In: Philosophy of Mind
Editors: R. J. Jenkins, W. E. Sullivan
ISBN: 978-1-62257-215-1

Chapter 2

HOW CONSCIOUSNESS BUILDS THE SUBJECT THROUGH RELATING

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ABSTRACT

This paper aims to show that the main difference that consciousness makes to human behavior is to provide us with a sense of self. Consciousness does this by allowing us to relate ourselves to other entities, and therefore to understand what kinds of relations exist between us and them. Variations in the state of nervous energy elicited by the use of attention are the basic underlying mechanism of consciousness. They are used to put things in relation, mainly by acting as the basis for the construction of possible orders (such as space and time).

Keywords: Consciousness, sense of self, relations, attention, nervous energy, order

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INTRODUCTION

The present-day philosophical debate and scientific research on human consciousness pose a fundamental question: Does consciousness epiphenomenally accompany our brain activity, with no consequences on our thoughts, actions, perceptions, etc. or does it play a role in our behaviour? And if so, what is its function?

One could certainly be led to accept the idea that consciousness has no significant function, after considering the bulk of empirical evidence showing that human beings process a large amount of information unconsciously (Merikle et al., 2001), that complex decisions are best made after a period of distraction assumed to elicit unconscious thought (Dijksterhuis and Nordgren, 2006; Zhong et al., 2008), and that a freely voluntary act is not initiated by the subject's conscious free, but by his brain's unconscious processes (Haggard, 1999; Haggard and Eimer, 1999; Haggard et al., 1999; Libet, 1985; Libet et al., 1983).

This idea is further supported by the fact that very sophisticated information processing, such as recognizing faces, analyzing speech and chess playing, can be performed not only by human beings, but also by modern computers, which few of us would qualify as conscious agents.

Some scholars, such as Rosenthal (2008) for example, who argues that "the consciousness of thoughts, desires, and volitions adds little if any benefit for rational thinking, intentional action, executive function, or complex reasoning" (*ibid.*, p. 839), have concluded that consciousness has no significant function.

However, if the available data is examined more carefully, things are not that simple.

My aim in this paper is to show: that consciousness does make a difference to human behaviour; what this difference is; how such a difference comes about in and through consciousness; the underlying mechanism of consciousness.

Most of the ideas presented here can be found in Marchetti (2010), which contains a more detailed discussion, as well as more extensive reference to supporting empirical evidence.

CONSCIOUSNESS PLAYS A ROLE IN OUR BEHAVIOUR

Does consciousness make any difference to human behaviour? Contrary to those who maintain that consciousness is a mere epiphenomenon with no consequences on a person's behaviour, there are many reasons to believe that consciousness *does* play a role. Four such reasons are listed here below.

Firstly, studies using different experimental paradigms show that conscious and unconscious processing can lead to qualitatively different consequences. In Pavlovian conditioning studies for example, Clark and Squire (1998) show that trace conditioning requires an awareness of the conditioned stimulus-unconditioned stimulus relationship for conditional response acquisition, whereas awareness does not appear to be necessary for simple delay conditioning[1].

In implicit learning studies, Fu et al. (2008) – consolidating the findings made by Destrebecqz and Cleeremans (2001) and confirming predictions by Cleeremans and Jiménez (2002) - show in their Experiment 3 that unconscious (versus conscious) knowledge arises early in training. Unconscious knowledge is characterized by weak, poor-quality representations that are already capable of influencing a person's performance and are too weak for the person to be able to exert control over them[2].

Secondly, the interpretation of empirical data supporting the primacy of unconscious processing is not as straightforward as it may initially seem.

Rey et al.'s (2009) experiment clarifies the claim made by Dijksterhuis et al. (2006) about the supremacy of unconscious over conscious thought at solving complex decisions. By using an experimental design similar to the one used by to Dijksterhuis et al. (2006) but with an additional control condition (the "immediate condition") in which subjects made their choice immediately without any period of thought (conscious or unconscious), Rey et al. showed that decisions made by subjects in the immediate condition were just as good as those in the unconscious one, hence challenging Dijksterhuis et al.'s (2006) interpretation.

The same finding was replicated by Waroquier et al. (2010). Additionally, they found that while too much conscious deliberation can actually deteriorate

[1] Bekinschtein et al. (2011) observe that at least three cases seem to challenge this view: trace conditioning can be 1) learnt by almost every animal, even sea slugs; 2) elicited using subliminal stimuli; 3) learnt by clinically-defined unconscious patients. However, as their analysis reveals, the three cases do not contradict the possibility that consciousness is a prerequisite for trace conditioning.

[2] For further examples in other field studies, see Merikle and Daneman (1998).

high-quality first impressions, conscious thought enhances the quality of decisions in the absence of such prior first impressions[3].

In the research field of unconscious priming, Kunde et al. (2003) show that - contrary to the hypothesis that unconscious priming originates from purely unconscious semantic processing of the prime - unconscious primes activate responses to the degree that they match pre-specified action-trigger conditions: that is, the impact of subliminal stimuli is crucially determined by the subject's pre-stimulus intentions.

Likewise, Libet's (2004) conclusions about his experiments seem unjustified. As I have tried to show (Marchetti, 2005), in his experiments subjects *were aware* of the task they had to accomplish *well before* the time in which the freely voluntary act was to occur. Therefore, in a causal chain of events, a conscious decision to perform a freely voluntary act indisputably precedes the act itself.

