe, albeit in a very articulated way, the circumstances that alter and condition our perception of time and duration.

Even Block and Zakay's attentional-gate model (Block and Zakay 1996) - although it additionally and explicitly indicates and specifies which kind of information a person could attend to when he or she focuses on time itself (i.e. the pulses produced by the pacemaker) - eventually resorts to a sort of internal-clock, which, like all internal-clocks, presents not only the drawbacks Block (1990, 2003) himself recognizes, but also those other inconsistencies and inconveniences I highlighted above. Incidentally, it should be noted that the alternative, pacemaker-free explanation Block puts forward (Block 2003) regarding prospective duration judgments, does not seem to be completely free from circularity either. Block (2003) proposes a memory-age model of prospective duration timing, which should be a plausible alternative to internal-clock models. The memory-age model uses the notion of "distance-based processes". Distance-based processes are those that involve judging the recency of an event in a way that is influenced by changes in the characteristics of memories, such as declines in vividness, elaborateness or accessibility of memories. Plainly speaking, according to a distance-based explanation, an event is recent if its memory is clear, while it is judged to be old if its memory is dim. Researchers usually contrast distance-based processes with "location-based processes" (for a review of the two processes, see Friedman 2001): the latter let us judge the recency of an event by retrieving whatever information is associated with it in memory, and relating this information to our rich store of knowledge about personal, natural, or social time patterns. While distance-based processes involve a judgment of the vividness of the memory for the event, and are based on the subject's capacity to have and rely on some impressions of the ages of the events, location-based processes involve inferences about other events in which the event was embedded. The difference between distance-based and location-based processes can be better understood if we consider the phenomena of "scale effects": a person may be quite accurate in dating an event as having occurred at a particular time of day (an evaluation based on location-based information), but quite inaccurate in remembering the day, month or year that the event occurred (an evaluation based on distance-based information). Evidence would seem to suggest that both distance- and location-based processes can be explained by resorting only to normal memory and cognitive processes, without any need to assume separate internal-clock mechanisms. According to Block (2003), prospective duration timing could be based on distance-based information, that is, on the apparent age of events. More precisely: "interval timing involves comparing *apparent ages* of events" (*ibid.*, p. 49; the italics are mine) and: "every act of attending to time involves retrieval of information concerning *the apparent age* of the previous act of attending to time" (*ibid.*, p. 50; the italics are mine). As one can easily see, the main hypothesis on which Block bases his explanation of ongoing duration timing in humans (i.e. that human beings have the capacity to have, and rely on, their own impressions of the ages of the events) does not explain time experience at all, but simply *describes* and *presupposes* it. Indeed, in Block's explanation, the capacity of human beings to estimate duration is based on their capacity to have impressions of the *ages* of the events: and this notion of "ages" clearly already includes the experience of time. Nor does the hypothesis that the capacity of human beings to have impressions of the ages of the events would be based on the capacity to perceive changes in the characteristics of memories (such as declines in vividness, elaborateness or accessibility of memories), seem to offer a better solution to the conundrum of subjective time experience.

We can have very clear memories of events which occurred a long time ago, or even in our infancy, and yet be unable to remember what we ate yesterday: however, the latter event does not seem to us to have occurred earlier than the former. Not always can the vividness or accessibility of memories account for their ages.

Lastly, as far as the general validity and applicability of attentional-based models is concerned, it should be noted that their predictions do not hold in those circumstances characterized by shocking or unexpected events. When facing shocking or unexpected events, prospective duration judgments are not always consistent with the predictions of the attention-based model: sometimes, contrary to what the attention-based models expect, subjects tend to *overestimate* the duration of shocking stimuli or stimuli requiring more attentional resources. For example, in a work by Angrilli et al. (1997), which had the main purpose of studying the influence of stimulus-induced emotional "arousal" and "affective" valence on the estimation of temporal intervals spent passively attending to the stimulus itself, subjects had to prospectively estimate the duration of a series of slides showing images belonging to four different categories defined by the intersection between the valence dimension (two levels: negative emotions vs. positive emotions) and the arousal dimension (two levels: low vs. high). Subjects were assigned to one of two estimation conditions: in one case subjects had to mark on a graduated analogue scale the perceived duration of the stimulus, in the other case, subjects had to reproduce the interval by pushing a button for a duration that matched the duration of the perceived period. Angrilli et al. collected heart rate, as an index of attention, and skin conductance responses, as an index of arousal, in order to measure the attentional processing and the arousal processing during the time processing period. Angrilli et al. found that: a) negative slides, regardless of the arousal level, elicited a stronger orienting reaction from the subjects suggesting that more attention was paid to negative slides than to positive slides; b) time perception during presentation of *low* arousal material was consistent with the predictions of attention-based models (according to which the duration of an interesting or complex stimulus is underestimated because the information processing of the stimulus requires a larger amount of attentional resources): positive low-arousal slides (such as: dog pets or happy babies), inducing less information processing, were relatively overestimated, whereas negative low-arousal slides (such as: big spiders or rats in the dirt), inducing a larger amount of information processing, were relatively underestimated; c) however, time perception during presentation of *high* arousal material was not consistent with attention-based models: negative high-arousal slides (such as: dead cut bodies or babies with eye tumors), inducing a stronger attentional response, were overestimated compared with positive high-arousal slides (such as: naked couples or erotic couples), inducing a weaker attentional response. The high arousal trend therefore conflicts with the attention-based model. Angrilli et al. concluded that their findings testify for: "a double mechanism triggered by arousal levels: an attention-driven mechanism at low arousal levels, clearly consistent with attentional models, and an emotion-driven mechanism at high arousal levels" (*ibid.*, p. 979).

Likewise, Tse et al. (2004) found that when a series of stimuli, each lasting the same objective duration, are shown in succession, subjects tend to report that the low-probability oddball stimulus in the series lasts subjectively longer than the high-probability stimulus (four different psychophysical methods were used to assess prospective time judgments: the method of constant stimuli, the method of magnitude estimation, the method of stimulus duration reproduction, and the method of single stimuli). Assuming that observers orient or attend to a low-probability stimulus more than they do to a high-probability stimulus, Tse et

al. conclude that this phenomenon, which they name *time's subjective expansion* (TSE), is due to the fact that: "the engagement of attention by un unexpected event (…) may actually increase the rate of information processing brought to bear on a stimulus" (*ibid.*, p. 1184). Their hypothesis that TSE is really due to an attentional effect is supported by additional findings (experiments 1B, 2, and 4) that: a) the expansion of perceived duration occurs only for objective durations above ~ 120 msec., but not for objective durations below this value: which reflects data showing that at least 120-150 msec. are required before attention can be fully allocated to a new detected stimulus (Nakayama and Mackeben 1989); b) the curve of the temporal expansion factor (temporal expansion factor = standard time / Point of Subjective Equality of oddball) for stimuli of different objective durations reflects the data showing that attention has two components, one transient, or exogenous, and one sustained, or endogenous. These two attentional components have different temporal dynamics: once attention is fully allocated to the stimulus, a transient component of attention peaks within approximately 100 msec. As the transient component weakens, a sustained component of attention comes to dominate that does not fade as rapidly (Nakayama and Mackeben, 1989); c) the basic pattern of results are found for both visual stimuli and auditory ones suggesting that the mechanism underlying TSE is a central process, just as attention.

Summarizing Tse et al.'s findings, and Angrilli et al.'s findings: subjects, when facing an unexpected or shocking stimulus A, pay a higher level of attention to it than when facing a neutral stimulus B; despite what is predicted by attention-based models, they perceive the more attended stimulus A as lasting longer than the less attended stimulus B that lasts the same objective duration as A (see also Flaherty 1999). The findings show therefore that the behavior of subjects during prospective duration judgments does not follow the homogeneous, consistent pattern hypothesized by attentional-based models.

3.5. Physical Time and Psychological Time

One of the main sources of circularity in studies of time is the bias towards considering time as a real, ontological entity existing in itself, independently of anything else. This bias is certainly well expressed by Newton's conception of time as a physical, absolute entity, which "flows equably without relation to anything external". The belief in an absolute, real time makes people explain any possible manifestation and aspect of time by referring it to that original, absolute, real time. Unavoidably, this implies giving up any attempt at defining time in positive, non-circular terms, that is, independently of itself. In fact, any manifestation and aspect of time, whether it refers to a subjective experience of duration, to an objective occurrence, or to something else, is reduced to, and explained by, absolute, real time, which in turn, being "original" and "real", can be explained only through itself, in a self-referential way.

Psychology has not been immune to the bias towards considering time as a real, ontological entity. Many psychologists have been led, for example, to explain psychological, phenomenal time in terms of an absolute, Newtonian, physical time, and, consequently, to believe that phenomenal time has to be analyzed in terms of, and reduced to, the physical time of physiological processes. This stance entails not only an inevitable circularity when the definition and explanation of time is involved, but other drawbacks as well. We have already seen some when dealing with Ornstein's criticism of the internal-clock model (Ornstein

1969). Others were highlighted by psychological experiments on the perception of simultaneousness, succession, and instantaneity, and on time estimation, which revealed the groundlessness of the prejudice about the necessity to treat and analyze phenomenal time in the same way as physical time, and to regard the latter as more real and fundamental than the former.

No doubt, one of the most striking and a counter-intuitive phenomenon is that of *temporal displacement*: given a sequence of very brief stimuli, say a-b-c, subjects often perceive a different sequence, say A-C-B. The phenomenon, which had been noticed by astronomers in the early 19th century, was named *Zeitverschiebung*, or temporal displacement, by Wundt, and largely investigated by psychologists (Wundt 1902, Benussi 1913, Rubin 1949, Ladefoged and Broadbent 1960).

Vicario (1963) devised an experiment in the auditory field using triplets of stimuli such as a_1-b-a_2, where a_1 and a_2 are high tones of 1760 and 1568 Hz respectively, and b is a low tone that is very different from the other two: 82,4 Hz (see Figure 11a). For tones lasting 100msec each, subjects perceive a succession of high notes followed by a low note (see Figure 11b). As Vicario observes (2005), it is as if the succession of similar, high notes has "expelled" the different, low note, relegating it to a position where it cannot disturb the succession.

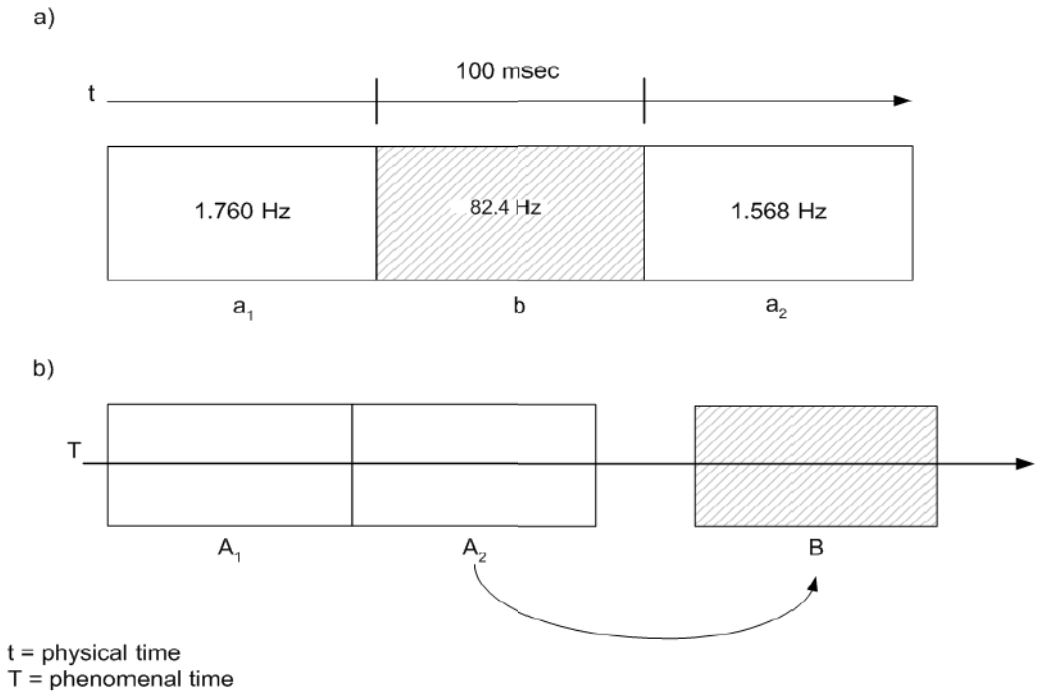


Figure 11. Vicario's experiment on temporal displacement.

Vicario (2005) observes that:

a) The displacement of the central note takes place only when stimuli are sufficiently short. For stimuli longer than 150msec, the sequence of notes perceived by subjects

tends to correspond to the sequence of the physical stimuli; when stimuli are shorter than 150msec, subjects tend to perceive the central note as displaced. According to Vicario, this finding supports Stern's hypothesis about the existence of the *Präsenzzeit*, or "phenomenal present", that is, the interval of physical time that, despite being composed of non-simultaneous parts, is perceived as a unitary and unique act of consciousness (Stern 1897). Temporal displacement takes place only if the sequence of physical stimuli occurs within this interval; if the sequence of stimuli occurs outside the "phenomenal present", temporal displacement does not take place.

b) With short stimuli of equal length, the probability that temporal displacement takes place increases as the tonal distance between the central note and the lateral notes grows.

On the whole, the experiments on temporal displacement clearly show that: a) a non-temporal characteristic, such as the qualitative difference of pitch between tones (low vs. high), determines a temporal characteristic (perceiving a stimulus as occurring after or before another stimulus); b) phenomenal time does not correspond, and cannot be reduced, to physical time: the former can be neither explained, nor understood in terms of the latter. Phenomenal time also depends on principles of organization, such as the Gestalt ones, that do not hold true for physical time: short, succeeding stimuli are perceived not as separated and isolated items following one another, but as parts of a whole, where the characteristics of the single items (i.e. being perceived as coming after or before) are determined by the global structure comprising them.

An even more astonishing piece of evidence corroborating Vicario's observation that phenomenal time is not the same as, and cannot be reduced to, physical time is provided by the phenomenon of *continuous displacement* or *stream segregation*, described in Bozzi and Vicario (1960). When subjects listen to a sequence of stimuli composed of the four tones shown in Figure 12a that is repeated cyclically, they will hear a single sequence of low and high sounds if each stimulus lasts about 200msec (Figure 12b), and *two different synchronized sequences* of sounds (a low trill and a high one) if each stimulus lasts about 50msec (Figure 12c).

According to Vicario, the phenomenon of continuous displacement, which can also be observed in visual experiments (Vicario 1965), can be classified as a case of *double representation*: a single physical (whether spatial or temporal) event or object gives rise to the perception of two different, but simultaneous events or objects. A paradigmatic example of double representation is the well-known cross of Fuchs-Metzeger. Double representation can be explained as an adaptive advantage that allows the human being to simultaneously perceive two different things from a single point of observation without spending additional energy or time.

The experiments on temporal displacements and, even more so, those on continuous displacement inflict a fatal blow on any theory that conceives phenomenal time as being an internal, subjective, and distorted copy, duplicate or representation of a purer, realer and more original form of time: the external, objective time of physics. What the psychological observation and analysis of perception reveals is that the order of perceived events does not correspond, and is sometimes in contradiction, to the order of physical events: what is "before" in phenomenal, subjective time can be "after" in physical time, and vice versa; what

is perceived as contemporaneous or simultaneous in phenomenal time, can be a sequence of events in physical time.

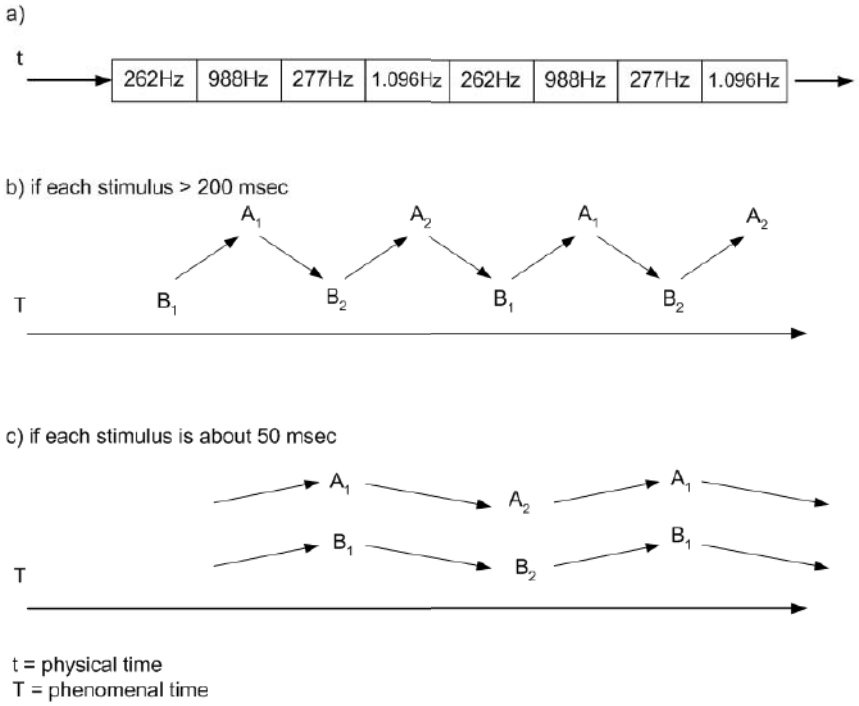


Figure 12. Bozzi's and Vicario's experiment on continuous displacement.

Moreover, while in physical time simultaneousness excludes succession – A cannot be simultaneous with B, and, at the same time, occur before B -, in phenomenal time the former does not exclude the latter, and vice versa. Indeed, under certain conditions, for instance, with sufficiently short stimuli, we can have the sensation that some non-simultaneous events are nevertheless also non-successive, and vice versa. From perceived simultaneousness to perceived succession there are various intermediate perceptual possibilities: heterogeneity, discontinuity, apparent movement; events can be perceived as "floating" in an undefined space, etc. (Vicario 2005, p. 116).

What holds for simultaneousness and succession also holds for continuity and discontinuity. Events that at the physical level are discontinuous can be perceived at the phenomenal level as continuous: As the phenomena described by Vicario (2005) show – the "tunnel effect", the "Renard effect", the perception of stopping, the "window effect", the stroboscopic movement -, a physical discontinuity is perceived as a phenomenal continuity; an object that has stopped, or that is still, is perceived as moving.

Moreover, the boundary between perceived continuity and perceived discontinuity is not very clear: between the two we can have different and various sensations. If in the realm of physics it is quite easy to distinguish what is continuous from what is not, in the realm of perception continuity and discontinuity represent the two extremities of a series of possibilities: in some cases, the movement of an object can be described, for example, as a compromise of continuity and discontinuity (Vicario 2005, p. 66).

Similar discrepancies between the realm of physics and the realm of phenomenal experience can also be observed for the relationship between cause and effect. As the "window effect" shows, as well as the "phi phenomenon", the causal theory of time, according to which a cause of a certain effect always precedes the effect in time, and, in turn, the effect always follows its cause in time, while being always valid in the realm of physics is not always valid in the realm of perception. In the realm of perception causes may lie not so much in the past as in the future. The usual relationship between what comes "before" and what comes "after" in the time of physics is sometimes overturned in perception.

In short, the stance of considering psychological, phenomenal time as a kind of internal, subjective copy or representation of an external, objective, more basic, and truer form of time - the absolute, Newtonian time of physics – not only represents a source of unavoidable circularity whenever one tries to define and analyze time itself, but also proves to be ineffective when put to the test. It is certainly more preferable and reasonable to conceive of the time of physics as a construction based and developed on the subjective, phenomenal and more fundamental experience we have of time. After all, everything we know is known primarily in, and through, our conscious experience. First of all, we come to know the world as it is thanks to our direct and subjective conscious experience and observation. Only successively can we "abstract" or rationalize our experience, and develop those *entia rationis* that characterize physics as well as the other sciences. As Vicario observes (2005, p. 13): "The vocabulary of physics derives from everyday language, which describes direct experience, that is, psychological experience".

4. Circularity in Neuroscience

As we have seen in the previous section, one of the main sources of circularity in studies of time is the bias towards considering time as a real, ontological entity existing in itself, independently of anything else, and permeating everything. This bias involves considering and conceiving things, objects and events of the world as "necessarily" being, occurring, and immersed in time (as well as in space): they would "naturally" be characterized by the temporal dimension. We would experience time because time permeates and constitutes everything.

Neuroscientists, just like psychologists and linguists, are not always able to escape from such a bias either. Sometimes they explain our capacity to discriminate intervals and durations, recognize speech, coordinate movements and actions, play the piano, and so on, simply put, process time, by resorting to notions such as the "rhythms" of our cerebral cortex, the "oscillations" of neurons, and the like (see for example, Churchland and Sejnowski 1992): that is, notions that already contain time in themselves as one of their fundamental components. According to this kind of explanation, we can process time in its various manifestations because we are provided with mechanisms (neurons, cell-assemblies, neural networks, etc.) whose working is inherently and essentially based on time. Time is not simply a product, an outcome of such mechanisms and of their working: it is inherent in them.

However, as we have seen, the idea that experienced time reflects a more "fundamental", objective form of time – the absolute time of physics - raises more problems than solutions. There are too many, very blatant differences and inconsistencies between phenomenal time

and physical time that need a plausible and satisfactory explanation and reconciliation. Moreover, as Dennett and Kinsbourne (1992) have shown, there is no need at all to postulate a sort of isomorphism between the neural level and the psychophysical level in order to explain phenomenal time. Phenomena such as the "color phi" or the "cutaneous rabbit" clearly show that phenomenal time, what Dennett and Kinsbourne call the "representation of time by brain processes", is not always based on "time-in-the-brain", that is, the actual sequence of events making up those brain processes. Using Dennett and Kinsbourne's terms, one must distinguish between "time represented" and "time of representing".

The limitation and uselessness in conceiving our capacity to process time as the expression of brain mechanisms and structures that would be *inherently* temporal is further highlighted by the impressive difference of scales and types of temporal processing that characterize the behavior of human beings. On the one hand, we are able to quite flexibly estimate intervals ranging from a fraction of a second to some minutes and to hours, which helps us sense how long we can lounge in bed after the alarm clock goes off, or how fast we have to run to catch a baseball. The brain circuitry that allows us to mark time spans seems to involve a loop from the cortex to the striatum to the thalamus and back to the cortex again: it is so powerful and flexible that, according to Warren H. Meck, it can learn the time stamp for every interval one can imagine (quoted in Wright 2006).

On the other hand, we are also provided with a mechanism, involving the suprachiasmatic nucleus, that serves to synchronize bodily functions with the cycles of sunlight and darkness quite accurately. They help to program the daily habit of sleeping at night and waking in the morning, they drive daily fluctuations in blood pressure, body temperature and other core rhythms. But some other mechanisms exist as well that tune the other bodily functions to other external cues, such as stress, temperature changes and exercise (Wright 2006).

The variety of tasks and behaviors that rely on temporal processing is so wide (they range from simple sensory tasks, such as interval, duration and motion discrimination; to complex forms of sensory processing, such as speech recognition; to motor tasks, such as playing the piano; and to daily and seasonal rhythms, such as appetite and sleep and wake cycles) and the brain areas potentially involved (basal ganglia, cerebellum, cortex) are so many and different that it is practically impossible to identify in and through them the common principle, mechanism or substratum on which time experience lies. Everything – whether it be neurons, cell assemblies, the cerebellum, the cerebral cortex, or something else - being intrinsically temporal and working on a temporal basis, then time cannot be localized in any specific place.

Realizing this, some neuroscientists prefer to abandon a purely locationalist approach in favor of an information processing approach. For example, Mauk and Buonomano go so far as to propose that: "temporal processing does not rely on specialized mechanisms, such as oscillators, or arrays of elements, as with a spectrum of different time constants. Rather, we believe that neural circuits are inherently capable of processing temporal information as a result of state-dependent changes in network dynamics" (Mauk and Buonomano 2004, p. 334) (see also Eagleman et al. 2005, p. 10370: "the way the network evolves through time can code for time itself"): which represents in my opinion, especially with regard to their reference to the "changes" undergone by the system, a first, though partial, step toward solving the puzzle of time experience. Equally interesting and full of promising implications, even though yet to be attentively considered and examined, is their supposition that:

"temporal and spatial information are generally processed together by the same circuits" (Mauk and Buonomano 2004, p. 334) (on this point see also the work by Wyss et al. 2002 and 2003, who put forward the hypothesis that visual patterns, that is, spatial representations, are made possible by and through temporal encoding).

5. A Way out of Circularity: Attentional Semantics

As we have seen in the first chapter, in order to escape circularity when dealing with consciousness and conscious phenomena it is necessary to take a first-person perspective. Describing and analyzing a person's conscious state from a first-person perspective means understanding how phenomenal experiences are generated by the person creating them. Substantially, this implies accounting for the process by means of which the person emerges, forms and develops, that is, for the process that, allowing the person to determine the relations existing between him-herself and other entities (and successively, between other entities themselves and between the person and him-herself), defines the person's own limits and boundaries. This process, which is governed by a hierarchical set of innate and acquired principles, goals and rules incorporated in the schema of self (at the top of which is the principle of survival, or the algorithm of life), and is made possible by the organ of attention and the support of many other organs, is realized through the person's use and application of his/her attention.

The relations – which form during, and make possible, the process of the person's emergence and development - between the person and other entities (and between other entities themselves, and between the person and him-herself), determine the meanings that the other entities (and the person him/herself) have for the person. Most of these relations, being commonly and repetitively experienced by communities of human beings, are usually encoded in a condensed, de-contextualized, frozen and classified way in word meanings. Each culture and society tends to develop and select during its own history those words and meanings that prove to be most useful for the survival, maintenance, control and development of the individuals belonging to the society itself: using von Glasersfeld's terms (1985), we could say that only those words that are most *viable* and function satisfactorily for a given society can emerge and survive.

The conscious experiences concerning the temporal dimension are among the ones that are usually best codified in languages, which makes it easier to analyze them starting from language and words. For this reason, I will resort mainly to semantic investigation (even though I will also take into consideration the findings of empirical psychology) to put forward my proposal on how to avoid circularity when dealing with the conscious experience of time. But there are two other reasons that lead me to adopt a semantic perspective to analyze the conscious experience of time. Firstly, the fact that languages codify many other conscious experiences as well: which allows one to easily contrast them with the conscious experiences pertaining to the temporal dimension for analytical purposes. Secondly, the fact that even though many conscious phenomena do not have a linguistic origin at all and can be experienced without the support of language and words, scientists investigating them usually have to use words (or symbols, which in ant case express meanings, albeit in a more precise and definite way than words) in order to describe and analyze them: and the conscious

experience of time is no exception. Consequently, even when one can analyze this conscious experience from a non-linguistic perspective, most of the times one ends up by using words to describe or analyze it. Therefore, in the end, semantic analysis turns out to be an adequate analytical tool.

To perform the semantic analysis, I will specifically adopt the perspective and principles of Attentional Semantics because it is expressly conceived to avoid circularity. In fact, it analyzes meanings as codified relations between the person and other entities, expressed in attentional terms, which allow the person to emerge and take form. In this way, the role of the person in constituting and characterizing his/her conscious states is fully taken into account; the person's conscious state is described and analyzed solely in relation to the person's activity constituting it; nothing is surreptitiously introduced in the analysis of the person's conscious state; the typical risk of a third-person approach of characterizing the person's conscious activity using the results of that very conscious activity is avoided.

According to Attentional Semantics, each word conveys condensed instructions on the attentional operations a person has to perform if he/she wants to consciously experience the relations (between the person and other entities, between other entities themselves, and between the person and him-herself) it expresses. Attentional Semantics aims explicitly at finding the attentional instruction conveyed by the meanings of words through the identification of (i) the sequence of the elementary conscious experiences that invariably accompany the use of the word being analyzed, (ii) the attentional operations that are responsible for the production of the elementary conscious experiences, and (iii) the possible unconscious or non-conscious operations supporting the attentional operations.

6. The Conscious Experience of Time Explained: Mach's Revised Hypothesis

The first question Attentional Semantics asks when analyzing the meanings of words is: "What are the elementary conscious experiences of the relations (between us and other entities, between us and ourselves, and between other entities themselves) that they invariably elicit in us?". The identification of the elementary and invariable conscious experiences produced by the meanings of words can be performed thanks to the fact that any conscious experience implies the possibility of being distinguished and differentiated from the other ones. Indeed, this is one of the most important characteristics of conscious experience (although it is not peculiar only to conscious processes): allowing us to distinguish things and differentiate an object from the others. It is the conscious experience of the meaning of a given word that makes us differentiate it from the meanings of other words. In analyzing (some of) the meanings of the word "time", I will rely mainly on this property.

6.1. Time and Space: A Comparison

As we have seen when dealing with Evans' work (Evans, 2004), more than one meaning can be identified in the case of the word "time". Let us consider the meaning referring to the subjective experience of time, that is, what Evans holds to be the "sanctioning" meaning associated with the lexical item *time*: the durational meaning. Here are some sentences by

means of which Evans exemplifies the durational meaning of the lexical item *time*: "The relationship lasted a long/short time"; "It was some/a short/a long time ago that they met"; "During their ill-fated marriage they fought a lot/some/much of the time"; "He returned to Germany for good in 1857, moving for a time to Berlin"; "Time flies (by) when you're having fun"; "Time crawls (by) when you're bored".

What distinguishes the subjective experience of time from the conscious experience elicited, for example, by a word which is usually contrasted with time, that is, "space"? Does the former imply the same relations (between us and other entities, etc.) as the latter? Or do they differ? In my opinion, these are the main differences between the subjective experience of time and the conscious experience of space:

i) firstly, while the former has only one dimension, the latter has more than one. This makes us perceive things in time as occurring only in succession; and makes us perceive things in space as given all at once, catching them all - as it were - with only one glance;
ii) secondly, time sensation is irreversible, whereas space sensation is not. We can walk back and forth over the same path more than one time, but we cannot go back to the past and live again the same moments, hours or days we lived; what is present now will become past, and the temporal order of events cannot be reversed. The irreversibility of some very important and vital processes clearly shows the directionality of experienced time. From a phenomenological point of view, time can only be experienced as irreversible. Even if it is possible to conceive time as being a reversible process, as sometimes physicists do, the sole way we can experience time is, as Vicario (2005) has observed, as something running on toward only one direction. If we witnessed a cold cup of coffee that somehow and unexpectedly warms up all on its own, or an old man who becomes younger, we would certainly report the inverted, unusual order of events. However we could not report that our subjective time has stopped running on, and that it has inverted its course, and is now starting to go back: actually, we would continue experiencing our subjective time as something proceeding forward, in the same direction as before. Moreover, it is precisely because of the fact that despite witnessing such strange and unusual phenomena we would not experience any difference in the course of time, that we could speak of events occurring in the reverse order. In the end, the succession of events would certainly seem illogical, unusual, and inverted, but our experience of the past, present and future, of before and after, would not change. The irreversibility of experienced time therefore constitutes one of the most important and unquestionable certainties we have about time.
iii) thirdly, space sensation is stationary, time sensation is not. Time flows on, in an unstoppable way, whereas space is still. Most probably, it is the association of this characteristic with the characteristic described in point i) that makes us have the different sensations described in Ceccato and Zonta's quoted passage (Ceccato & Zonta 1980) when considering objects from a spatial point of view and from a temporal one.
iv) fourthly, time-sensations are more "abstract", intangible in nature (that is, determined by inner processes) than space-sensations, which are more concrete, tangible, and visible: that is, time-sensations can be considered to be more akin to sensations like

> pain, pleasure, thirst, hunger, sexual desire and tiredness, and to psychological states such as emotions, moods and impulses, than to sensations such as colors, sounds, tastes, smells and movements. Most probably, this can be explained by the fact that space-sensations are more strictly and directly linked to and determined by our exteroceptive and proprioceptive organs (see Berthoz 1997) than time–sensations, which on the contrary seem to be linked to and determined by more internal senses and organs. As Wittmann points out: "Although we doubtless have a time sense, our bodies are not equipped with a sensory organ for the passage of time in the same way that we have eyes and ears – and the respective sensory cortices – for detecting light and sound" (Wittmann 2009, p. 1995).

Incidentally, it should be noted that this last kind of difference between space and time underlies the fact that we ordinarily use language pertaining to motion through three-dimensional space and locations in three-dimensional space in order to think and talk about time. As highlighted by Evans (2004), there is a fundamental bifurcation in the conceptual system between concepts of sensorimotor, i.e. external origin, such as those which relate to visual-spatial experiences and are symbolized by the words like "near" and "motion", and concepts of subjective, internal origin, such as "time" and "similarity". According to Evans, concepts of external origin are a result of the elaboration in conceptual terms of visual-spatial information, or "inter-subjective information"; concepts of subjective origin are a result of the elaboration in cognitive terms of internal states, or "subjective-information" (*ibid.*, p. 34). While inter-subjective information is quite easily elaborated in conceptual terms, and consequently encoded and "translated" in linguistic terms, subjective information is difficult to conceptualize and verbalize. Indeed, it is easier to talk about what we perceive out in space than to talk about the states of our body or about what we feel. An example of the difficulty of directly verbalizing subjective information is given by the experience of time: in fact, we ordinarily think and talk about time not in time's own terms, but rather in terms of motion through, and location in, three-dimensional space, as evidenced by sentences such as "We are getting close to Christmas" or "The deadline is approaching" (on this point, see also Lakoff and Johnson 1999, Talmy 2000a). As Jackendoff has suggested (Jackendoff 1992), our relatively poor ability to verbalize internal states compared to our relatively good ability to articulate external information, may be due to a lack of sufficient "hardwiring" between the body format, which encodes subjective information pertaining to internal states, and the conceptual format, which provides information in a form ready for linguistic encoding, compared to the strong connection between the visual or 3D format, which encodes visual-spatial information from the external world, that is, inter-subjective information, and the conceptual format. It is highly plausible that the human brain has been able to circumvent the lack of "hardwiring" between the body format and the conceptual format by directly connecting the body format to the visual/3 D format. In such a way, subjective information is elaborated in terms of inter-subjective, external sensory experience, and can therefore more readily and easily enter into focal consciousness and be verbalized.

So much for the differences between space and time. However, there are not only differences, there are also similarities. William James, for example, found that, just as the same objective length of time can be subjectively perceived as either long or short according to the context, age of the perceiver, conditions of perceiving, and so on, an exactly a parallel variation occurs in our consciousness of space:

> A road we walk back over, hoping to find at each step an object we have dropped, seems to us longer than when we walked over it the other way. A space we measure by pacing appears longer than one we traverse with no thought of its length. And in general an amount of space attended to in itself leaves with us more impression of spaciousness than one of which we only note the content (James 1890, Vol. I, p. 627).

Both temporal experience and spatial experience are then characterized by a certain variability compared to objective time and space, that is, time and space measured with physical instruments such as clocks and rulers.

In my opinion, there also exists another important similarity between time and space, strictly linked with the property described in point i): on space and time, it is possible to build the notions of "order", "sequence" and "series". When we perceive objects, we can either perceive them isolated from their environment and the other objects, as it were, in themselves, or perceive them as placed in space or time (or, more specifically and accurately, in their environment, in a context, in a house, in the past, and so on). In the latter case, and only in the latter case, it is possible for us to ascertain whether an object lies "behind" or "in front of" another object, whether it appeared or came "before" or "after" another object, and so on. That is to say, by putting the object in a spatial or temporal dimension, we can create, constitute, and build up an order, a sequence, or a series of objects. Obviously, by putting objects in a spatial dimension, we will characterize them with properties that differ from the properties they assume when put in a temporal dimension: for example, object A cannot occupy the *same space as* that occupied by object B; on the contrary, both objects can exist at the *same time*. Nonetheless, both time and space give equally the same possibility of constituting an order, and arranging objects in sequences and series (for some other possible parallels between space and time see: Glicksohn 2001 and Wackermann 2007; for an analysis of space in attentional terms, see Benedetti 1999, and Carstensen 2002, 2007).

Therefore, basing ourselves on these differences and similarities, it is possible to formulate a hypothesis about what elementary and invariable conscious experiences characterize and constitute the sanctioning meaning of the word "time". We can summarize them with the following list of substantives: *one-dimensionality, irreversibility, unstoppability, impalpability, variability, and orderability*.

6.2. Mach's Revisited Hypothesis

How can we translate this set of elementary conscious experiences into attentional terms? To what attentional operations does this sequence of conscious experiences correspond?

In my opinion, a very important suggestion comes from Ernst Mach (1890). He argued that it is probable that time-sensation is connected with the organic consumption of our attentional energy: "we feel the *work of attention* as time" (*ibid.*, p. 111). He reached this conclusion by observing that: a) so long as we are conscious, time-sensation is always present, while in dreamless sleep – when our attention is completely exhausted - the sensation of time is lacking; and b) during severe effort of attention time is long for us, during easy employment short: "in phlegmatic conditions, when we scarcely notice our surroundings, the hours pass rapidly away" (*ibid.*, pp. 111-112). Time-sensation would then be correlated with and conditioned by the "fatiguing of the organ of consciousness", which goes on continually

in waking hours, and the labor of attention, which increases just as continually. Consequently: a) "The sensations connected with greater expenditure of attention appear to us to happen *later*" (*ibid.*, p. 112); b) "it is intelligible why physiological time is *not reversible* but moves only in one direction. As long as we are in the waking state consumption and the labor of attention can only increase, not diminish" (*ibid.*, p. 115).

As we see, then, Mach relies on attention to account for some of the main experiences associated with time:

1) irreversibility and one-dimensionality: "If time-sensation is conditioned by progressive organic consumption or by the corresponding steady increase of the effort following upon attention, then it is intelligible why physiological time is *not reversible* but moves only in one direction" (*ibid.*, pp. 114-115);
2) unstoppability: "The fatiguing of the organ of consciousness goes on continually in waking hours, and the labor of attention increases just as continually" (*ibid.*, p. 112);
3) variability: "during severe effort of attention time is long to us, during easy employment short" (*ibid.*, p. 111);
4) orderability: "The sensations connected with greater expenditure of attention appear to us to happen *later*" (*ibid.*, p. 112).

However, on the face of the results of research adopting the prospective paradigm (Bloch and Zakay 2001, Brown 1985, Hicks et al. 1976), Mach's hypothesis obviously needs to be slightly modified as far as the phenomena of variability is concerned. As we have seen in the preceding paragraphs, abundant evidence shows that the degree to which attention is directed to the flow of time itself greatly affects the experience of duration: prospective time judgements increase as a result of decreased attention to non-temporal processing. Situations involving a heightened temporal awareness, such as impatience, anticipation and expectation, produce a lengthening or slowing down of time; in contrast, concurrent situations involving absorbing activities that distract the subject from processing time produce shortened durations (Flaherty 1999). As Tse et al. observe, "Attention increases duration judgements when duration per se is attended" (Tse et al. 2004, p. 1172).

As these findings show, therefore, what determines the sensation of duration would be not the total labor (or expenditure) of attention in general (as instead Mach's hypothesis seems to imply), nor *only* the specific labor of attention necessary to perform a certain activity or perceive a certain event (if it were so, activities requiring a great expenditure of attention would *always* entail an expansion of the perceived time: which however is precisely what the findings on prospective duration judgment confute), but the labor of that portion of attention dedicated to the estimation of the duration of a given activity, event or interval: the more attention we pay to estimating the duration of a given event or interval, the longer the event or interval seems to last.

Therefore, if we complement Mach's hypothesis with the findings resulting from research adopting the prospective paradigm, we can explain the experience of duration in the following way, which we can name "Mach's revised hypothesis":

a) we devote a certain portion of our attention (let us call it A_e) to a certain kind of activity, which we call "non-temporal processing", that is, the event or activity whose duration we have to estimate;

b) we devote another portion of our attention (let us call it A_t) to another kind of activity, which we name "temporal processing";
c) the activity of A_t consists in being associated with A_e, in the sense of: i) being focused on the conscious product of the activity performed by means of A_e, and ii) staying focused on such a product, also keeping present at each new act of focalization the results of the previous focalizations, in a continuous and incremental way;
d) A_t is independent of, and does not correspond with A_e, in the sense that despite drawing resources from the same limited pool, A_t and A_e are – at least, to a certain extent - separate and independent streams of attention;
e) the labor of A_t, A_t being associated with A_e, increases continually and proportionally with the labor of A_e;
f) however, A_t, drawing resources from the same limited pool as A_e, is unavoidably affected by the labor of A_e, so much so that an excessive increase of labor of A_e entails a decrease or slowing down of labor of A_t, (as the experiments using the prospective time paradigm show, time generally contracts as a function of the amount of non-durational information to be processed, or the difficulty of the concurrent task);
g) it is the continuous increase in the labor of A_t that constitutes the basis for any temporal estimation: it represents the cue we use to determine the elapsed time. The amount of labor performed by A_t *is* the time elapsed. More in general, it is this continuous increase in the labor of A_t that represents the basis on which human beings have built their notion of time;
h) since, as we have seen, attentional activity produces conscious experience, also in the case of the activity performed by A_t do we have a conscious outcome: the conscious experience of the elapsed time.

Compared to Mach's original hypothesis, then, the revised version also allows one to account for the findings on prospective duration judgments: when the event whose duration has to be estimated needs too much A_e to perform the non-temporal task, A_t undergoes a slowing down.

6.3. Attending to Time is Experiencing the Effort Made by the Organ of Attention

Mach's revised hypothesis, linking time-sensation with the quantity of labor performed by A_t, is based on the possibility of monitoring and determining such a quantity. Without such a possibility, one could not estimate how much labor A_t has performed. This possibility relies entirely on the capacity we have of directly experiencing *the effort* the organ of attention makes while performing a certain activity. This kind of experience is akin to any other experience that makes us feel the fatigue of our various organs, and have sensations of exhaustion, weariness, tiredness, freshness, etc. In the specific case of the organ of attention, the experience of the effort made by it derives from the continuous, incremental and cumulative working of A_t. As we have seen, when we want to experience the duration of a certain event, we devote a certain part of our attention, A_t, to the temporal task, associating it to the conscious product of the activity performed by another portion of attention (A_e), which

is necessary to perceive, bring about, etc. the event. A_t has to remain focused on the product of the activity performed by means of A_e, as long as the activity takes place; furthermore, and most importantly, A_t has to keep present the results of its continuous work, that is, at each new act of focalization it has to keep present, in an incremental way, the results of the previous focalizations. Keeping present the results of its continuous work while performing its successive acts of focalization, obviously requires an additional, cumulative effort for the organ of attention. As we have seen, attentional activity in general is made possible thanks to the nervous energy supplied by the organ of attention: therefore devoting a certain part of our attention (A_t) to a certain kind of task (a temporal one) implies devoting a certain portion of the nervous energy supplied by the organ of attention to that task. Since the temporal task requires that A_t performs an incremental work, the expenditure of the nervous energy supplied by the organ of attention will have an analogous incremental trend. At the beginning of the event whose duration we want to experience, the work performed by A_t is minimum and the expenditure of the nervous energy (supplied by the organ of attention) dedicated to the temporal task is similarly minimum. At the end of the event, the work performed by A_t is maximum and the expenditure of the nervous energy similarly maximum. While low amounts of expended nervous energy entail low sensations of effort, high amounts of expended nervous energy correspond to high sensations of effort. The final amount of the expended nervous energy devoted to the temporal task represents the total effort that the organ of attention has made to support the activity of A_t. This effort constitutes and determines the basis on which the conscious experience of duration and time-sensation more in general are built (Eagleman puts forward a similar explanation: "duration is a signature of the amount of energy expended by neurons", 2008, p. 134, even though he [Eagleman and Pariyadath 2009] does not seem to directly link the notion of neural energy expenditure to attention).

As we can see, the conscious experience of time is made possible by attentional operations, which in turn are primarily based on the expenditure of the nervous energy that the organ of attention specifically devotes to temporal processing. However, some other organ is necessary as well, such as working memory: in fact the results of the previous acts of focalization of A_t must be kept present while new acts of focalization occur. The characteristics of working memory are well known and its relations with attention have been investigated (see for example Oberauer 2002): when rehearsing a given string of numbers or letters, for example, a telephone number, we can, also thanks to short term memory, be conscious not only of the rehearsed item, but also of some of the immediately preceding or following items. There is however a limit in this capacity of keeping more than one item simultaneously present. In fact, when dealing with very simple perceptual items (that is, involving low level of processing demand), we can keep only some of them simultaneously present in consciousness, i.e. from three to four or five at the most: we cannot keep as many items as we want.

The involvement of additional organs other than the organ of attention is further evidenced when a specific duration judgment is required, instead of the bare, general sense of time-in-passing. In the case of a duration judgment, at least a long term memory and a comparator are needed: the former, to store the knowledge about personal, natural, or social time patterns; the latter, to compare the subjective sensation of fatigue ensuing from the activity of A_t with the knowledge about time patterns stored in memory.

While the idea that time-sensation derives specifically from experiencing the changes (namely, the effort made by the organ of attention) entailed by the activity of *attention*, is

relatively new (with the only exception of Mach, and in part of James, as far as I know), the idea that time-sensation is, in general, somehow linked to the capacity to detect *changes* is not new.

As we have already seen, for example, for Lakoff and Johnson: "Literal time is a matter of event comparison" (Lakoff and Johnson 1999, p. 139). According to William James, not only time sensations but also space sensations rely on an awareness of change:

> In short, empty our minds as we may, some form of *changing process* remains for us to feel, and cannot be expelled. And along with the sense of the process and its rhythm goes the sense of the length of time it lasts. Awareness of *change* is thus the condition on which our perception of time's flow depends (…) The change must be of some concrete sort – an outward or inward sensible series, or a process of attention or volition. And here again we have an analogy with space. The earliest form of distinct space-perception is undoubtedly that of a movement over some one of our sensitive surfaces, and this movement is originally given as a simple whole of feeling (James 1890, Vol. I, p. 621).

Mach himself believed that time is an abstraction that we arrive at by means of the changes of things (Mach 1883). Fraisse stated that: "psychological duration is composed of psychological changes" (Fraisse 1963, p. 216). Gibson maintained that: "external stimuli (…) provide a flow of change, and it is this we perceive rather than a flow of time as such" (Gibson 1975, p. 299). Block stated that: "attending to the passage of time means attending to changes in cognitive context – that is, certain aspects of the contents of consciousness" (Block 1979, p. 195).

Moreover, it should be noted that by relying on the very notion of change, some psychologists have developed part of their theories and research on time. Let us consider, for example, the work on retrospective duration judgments (or remembered duration) by Block, Reed and Zakay (Block 1990, Block and Reed 1978, Block and Zakay 2001, Zakay and Block 2004). Contrary to what Ornstein proposed with his storage-size model (Ornstein 1969), Block and Reed (1978) found that changes in cognitive context have a more important influence on retrospective duration judgments than does the number of stored events: "the greater are the encoded and retrievable contextual changes, the longer is the remembered duration of a time period" (Block 1990, p. 25). Contextual changes may occur as a result of a variation in background stimuli, interoceptive stimuli (e.g., posture, temperature, etc.), the psychological context (e.g., what the subject is thinking about), the processing context (e.g., the different kinds of cognitive strategies adopted by a subject during a given task), and the environmental context. According to Block and Reed, remembered duration involves a cognitive reconstruction based on retrieving not the stimulus information per se, as Ornstein hypothesized, but the contextual information that was stored as an integral part of the memory encodings of events. People apparently encode automatically contextual information as an integral part of their memory representations of events, and use it whenever they are requested to make retrospective duration judgments.

People rely on contextual information to make not only retrospective duration judgments, but also temporal order, temporal dating and recency judgments. Evidence is given by experiments showing that people are quite accurate in dating an event as having occurred during a particular time of day, but are considerably inaccurate in remembering the day, month or year during when the event occurred (Friedman and Wilkins 1985). According to

Friedman (1993, 2001), such a kind of phenomena – called "scale effects" – highlights the fact that people judge the recency of an event basing themselves on important contextual landmarks, rather than on a more absolute way, such as in terms of time tags or the strength or vividness of a memory trace: that is, they rely on "location-based processes" rather than on "distance-based processes". Block and Zakay conclude: "In short, people automatically encode contextual information concerning experienced events, a process that does not require conscious intention. When they later need to make a temporal order or recency judgment, they rely on whatever information is available in memory to reflect the temporal dimension, and they use contextual information and logical inferences based on it" (Block and Zakay 2001, p. 61). Evidence that people automatically encode contextual information about experienced events is given, for example, by the fact that they can make rather accurate temporal judgments without being previously forewarned that they will be requested to do so.

The hypothesis that people remember a time period as being longer in duration to the extent that there were greater context changes – called the "contextual-change model" – predicts, contrary to Ornstein's storage-size model, a positive time-order effect in retrospective duration judgments, that is, the fact that subjects remember the first of two equal time periods as being longer than the second. Indeed, according to the contextual-change model, a subject encodes greater contextual changes during a more novel experience, such as during the first of a series of several durations, than during the following durations. Evidence supporting the prediction of the contextual-change model shows that the positive time-order effect is eliminated if the environmental context prevailing during the second of two durations is different from that prevailing during the first (Block, 1982), and if changes in emotional context that would ordinarily occur during the first duration occur instead during a preceding time period (Block, 1986).

The work by Block and Zakay also seems to reveal a double dissociation between retrospective duration judgments and prospective duration judgments: if a subject must change the way he or she processes information, retrospective duration increases, but prospective duration is not affected. On the contrary, non-durational information-processing difficulty, while greatly affecting prospective duration judgments, has little or no influence on retrospective duration judgments. Empirical findings revealing the double dissociation were obtained in regard not only to non-executive functions and information-processing tasks (Block and Reed 1978, Block and Zakay 1996), but also to executive-control functions and tasks (Zakay and Block 2004), that is, those involving the regulatory processes supervising the translation of intentions into a goal-directed behavior and controlling and governing its conduct.

In one of their experiments, for example, Zakay and Block (2004) had their subjects resolve syntactic ambiguities, that is, read sentences that have several possible syntactic analyses (such as the sentence: "The horse galloped fast after the race his legs always shiver". The ambiguity of the sentence is due to the omission of the full stop, which can create different meanings if it is put after "fast" or after "race"). Resolving syntactic ambiguities requires that subjects, at least, compute the multiple interpretations of the sentence, choose the more likely syntactic interpretation on the basis of the context and relative frequency of occurrence, discard the alternative interpretations, and mark that point in their representation of the sentence as a choice point. All these operations clearly indicate that resolving syntactic ambiguity involves executive-control functions such as initiating memory search, inhibiting responses, encoding high-level structures in memory, etc. In this experiment, each subject

was randomly assigned to one of four experimental conditions formed by the orthogonal combination of temporal paradigm (retrospective vs. prospective) and reading task (syntactic ambiguity vs. no-syntactic ambiguity). After reading, the subjects were asked to reproduce the reading duration and rate the degree of mental load they experienced while performing the reading task. While in the prospective condition subjects were told that after the reading was completed they would be asked to reproduce the total reading duration, in the retrospective condition, subjects were not. Actual reading duration was measured for each subject without his or her knowledge.

The results were the following: a) actual reading duration was significantly longer if there was syntactic ambiguity than if there was no syntactic ambiguity; b) ratings of mental load were significantly higher if there was syntactic ambiguity than if there was no syntactic ambiguity; c) if there was no syntactic ambiguity, prospective reproductions were significantly longer than retrospective reproductions; on the contrary, if there was syntactic ambiguity, retrospective reproductions were significantly longer than prospective reproductions; d) if there was no syntactic ambiguity, the duration-judgment ratio, that is, the ratio of the reproduced duration to the actual reading duration, was significantly longer in the prospective paradigm than in the retrospective paradigm; on the contrary, if there was syntactic ambiguity, the duration-judgment ratio was greater in the retrospective paradigm than in the prospective paradigm.

Overall, the results seem to reveal a double dissociation between prospective and retrospective duration judgments. According to Zakay and Block, this is due to the fact that different cognitive processes underlie prospective and retrospective timing:

> The decrease in prospective reproductions in the syntactic ambiguity condition in comparison to the simple reading (no-syntactic ambiguity) condition indicates that resolving syntactic ambiguity is a process that consumes attentional resources. The increase in retrospective reproductions in the syntactic ambiguity condition in comparison to the non-syntactic ambiguity condition indicates that resolving syntactic ambiguity is a process that produces contextual changes that are encoded in memory (*ibid.*, pp. 323-324).

Without doubt, as far as retrospective duration judgments are concerned, Block, Reed and Zakay's work represents an important improvement compared to Ornstein's (Ornstein 1969). However, I think that the conclusion they reach concerning the double dissociation between prospective and retrospective duration judgments is not correct. I do not think that, in order to estimate duration in the two different paradigms (prospective and retrospective) we use two different processes (attention and memory, respectively). I think that the means by which we estimate duration always remains the same (for a similar opinion, see also Brown and Stubbs: "despite a number of striking differences, prospective and retrospective timing involve the same or similar processes" 1992, p. 546), and that it mainly involves attention. There are at least two reasons that lead me to think this:

a) Firstly, from an evolutionist point of view, it seems really implausible that in order to perform the same activity (estimating time) an organism had to develop two different systems and processes.
b) Secondly, it is certainly true that in the retrospective condition we have to resort to memory. However, it should be noted that resorting to memory means *paying*

attention to the material stored in memory: that is, performing a certain "non-temporal" attentional activity (A_e) in order to consciously experience the stored material again. Indeed, when estimating past events, it is as if we lived them again, even if for a short period. As Glicksohn observes, it is conceivable that: "the retrospective judgement of time is determined (at least in part) by what would have been a prospective judgement of time. That is to say, retrospective time estimation could entail reperceiving (imaginally) the required interval" (Glicksohn 2001, p. 15). We can then hypothesize that, excluding the cases in which we estimate the duration of a past event by repeating the original experience of duration we could have actually had when the event occurred, in all the other cases we estimate the duration of a past event by allocating part of our attention (A_t) to this purpose, focusing it on the conscious product of the activity performed by means of A_e and experiencing the effort made by the organ of attention while the event is consciously remembered. Two things should be noted: i) In the retrospective condition, once the event whose duration we have to estimate has been retrieved from memory, it is fully available to us and we have to make no additional effort to produce it again while we are processing time: that is, in the retrospective condition, the work done by A_e to bring forth the event is minimal compared to the work done in the prospective one. This implies that, unlike what happens in the prospective condition, we can dedicate the greatest part of our attention to the temporal task (A_t), focusing almost our full attention on the contextual "clues" (that is, the product of the activity performed by A_e). The greater the number of available clues, the higher are the possibilities we have to anchor and deploy A_t, the longer is the remembered duration of a time period. Therefore the retrospective situation can be assimilated to a prospective situation in which we are allowed to allocate the greatest part of our attention to the temporal information task rather than to the non-temporal information task. Being allowed to pay almost our whole attention only to the estimation of the duration of the event, we experience an expansion of time that is directly proportional to the amount of (contextual) information retrieved from memory: which reconciles Block and Zakay's finding on retrospective duration judgments with Mach's revised hypothesis. ii) In the retrospective condition we cannot use the same parameters as in the prospective one: an event that actually lasted an entire day may be consciously remembered and synthesized in a few seconds. Therefore, one can legitimately deduce that the amount of labor performed by attention while the event is remembered, must be adapted and parametrized as much as possible to the real, original situation.

Moreover, there is also evidence suggesting that the double dissociation between prospective and retrospective duration judgments hypothesized by Block and Zakay does not always hold. As we have seen when considering the work by Angrilli et al. (1997) and by Tse et al. (2004), the behaviour of subjects during prospective duration judgments does not follow the homogeneous, consistent pattern hypothesized by attentional-based models. Unlike what attentional-based models predict, when facing shocking or unexpected events subjects tend to *overestimate* the duration of stimuli requiring more attentional resources. In such cases, contrasting the behaviour of subjects during prospective duration judgment with their

behavior during retrospective duration judgment does not produce the double dissociation found by Block and Zakay.

Incidentally, how can we explain the findings by Angrilli et al. (1997) and by Tse et al. (2004) by using Mach's revised hypothesis?

As we have seen, Angrilli et al. (1997) found, contrary to what attentional-based models predict, that negative high-arousal stimuli, inducing a stronger attentional response, were overestimated compared with positive high-arousal stimuli, inducing a weaker attentional response. Psychological evidence suggests (for a review, see Kahneman 1973) that, to a certain extent, higher levels of arousal enhance the capacity of processing stimuli: that is, stimuli can be processed faster and deeper at high levels of arousal than at low levels of arousal. This implies that, at higher levels of arousal, less attention is needed to process stimuli than is usually required, or alternatively, that stimuli are processed at lower or marginal levels of attention. Psychophysiological and neurophysiological studies also show that emotionally arousing stimuli are processed in a very quick, automatic way compared to neutral stimuli. For example, Öhman and Soares (1994) found unconscious pre-attentional responses to phobic masked stimuli lasting only 30 msec in subjects that reported no awareness of the content of the stimuli. According to LeDoux (1995), two different pathways are responsible for emotional stimulus processing: one subcortical, which is quickly activated by potentially dangerous stimuli but receives only incomplete information, and one cortical, which is slower but processes more precise information on the nature of the stimuli. The subcortical pathway can rapidly activate physiological autonomic responses for avoidance and fear-related behavior, which is certainly in line with a biologically adaptive function. The very fast, unconscious processing of emotionally arousing stimuli makes stimuli almost completely available to us without requiring from us any specific conscious activity to bring them about.

Therefore, stimuli becoming almost fully available with little or only marginal attention, we can dedicate the greatest part of our attention to the temporal task (even though it should be noted that: a) when facing emotionally arousing stimuli, we also devote some amount of our energy to maintaining$ our attention on them; b) this amount of energy increases proportionally with the negative quality of the stimuli: it is easier to maintain one's attention on a pleasant image than on an unpleasant one). Paying almost all our attention to the temporal task, we consequently experience an expansion of time. Just as in retrospective conditions, in prospective conditions entailing high levels of arousal, temporal processing is affected less by the amount of attention (A_e) used to process non-temporal information than by the amount of attention (A_t) focused on the products of A_e. Negative stimuli, entailing because of their content more clues than positive stimuli, induce a higher deployment and expenditure of A_t compared to positive stimuli: consequently, negative stimuli are overestimated compared with positive ones.

As to Tse et al.'s experiments (2004), which showed that low-probability oddball stimuli are judged to last subjectively longer than high-probability stimuli lasting the same objective duration as low-probability ones, two different but concurrent factors must be taken into account. Firstly, high-probability stimuli facilitate and induce habituation and automatic processing: which implies that less attention (A_e) is needed to perceive high-probability stimuli compared to low-probability stimuli. Consequently, since A_t is focused on the conscious product of the activity performed by means of A_e, less A_t is expended for high-probability stimuli than for low-probability stimuli (see also Pariyadath and Eagleman 2007,

and Eagleman and Pariyadath 2009, who point out that the pattern of duration distortions found with repeated stimuli parallels the pattern of neural activity seen with repetition, that is, the phenomenon known as "repetition suppression": neuronal firing rates become suppressed after repeated presentations of a stimulus. This makes Pariyadath and Eagleman argue that the total amount of neural activity maps onto duration). Secondly, it is known that novel and odd events tend to capture and engage attention more than usual and normal stimuli. Low-probability oddball stimuli, therefore, tend to consume more A_e resources than high-probability stimuli, and, consequently, proportionally entail a higher expenditure of A_t compared to low-probability ones.

6.4. The Economical Nature of "Mach's Revised Hypothesis"

As we have seen, "Mach's revised hypothesis" is able to account for empirical evidence resulting from research carried out in both the prospective paradigm and the retrospective one. Contrary to what Block and Zakay claim, it is not necessary to resort to two different kinds of processes in order to account for prospective and retrospective timing.

But this is not the only advantage "Mach's revised hypothesis" offers; indeed, it offers some other important advantages. Firstly, it does not imply any dedicated internal-clock or pacemaker mechanism. This entails a double advantage. On the one hand, it avoids all the epistemological, theoretical and methodological problems raised by the internal-clock model, which we have seen in the previous sections. On the other hand, it relies only on a very basic component such as attention that is used also for other and different purposes, without needing to resort to additional components, such as a pacemaker. Incidentally, it should be noted that the choice of relying on a pacemaker would imply the additional problem of identifying *the plausible* pacemaker: as shown by Mauk and Buonomano (2004), the impressive difference of scales and types of temporal processing characterizing the timed responses and behavior of human beings makes any hypothesis about specialized and dedicated mechanisms such as oscillators, pacemakers and the like implausible.

Secondly, contrary to what Ornstein maintained ("The different times of experience will require different types of explanation. A theory which might account for the experience of simultaneity might not handle the experience of duration", Ornstein 1969, p. 109), "Mach's revised hypothesis" proves to be very economical: it can cover the various and diverse aspects of phenomenal time in a way that was unknown to the other models and theories. As we have already seen, it can account for the principle aspects of one-dimensionality, irreversibility, unstoppability, variability, and orderability that characterize the subjective experience of time. But it can also account for some other phenomena, such as:

i) The ability of human beings to *directly* experience and estimate the duration of events. Human beings experience the passage of time directly, and are able to perceive the difference between a situation in which time is passing by smoothly and effortlessly and one in which time is dragging on. Mach's revised hypothesis, on the one hand, by identifying time-sensation with the experience of the effort made by the organ of attention, supplies the basis for explaining, from a first-person perspective, how it is possible for us to autonomously build and develop a conscious sense (and subsequently, a notion) for time, basing ourselves completely and only on our own

(physical and mental) means. On the other hand, not resorting to any dedicated internal-clock mechanism, Mach's revised hypothesis prevents any possibility of explaining time experience adopting a third-person perspective, that is, by surreptitiously introducing a ready-made, unanalyzed concept (that of time) from the outside into us. Consequently, Mach's revised hypothesis explains time-sensation not as an external entity that is imposed on us and that, as such, is and remains unknown to us, but rather as the product of autonomous beings who, by acting, determine and come to directly know themselves and their environment.

ii) The phenomenon known as *prior-entry*: when a person attends to a stimulus, he or she perceives it as having occurred earlier in time than it would if he or she was not attending to it. As we have seen when considering the experience of orderability, Mach's revised hypothesis predicts that the event associated with the lowest amount of labor performed by A_t (that is, the event on which attention is focused first) is the one coming "first" or "before"; conversely, the event associated with the highest amount of labor performed by A_t (that is, the event on which attention is focused later) is the one coming "later" or "after". The phenomenon of prior entry has been claimed and attested by many psychologists, such as for instance Wundt and Titchener. Although the empirical evidence for this phenomenon has been questioned on the methodological grounds that it could reflect the influence of response biases on the observer's judgement (Pashler 1998), that is, the fact that observers may be biased to report the event to which they were instructed to attend as having the requisite quality, the latest research, successfully attempting to reduce, if not eliminate entirely, the influence of response biases and other confounding factors, confirms the existence of a robust prior entry effect (Shore et al. 2001, Shore and Spence 2004). Incidentally, it should be noted that the phenomenon of prior entry, which is usually studied by having subjects perceive the temporal order of pairs of stimuli separated by an Inter-Stimulus-Interval (ISI), occurs only when certain conditions are met. For example, outside a certain range of ISI, prior entry does not take place: a pair of stimuli each one 15msec long, separated by an ISI shorter than 40ms, cannot be perceived in succession (Kanabus et al. 2002). With sufficiently longer stimuli, non-temporal factors intervene as well, such as the degree of resemblance between the stimuli, causing the phenomena of temporal displacement and continuous displacement that is so well described and analyzed by Vicario (2005). The temporal limits described in the works of Kanabus et al. (2002), as well as the "phenomenal present" advocated by Vicario (2005), can be taken as further evidence supporting the assumptions I made about attention in chapter I, namely, that: attention is a cyclical phenomenon; each attentional cycle has a certain minimal duration; and attentional cycles represent the building blocks of conscious experience (on this point see also Pöppel 2004). Events occurring within, or lasting approximately as long as, the minimal duration of an attentional cycle either are not differentiated and discriminated, or undergo some process of restructuring and grouping, according to non-temporal principles of organization, such as the Gestalt ones.

iii) The phenomenon observed by James whereby if an impression or event, which we are expecting and ready for (such as a word in a speech, a note in a piece of music, the bus, etc.), fails to come, we will become "most formidably aware of the extent of

the mere time itself" (James 1890, Vol. I, p. 626): that is, all those instances which induce us to think about, and perceive the passage of, time even if we did not intend to do so. In my opinion, what happens in these cases is that expecting too much, without being able to, so to speak, "close the loop", that is, not perceiving what we expect, engenders a feeling of frustration and discomfort in us. The discomfort is strictly determined by the sensation of the effort that the organ of attention makes in order to wait for the impression or event to come. Discomfort, like all kinds of pain, fatigue, and tiredness, automatically compels us to focus on, and monitor its possible cause (so as to be able to solve the cause itself). Since the cause is the very activity performed by ourselves (that is, waiting for something that does not come), the additional, secondary activity of repeatedly focusing on the primary activity performed by us (waiting for something that does not come) represents the first necessary step to bring about what, in terms of Mach's revised hypothesis, is called A_t: that is, the portion of attention allocated to a temporal task. Indeed, A_t is defined as that portion of attention that is associated in a continuous way to the portion of attention (A_e) necessary to perform a given, "non-temporal" activity. Therefore, waiting for something in vain brings about a secondary activity of attentional focusing, which, being repeatedly performed, constitutes the basis for temporal estimation and, consequently, makes us aware of the passage of time itself. Obviously, if we distract ourselves while waiting for something, for example by reading or speaking with someone else, we will prevent or diminish the possibility of bringing about the phenomenon.

iv) The fact that novel events seem to last longer the first time they are seen than the subsequent times, and the fact that complex and demanding activities seem to last longer the first time they are performed than the subsequent times. Compare, for example, the first time you saw a movie, heard a song, or drove through a place with the second time you saw the same movie, heard the same song or drove through the same place: usually, the second time the event seems to last shorter than the first one. These phenomena can be explained by considering the fact that the first time we performed a certain activity or perceived a certain event, or when the activity we performed was too complex, our *whole* attention was involved in, and absorbed by, the activity or event. On the contrary, the subsequent times we perform the activity or perceive the event, we automatically perform, that is, in a unconscious way, some of the operations that were under our conscious control during the first time, because we have become accustomed to the activity or event: consequently, we do not need to pay as much attention to the activity or event as we did the first time. This implies that when evaluating – either prospectively or retrospectively – the various durations, less A_t is expended in the subsequent times than in the first time, A_t being associated with the portion of attention (A_e) necessary to perform the activity or perceive the event.

v) The fact that while witnessing unexpected, dangerous or shocking events, even if they are misperceived or false threats, we are induced, firstly, to become aware of the passage of time itself, and secondly to perceive time as slowing down, almost to the point of having stopped. Consider for example one of the many narratives quoted from the interviews collected by Flaherty in his work on the perception of time:

> I was in the bathroom, and I heard someone come up the stairs. I was alone and … I had left the door unlocked because my sister would come in late. I could hear the person come up the stairs because the floor cracked. I … instantly focused on my watch [thinking] I could give it to the maniac so he wouldn't kill me (which was pretty stupid). It seemed like he was coming up those stairs so slowly. I thought it took about fifteen minutes [but] it only took less than a minute. I heard the maniac come toward the bathroom, and I was ready to [offer] my watch for my life. It turned out to be my brother (Flaherty 1999, p. 56).

If the girl had not thought that the person coming up the stairs was a maniac but her brother, she certainly would not have had such an abnormally protracted experience of time. Flaherty notices acutely that: "Subsequent to *The Wild Bunch* by Sam Peckinpah, it has become commonplace for directors to depict violence in their films through slow-motion cinematograph" (*ibid.*, p. 51). As Flaherty observes, what characterizes unexpected, dangerous or shocking events, and brings about the experience of protracted duration, is both a narrowing of the scope of the subject's attention to the immediate circumstances, and a heightening of his/her attention to his/herself. I think that while the latter characteristic represents the main factor inducing the experience of time, the former characteristic represents the main factor inducing the experience of a protracted duration as opposed to a compressed one. Heightened attention to the self - which can be due either to the direct involvement of the subject in the situation, and the consequent threat to his/her personal safety, or to the subject's capacity for sympathy and taking on the role of the other - implies that the subject focuses, among other things, on his/her own attentional activity and the products of such an activity: which is precisely the condition necessary to bring about temporal processing. The narrowing of the scope of the subject's attention to the immediate, potentially dangerous circumstances can be considered a consequence of the fast, unconscious mechanisms that - as we have seen when considering the processing of emotionally arousing stimuli - make potentially dangerous stimuli available to the subject without the need for the subject to perform a dedicated conscious, attentional activity. This automatic, unconscious availability of the dangerous stimuli makes the subject experience the event as slowing down.

vi) The fact that duration is dilated by the magnitude of a stimulus. In Xuan et al.'s (2007) experiments, subjects had to prospectively judge the duration of stimuli while four types of non-temporal magnitude information – which included the number of dots, size of open squares, luminance of solid squares, and numerical value of digits - were manipulated in Stroop-like paradigms. They found that stimuli with larger magnitudes in these non-temporal dimensions were judged to be temporally longer. In my view, the phenomenon can be explained by considering two concurrent factors. Firstly, stimuli were processed by using a minimal amount of A_e (as Xuan et al. observe, the magnitude information of the stimuli was processed somewhat automatically, because it was not relevant to the experimental task, in the sense that the subjects were not required to evaluate it) compared to the amount available for the temporal task (A_t). Since the incidence of A_e is marginal compared to that of A_t, the effect revealed by the experiments adopting the prospective paradigm (judged time decreases linearly with the increased processing demands of the non-durational

information) can therefore be considered negligible. Secondly, stimuli with larger magnitudes tend to engage more attentional resources to be processed than stimuli with smaller magnitudes. Consequently, the former induce a higher deployment and expenditure of A_t than the latter, resulting in a temporal dilatation of stimuli with larger magnitudes.

Table 5. summarizes the explanations that Mach's revised hypothesis provides of the main phenomena related to the experience of time that we have analyzed in this chapter.

Table 5. The explanations that Mach's revised hypothesis provides of the main phenomena related to the experience of time

Phenomena associated with time	**Explanation based on Mach's Revised Hypothesis (A_e = the portion of attention devoted to the "non-temporal processing"; A_t = the portion of attention devoted to the "temporal processing")**
Irreversibility	The phenomenon is determined by the incremental labor of A_t
One-dimensionality	The phenomenon is determined by the continuous and incremental labor of A_t
Unstoppability	The phenomenon is determined by the continuous labor of A_t
Variability	The experience of duration varies according to the labor of A_t: the higher the labor of A_t the longer the duration experienced
Orderability	The event associated with the lowest amount of labor performed by A_t is the one coming "before"; conversely, the event associated with the highest amount of labor performed by A_t is the one coming "after"
Prospective time judgments increase as a result of decreased attention to non-temporal processing, and vice versa (Bloch and Zakay 2001, Brown 1985, Hicks et al. 1976)	A_t, drawing resources from the same limited pool as A_e, is affected by the labor of A_e, so much so that an excessive increase of labor of A_e entails a decrease or slowing down of labor of A_t
In retrospective time judgments, the greater are the retrievable contextual changes, the longer is the remembered duration of a time period (Block 1990, Block and Reed 1978, Block and Zakay 2001, Zakay and Block 2004)	The event whose duration has to be estimated is retrieved from memory: therefore, it is fully available and no additional effort is required to produce it again. Consequently, the greatest part of attention can be allocated to the temporal processing task rather than to the non-temporal one. This implies that time judgment is directly proportional to the amount of (contextual) information retrieved from memory
In prospective time judgements, negative high-arousal stimuli, inducing a stronger attentional response, are overestimated compared with positive high-arousal stimuli, inducing a weaker attentional response (Angrilli et al. 1997)	At higher levels of arousal, less attention is needed to process stimuli than is usually required. Consequently, the greatest part of attention can be allocated to the temporal information task rather than to the non-temporal information task. Negative stimuli, entailing because of their content more clues than positive stimuli, induce a higher deployment and expenditure of A_t compared to positive stimuli
In prospective time judgements, subjects facing unexpected events tend to overestimate the	Firstly, high-probability stimuli induce automatic processing: which implies that less A_e is needed to perceive high-probability stimuli compared to low-probability stimuli. Consequently, less A_t is

duration of stimuli (Tse et al. 2004)	expended for high-probability stimuli than for low-probability stimuli (A_t being associated with A_e). Secondly, odd events tend to capture attention more than normal stimuli. Low-probability oddball stimuli, therefore, tend to consume up more A_e resources than high-probability stimuli, and, consequently, to proportionally entail a higher expenditure of A_t compared to low-probability ones.
Prior-entry	The event on which attention is focused first (that is, the event associated with the lowest amount of labor performed by A_t) is the one coming "first"
An expected event that fails to come induces us to perceive the passage of time	An expected event that fails to come engenders discomfort, which is strictly determined by the sensation of the effort made by the organ of attention in order to wait for the event to come. Discomfort automatically compels one to focus on its possible cause in order to solve the cause. Since the cause is the very activity of waiting for something that does not arrive, the additional, secondary activity of repeatedly focusing on the primary activity of waiting represents the first necessary step to bring about At
Novel or complex events seem to last longer the first time they are experienced than the subsequent times	The first time an activity is done, the whole attention is absorbed by it; at subsequent times the activity is partly performed automatically (that is, less Ae is needed). Therefore, less At is expended in subsequent times than in the first time (At being associated with Ae)
Witnessing unexpected, dangerous or shocking events induces us to become aware of the passage of time itself	The heightened attention to the self (due to the direct involvement of subjects in the situation, and the consequent threat for their personal safety) implies that subjects focus on their own attentional activity and the products of such an activity: which is precisely the condition necessary to bring about temporal processing.

7. A Semantic Analysis of other Meanings Associated with the Word *Time*

In the preceding section, we mainly dealt with the elementary conscious experiences that are invariably elicited by the "sanctioning" meaning associated with the lexical item *time*, that is, the durational meaning. We also identified the attentional operations responsible for the production of such conscious experiences, and briefly dealt with the physical organs and the unconscious or non-conscious operations that serve as a support that makes it possible for the attentional operations to take place and to be completed.

However, as Evans (2004) shows, the lexical item *time* is associated with other meanings as well: by adopting the three criteria he devised by himself - the meaning criterion, the concept elaboration criterion, and the grammatical criterion – Evans is able to distinguish eight different lexical concepts. In this final section I will try to sketch an analysis of some of these additional meanings, starting from the results achieved on the durational sense in the previous section. But before proceeding, let me make some general considerations concerning the observation that a word may have one or more meanings associated with it.

I think that apart from the cases of pure and real homonymy, the different meanings that may be associated with a word *are* indeed related to each other. In my opinion, this fact is better accounted for by the "principled polysemy approach" put forward by Evans (2004) rather than by the "homonymy approach" or the "monosemy approach".

While the principled polysemy approach claims that a word such as *time* has various, different, but related, meanings associated with it, the "homonymy approach" admits that a lexical form can have different meanings associated with it, but that they constitute a bundle of completely distinct, unrelated senses that merely happen to be associated with the same lexical form by accident, and the "monosemy approach" holds that a lexical form is paired only with a highly abstract sense, and that the various meanings that sometimes happen to be associated with that lexical form would simply be explained in terms of contextually derived variants of the single monosemous abstract sense.

According to Evans (2004), the homonymy approach cannot account for the fundamental fact, which is well attested by etymological and philological studies, that language constitutes an evolving system in which: a) the meanings associated with words may not only undergo changes in time, but also, through a process of metaphorical extension, give birth to new meanings; b) these new meanings, despite being different from the original ones, remain associated to the lexical form to which the original meanings were associated, instead of being associated to new lexical forms. By overlooking this evidence, the homonymy approach fails to consider the fact that there must be some degree of commonality and relatedness between the yet distinct original and extended meanings associated with a given word. In fact, if the meanings associated with a given word were completely distinct and unrelated to each other, there should be no reason why they remained associated with the same original lexical form rather than being associated with completely new lexical forms.

The monosemy approach, on the contrary, fails to recognize that a word such as *time* has a number of different meanings associated with it that are demonstrably context-independent, and is unable to account for the fact that the context cannot always be invoked in order to explain differences in interpretation and distinctions of meaning. Furthermore, the monosemy approach cannot account for all those words whose meanings, despite stemming from the same historically earlier sense (what Evans would call the "origination sense"), designate as distinct and different entities as a physical object and a mental entity. The word "volume", for example, identifies both a physical object, that is, a book, and an abstract entity more akin to a pure mental entity than to a physical object, that is, the amount of space in a container or occupied by a substance. As Benedetti argues (Benedetti, 2001), the monosemy approach cannot account for the difference existing between the literal or original meaning of a word and the meanings that derive from its extended and figurative uses. That the original meaning differs from and is not the same as the extended and figurative ones is supported by a body of evidence: a) the appearance of an extended or figurative meaning is so recent that it can easily be documented: only quite recently from an historical point of view has a word such as "left" begun to designate a specific political party; b) the humorous use by comics of the different meanings of a word (including the extended or figurative ones) to produce puns or ironic or comical effects; c) the fact that while a given language has developed extended or figurative meanings of a given word, another language has not: for instance, while the Italian language has developed an extended meaning of the verb "mangiare" ("to eat") to indicate gaining possession of a chesspiece, the English language has not; d) some words, especially adjectives, while being perfectly synonymic in their extended or figurative use, are not so in their literal use: for example, the Italian adjectives "piccola" ("little", "small"), "leggera" ("light"), "debole" ("weak", "feeble"), "poca" ("little"), "scarsa" ("poor", "short"), and "bassa" ("low", "short") are interchangeable when used in their extended or figurative sense, as when they are used in association with a word designating a purely mental content, such as

"differenza" ("difference"), while they are not synonyms when used in their literal sense, as when they are used in association with a word designating a physical object; e) usually, there is wide agreement between dictionary compilers on the existence of figurative or extended meanings that are different from the literal one.

7.1. The Moment Sense

As shown by Evans (2004), the moment sense does not prompt for a reading relating to an interval, as the duration sense does, but rather to a discrete point: "The time for a decision has arrived/come"; "What size was she at the time of change?"; "What time is it?"; "She could die at any time". That the moment sense is an additional meaning not apparent in the duration sense is corroborated by the concept elaboration criterion. "A moment reading appears to be elaborated solely in terms of deictic motion: that is, motion which presupposes a particular deictic centre with respect to which the motion takes place" (*ibid.*, p. 124). It is with respect to a specific deictic center that a temporal moment can come or arrive. The duration sense, on the contrary, is elaborated, especially in its two variants of "protracted duration" and "temporal compression", in terms of the relative rapidity (or otherwise) of the motion event: "Time whizzed/zoomed/flew/sailed/raced/dashed along". The grammatical criterion also confirms the fact that the moment sense is different from the duration sense: while the latter is a mass noun, the former is a count noun, as evidenced by its ability to be determined by the indefinite article: "Due to the volatile nature of the market, we left instructions to sell at an appropriate time" (*ibid.*, pp. 125-126).

Evans puts forward two different motivations for the derivation of the moment sense from the duration sense: a) the first relates to the phenomenon of time embeddedness, that is, the fact that all social acts are temporally fitted inside larger social acts. As certain events or intervals are embedded within other, larger events or intervals, it is highly plausible that the embedded intervals come to be re-analysed without reference to their duration, that is, as discrete "points" within the greater interval; b) the second relates to the phenomenon of temporal compression: "past intervals held in memory may, due to the erosion of episodic memory, lose their durational significance, and accordingly become point-like" (*ibid.*, p. 129).

So what seems to distinguish the moment sense from the duration one is the fact that the event or interval it refers to has lost almost any durational significance, despite maintaining its own temporal uniqueness and specificity: the time at which something happens is not the same as another time. In terms of Mach's revised hypothesis, and in comparison with the attentional operations involved in the production of the durational sense, this can be obtained by limiting the acts of focusing A_t to the minimum number, that is one. One more condition has to be met, however, in order to produce the moment sense. Indeed, the moment sense also implies the reference to the continuum of temporal sequences: "the Moment sense relates to a purely temporal event, i.e., an event defined purely in terms of its relation to a temporal event-sequence" (*ibid.*, p. 137). Therefore, the production of the moment sense requires that the act of focusing by A_t be placed inside the more general framework of the temporal continuum.

7.2. The Lexical Item Moment

In my opinion, a meaning similar to the moment sense of the lexical item *time* but that does not require the reference to the temporal continuum is one of the meanings associated with the lexical item *moment*. As one can see from the following examples, no reference is made to any temporal framework: "He thought for a moment before replying"; "She answered without a moment's hesitation"; "Could you wait a moment please?"; "One moment please"; "I will be back in a moment". In these cases, what is elicited is the experience of a very short interval considered on its own, without any reference to an external, preceding and following flow of events. Furthermore, the meaning associated with the lexical item *moment* seems to imply a certain amount of duration that the moment sense of the lexical item *time* does not possess. While the latter certainly has the quality of being "instant-like" or "point-like" ("What time is it?"), the former entails in any case a certain temporal extent, consistency or "thickness" (to the point that it can be "long", as in: "There was a long moment of silence in the room as the sharp division between students and teachers soaked in") that the latter lacks. This characteristic is most probably produced by having A_t perform at least two acts of focusing.

7.3. The Instance Sense

A case similar to the meaning associated with the lexical item *moment* is that of the "instance sense" of the lexical item *time*. As evidenced by Evans (2004), the instance sense prompts for a reading in which an instance of a particular event, activity or process is being referenced: "Devine improved for the fourth time this winter when he reached 64.40 metres at a meeting in Melbourne"; "This time, it was a bit more serious because I got a registered letter". In terms of the concept elaboration criterion, it appears that the instance sense has no particular patterns of conceptual imagery associated with it. "This may follow as an instance is precisely that, an instance (of something else). Hence, instances only have structure in so far as they are tokens of other types of experiences, and have no inherent structure beyond the experiences they are instances of" (*ibid.*, p. 134). In terms of the grammatical criterion, the instance sense is highly distinctive: it can be formalized, like the moment sense, as a count noun; however, unlike the moment sense (and the duration sense), the instance sense can be pre-modified by both ordinal numbers and cardinal numbers. This follows as the instance sense relates to distinct occurrences of the same event, and hence is iterative.

That the instance sense constitutes an additional meaning not apparent in the other sense is moreover evidenced by the fact that languages other than English use different lexical items to express the instance sense. Italian language, for example, uses the word *volta* ("This time, it was a bit more serious…:" = "Questa *volta* la faccenda è stata un po' più seria…").

The instance sense is then similar to the meaning associated with the lexical item *moment* in that both can be considered by themselves, without any reference to the backdrop of a temporal continuum constituted by an endless sequence of events, facts, etc. However, unlike the meaning associated with the lexical item *moment*, but like the moment sense of the lexical item *time*, the instance sense completely lacks any temporal consistency or "thickness".

7.4. The Matrix Sense

The various meanings associated with the lexical item *time* examined so far – the duration sense, the moment sense, the instance sense – have shown how it is possible to produce different meanings by progressively modifying and abstracting away from the same, original meaning. Without doubt, the extreme instance of abstraction, as far as the lexical item *time* is concerned, is represented by what Evans calls the Matrix Sense, which is exemplified by sentences such as: "Time, of itself, and from its own nature, flows equably without relation to anything external"; "Time flows/runs/goes on forever"; "Time has no end"; "Nothing can outlast time"; "We live in time".

According to Evans' analysis, the matrix sense, unlike the other meanings associated with the lexical item *time*, indexes an unbounded entity which has an infinite elapse and is not constrained by the interval holding between individual events: an entity whose passage is unaffected by external events and within whose frame events unfold and states persist. As such, it is conceived as a manifold which contains and subsumes all other events and is thus independent of them. It is the objective time of physics and physicians, which radically differs from the subjective conscious experience of time.

The matrix sense therefore seems to differ from the other senses in that it elicits the conscious experiences of something: a) infinite, unbounded; b) akin to a kind of backdrop against which other events occur; c) independent of any external events.

Let us examine how these conscious experiences can be produced. Generally speaking, it is quite realistic, as we have seen, to conceive the time of physics as being a construction developed on the subjective experience of time: indeed, what we come to know of the world is known primarily in and through our conscious experience. Therefore, the specific conscious experiences the matrix sense elicits can reasonably be thought to derive from the more fundamental subjective experiences of time by means of some operations of abstraction.

In my opinion, in order to reach or produce the level of abstractness referred to by the matrix sense, human beings had to perform at least two fundamental steps. The first one was that of correlating or associating their subjective experience of duration with some *recurring, cyclical event*, whether it was natural, such as the daily rhythm of day and night, or artificial, such as the running of the sand out of the upper chamber into the bottom chamber of hourglasses. On the one hand, this first step allowed human beings to more precisely estimate durations, ridding themselves of the variability characteristic of the subjective sensation of time (a variability that is the direct cause of the phenomena of the experiences of protracted duration and temporal compression: see Flaherty 1999). On the other hand, by implying that a subjective sensation can be attributed to an external event or object, it gave them indirectly the great opportunity to realize that even external events may possess, and be characterized by, their own, albeit limited, duration. Therefore, duration could also be envisaged as something objective, belonging to external events and objects, and independent of what human beings could subjectively experience. Moreover, human beings could begin to use specific external objects and events (such as hourglasses) to represent, measure and keep trace of specific durations.

The second step was represented by a process of further reification by means of which duration became completely independent of any event or object. Most probably, this process was occasioned by the observation that certain events (such as the daily hours of sunlight) either contain many other shorter events, or can be conceived of as being formed by the

juxtaposition or combination of many shorter events. Indeed, once this kind of observation was made, it became possible to imagine longer and longer durations or periods, so as to arrive at the extreme extent of conceiving an unbounded duration capable of containing all sorts of events and durations.

In terms of Mach's revised hypothesis, the conscious experience elicited by the matrix sense may be obtained by associating A_t with an entity a) that has the properties of being recurring or cyclical, or of being able to give rise to recurring or cyclical events; b) whose boundaries are not and cannot be defined or specified (this is precisely the characteristic of events or entities such as God or the Universe that are conceived of as subsuming all the other events and entities). In this way the amount of labor performed by A_t is freed from any subjective variability and left undefined.

It should be noted that the achievement by human beings of the level of abstraction referred to by the required matrix sense was most probably a gradual conceptual and evolutional process implying a lot of time, and that it was not a sudden accomplishment. This hypothesis seems to receive support from the observation that human beings need some years to develop a consistent conceptual system able to represent and account for the abstract forms of time referred to by the matrix sense. As evidenced by studies of developmental psychology (Droit-Volet 2001), until the age of 4 children can only live time, but they cannot think about it: that is, they can reproduce the durations of certain actions, compare the durations of different actions, etc. but they cannot yet represent time as an abstract entity, or as a reference framework. Only at 6 can they conceive time as something that can be measured, and it is only at 11-12 that they can conceive time as a completely arbitrary entity.

Let me make a final observation in connection with the matrix sense and the objective sense of time it entails. In this work, I have defined the conscious experience of time in terms of attentional operations, and, consequently, of the quantity of labor performed by the organ of attention, or, alternatively, the expenditure of the nervous energy supplied by the organ of attention for the temporal task. It should be pointed out, however, that when I state that phenomenal time derives from some form of energy, I do not mean at all that this kind of time is like, or can even be assimilated to, the Newtonian absolute time, which "flows equably without relation to anything external", that is, a kind of time existing in itself, independently of anything else, which only represents true and real time, and against which any other kind of time has to be compared, or to which any other kind of time has to be referred. Neither do I mean that time is, more in general, something that "really" exists as an ontological entity, having its own life independent of us, and of our mental and perceptive activity, which is the only thing that gives it life. Neither, finally, do I mean that time is the cause or lies at the origin of the expenditure of the aforesaid form of energy. On the contrary, I think that: a) time is, like all other notions, concepts, meanings, ideas and representations, a product of the human being's mind and thought, that is, something human beings have mentally constructed; b) they have constructed it for their own adaptive and developmental purposes; c) in order to construct it, human beings have used as building blocks the expenditure of nervous energy associated with, and due to, the labor of attention. Therefore, when I say that time derives from a form of energy, I mean that it is a construction of human mind activity and that it could not exist without such an activity; a construction based primarily on the energy consumed in order to perform attentional activity.

8. Final Comments

What can be considered the most elementary and primitive experiences of times, that is, duration and moment, served, in my opinion, as the basis to develop some other, more elaborated, temporal constructs and notions: succession, sequence, order, after, before, now, yesterday, tomorrow, when, past, future, present, day, month, year, to last, to continue, etc. This is primarily suggested by the fact that the duration sense of the lexical item "time" is characterized by the conscious experiences of one-dimensionality, irreversibility, and orderability, which evidently make the existence of constructs such as "succession", "sequence", "order", "after", and "before" possible. If we consider, for example, that a given event A can be associated with a certain level of expenditure of the nervous energy supplied by the organ of attention for the temporal task, an event B that is associated with more expenditure of attention appears to us to happen "after" A, whereas an event C that is associated with less expenditure of attention appears to happen "before" A. This same fact, moreover, allows us to understand how we can build a "succession" or "sequence" of events, actions, etc. out of the levels of nervous energy associated with them. Since the level can only increase, this makes it possible for us to arrange or order events, actions, etc. in a univocal and exact way: precisely, in a temporal way.

The possibility of developing more elaborated temporal constructs – among which the more important one is represented, without doubt, by the grammatical category of verb - out of the elementary experiences of time is also suggested by the pioneering work of Ceccato and Zonta (1980) who gave a first indication of how one can derive some of these constructs from the more basic construct "time". A similar proposal has also been recently put forward by Benedetti (2008), even though within a new analytical framework. The analysis of these constructs, however, requires a specifically dedicated study, which goes beyond the scope of the present book.

A BEGINNING RATHER THAN A CONCLUSION

Books usually end with a conclusion. However, I do not think that a conclusion is very appropriate for this book: under certain aspects, my work is just at its beginning because a great deal has still to be done in order to improve the theories I have put forward here and verify the correctness of the analyses I have performed on the basis of such theories. Therefore, I think that it is certainly more appropriate that I try to outline in a very general way the most urgent lines of development of my work, and to present some possible applications it can have, rather than to write a conclusion.

There is no doubt that it is certainly important to continue to carry out the analytical work in order to expand the number of analyses and refine their quality and reliability. However, it is likewise important to systematically verify from an empirical point of view the correctness of such analyses. In fact, an empirical verification can provide essential indications on how to improve the theories and analytical tools that intellectual speculation alone seldom affords.

As we have seen, both the theoretical framework I have put forward on consciousness and meanings, and the analyses that are performed using the kind of semantics I developed within this framework – Attentional Semantics - are formulated in terms of operations. As such, they can be empirically tested and verified. Various experimental methods can be used to this aim; those for which some experiments were already devised include:

i) Neurobiological methods. In chapter II, I mentioned the experiments designed by Giulio Benedetti, Andrew Fingelkurts, Alexander Fingelkurts and myself. The experiments are based on the putative correspondence between the operations identified by Attentional Semantics and Operational Semantics, on the one hand, and by Fingelkurts and Fingelkurts' (2001, 2005, 2006) Operational Architectonics, on the other hand. The reader can find in Benedetti et al.'s (in press) the detailed project of research.

ii) Classical psychological behavioristic methods based on chronometric data, the usage of cues, primes, etc. Although, these methods, generally speaking, usually afford less detailed data than other methods, they can nonetheless be used to provide a first indication about the kinds of attentional operations involved in the formation of the conscious experiences and meanings being analyzed. Let us briefly examine a couple of examples of applications (designed by Benedetti and myself) of psychological behavioristic methods in the analyses performed by Attentional Semantics and Operational Semantics. Let us consider for example the case of negation, which is

usually expressed by words such as "not", "no", "never", etc. According to the analysis performed by Benedetti (2008, 2009), negation first implies the formation of the representation of the object or event being negated (on this aspect, see also the experimental evidence in Giora et al. 2005 and Kaup et al. 2007), and subsequently an operation of attentional discarding of such representation. As such, the use of negation is more laborious than the pure representation of the object or event being negated because of the additional operation of attentional discarding that the latter does not imply. Therefore longer reaction times should be involved in negating an object or event than in purely affirming it. Moreover, hindering the process of attentional discarding by introducing interferences (such as those implied by the Stroop effect) should also imply longer reaction times. Or let's consider the difference between the conjunction "and" and the preposition "with". According to Benedetti's (2008, 2009) analysis, when we use the preposition "with" we focus our attention on two things together, as a whole; instead, when we use the conjunction "and", we first focus our attention on something, say A, then, keeping it present, we focus our attention on something else, say B. On the basis of this analysis, it can be predicted that, in an experimental condition in which subjects are requested to describe a scene using either the conjunction "and" or the preposition "with", any cue disrupting or inhibiting the fusion of the two objects will induce subjects to use "and", and any cue facilitating the fusion of the two objects will induce subjects to use "with". Finally, it should be noted that psychological behavioristic methods can provide not only an indication about the kinds of attentional operations involved in the formation of the conscious experiences and meanings being analyzed, but also the order in which such attentional operations enter in combination with each other: see for example Sackur and Dehaene (2009).

iii) Eye tracking. Eye movement is a good correlate of the shifting and fixating of the focus of attention. Therefore, it can be used to experimentally verify the analyses performed in attentional terms (see also Ceccato's proposal and use of this method: Ceccato, 1987). Considering, for example, the difference that both Benedetti's (2008, 2009) and my (1993) analysis found between singular and plural (that is, while the use of plural implies a repetition of attentional focalizations, the use of singular implies only one fixation), it can be predicted that, in an experimental condition in which subjects are requested to describe an image using either the singular form or the plural one (for example, wood/trees, fleet/ships, etc), they will perform more fixations when using the plural form (trees, ships) than when using the singular one (wood, fleet).

iv) Gesture. The study of the gesture that may accompany the linguistic expression: see for example Amietta and Magnani's (1998) work, who develop and treat in depth the idea of using the study of gestures as a means for verifying the analyses performed in attentional terms.

v) The use of surveys to ascertain if subjects sense what the analyses reveal: see for example Marchetti's (1997b) analyses in the aesthetic field.

What the empirical research will reveal can be used not only to improve the analysis already performed, but also, if necessary, to modify and adjust the set of elemental operations

used to perform the semantic analyses (see for example those listed in Benedetti 2005, 2009, and the list of attentional basic operations I described in chapter II).

As we have seen in chapter III, the analyses performed by Attentional Semantics can also highly benefit from the constraints provided in general by the results of the empirical research performed in the other research fields (psychology, psycholinguistics, neuropsychology, neuroscience, cognitive science, etc.).

Conversely, the analyses performed with the methods of Attentional Semantics can help improve research in specific psychological fields, such as – just to mention a few - those dealing with attention, time and space.

Moreover, the theory of consciousness that I have put forward here (based on the ideas of the continuous interplay between the perceptual system and the schema of self, and the variation of the organism's state of nervous energy - supplied by the organ of attention - induced by the organism's continuous application of its own nervous energy) can help identify the nervous structures responsible for the production of consciousness.

Additionally, it should also help to better identify the nervous structures of the organ of attention. The individuation of the organ of attention, as I have defined it, should take into consideration not only all those operations that we all know attention allows us to do, such as focusing or zooming on an object, maintaining a state of alertness, selecting items, filtering unwanted information, and so on, but also and above all the fundamental function of generating conscious experience in its various qualitative and quantitative aspects.

In turn, the results of the empirical investigation on these organs can better constrain the models of consciousness and attention I have put forward here.

Finally, some possibilities of improvements of the theories and analyses put forward here can come from their application to fields such as robotics, artificial intelligence, artificial conscious machines, mechanical translation, and internet.

Obviously, the success of the scientific project developed in this book will depend, like all modern scientific projects, not only on the soundness of the theories underlying it and the quality of the ideas it expresses, but also on the collaboration of many researchers and the support of institutions.

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