Some researchers are also very critical towards empirical evidence (supported by implicit learning studies: Destrebecqz and Cleeremans, 2001; Nisbett and Wilson, 1977; Reber, 1967) proving that learning can be dissociated from awareness. In reviewing literature on implicit learning, Shanks (2005) finds that "it has yet to be proved beyond reasonable doubt that there exists a form of learning that proceeds both unintentionally and unconsciously" *(ibid.*, p. 216), and Perruchet (2008) argues: "there are quite limited supports to claim that while they perform the implicit test participants (1) have no conscious knowledge about the study material, (2) have the subjective experience of guessing, or (3) have no control over the expression of their knowledge" *(ibid.*, p. 615).

Thirdly, studies such as those by Perruchet and Vinter (2002), show that, in a dynamic perspective, conscious mental life is sufficient to account for (at least part of) human behaviour without any need to resort to the concepts of unconscious representations and knowledge, and the notion of unconscious inferences. The "mentalistic" framework put forward by Perruchet and Vinter, and expressed by the concept of self-organizing consciousness (SOC), proves to be more parsimonious than the prevailing view of the mind being based on the postulate of an omnipotent cognitive unconscious. Their model adopts

[3] Moreover, it should be noted that Dijksterhuis and Nordgren themselves cannot fail to recognize the usefulness of consciousness in aspects of human information processing at least: while arguing that in many ways unconscious thought is superior to conscious thought, they admit that "this superiority of unconscious processes does not pertain to the earlier stage of information acquisition. At that stage, conscious processes are superior" (Dijksterhuis and Nordgren , 2006, p. 106).

basic associative principles that operate on successive conscious contents while respecting and taking advantage of the constraints inherent to the conscious system, such as limited capacity, seriality and relative slowness of processing and memory decay. As such, it appears to be capable of generating highly complex representations that are able to fulfil functions which are generally assigned to unconscious rule-governed thinking.

Fourthly, experiments directly comparing the brain activation evoked by conscious versus nonconscious stimuli, have revealed that conscious processing involves neural processes other than those involved in nonconscious processing, thus supporting – albeit indirectly - the idea of a distinct functional role for consciousness[4]. For example, time-resolved experiments using ERPs aimed at following the processing of a visual stimulus in time as it crosses the threshold for conscious perception, show that (i) during the first 250 ms subliminal stimuli produce a transient, small and brief activation that progresses from the occipital pole toward both parietal and ventral temporal sites (ii) at around 270 ms conscious stimuli elicit a sudden onset of high-amplitude activity that is broadly distributed in the inferior and anterior prefrontal cortex as well as in the posterior parietal and ventral occipito-temporal cortices (Dehaene, 2009; Del Cul et al., 2007).

Accordign to Lamme (2003, 2006, 2010), a similar division of stimulus processing in different stages is associated with different levels of conscious access but is based on different neural mechanisms. Rees et al. (2002) offer a possible explanation that reconciles Lamme's and Dehaene's accounts.

EEG studies also provide evidence that different brain processes underlie conscious and nonconscious processing. Fingelkurts et al.'s (2011) study on vegetative (VS) and minimally conscious (MCS) patients shows that the size and duration of local EEG fields are smallest in VS patients, intermediate in MCS patients and highest in healthy fully conscious subjects. At the same time, these fields are quite stable in healthy subjects, less stable in MCS patients and very unstable in VS patients. The number and strength of coupling of local EEG fields (thought to be responsible for integrated subjective experiences) are highest in healthy subjects, intermediate in MCS patients and smallest or even absent in VS patients.

In short, although some contend that consciousness is a mere epiphenomenon that has no consequences on a person's behaviour, evidence shows that conscious processing does lead to behavioural consequences that

[4] However, it must be noted that there is no general consensus among researchers not only regarding the neural basis or correlate of consciousness, but also over the investigation stance and methods for determining the neural basis of consciousness (Lamme, 2010).

are qualitatively different from those produced by unconscious processing, and that different neuronal processes underpin conscious and unconscious processing.

Moreover, there are also strong arguments refuting the validity of evidence that certain phenomena, such as implicit learning and unconscious priming, can occur in the absence of awareness. This supports the view that part of human behaviour can be explained through conscious processing only.

FROM AN INFORMATION-PROCESSING TO A PERSON APPROACH TO CONSCIOUSNESS

I think that much of the misunderstanding concerning the role played by consciousness in a person's behavior originates from the level of analysis that is usually adopted by researchers when investigating it: namely, the information-processing conception of mind.

In its best known version, the information-processing approach considers the mind as a computer that processes information coming from external or internal sources in order to allow the person to provide appropriate behavioral responses. The information processed by the mind flows from one module to the next, until it reaches the last module of the chain: consciousness. Following the computer metaphor of the mind, this last module has been termed an "operating system" (Johnson-Laird, 1988), a "central processor" (Umiltà, 1988), or a "supervisory system" (Shallice, 1988).

The information-processing approach has certainly yielded various and positive results in psychological research on the mind: it can tell how long it takes for information to become conscious (Cleeremans and Sarrazin, 2007; Libet, 2004), the different levels of processing information involved by conscious vs. unconscious processes (Dehaene, 2009; Kouider and Dehaene, 2007), the different consequences that consciously vs. unconsciously processing information has on memory, learning, etc.

However, it is not the most appropriate approach when studying consciousness because it can neither provide the adequate level of analysis of the phenomenal aspect of consciousness, nor account for the emergence of the sense of self[5].

[5] By the expression "the sense of self" I mean the sense of a minimal self - with its sense of agency and ownership - and the sense of a narrative self (Gallagher, 2000; Hohwy, 2007),

The information-processing approach cannot provide the adequate level of analysis of the phenomenal aspect of consciousness simply because it does not address it. The information-processing approach analyzes the processes involved in transforming and elaborating information, the time needed to process information, how information is transformed, transmitted and disseminated, and so on, but not why these processes give rise to phenomenal experience. Let's consider for example Baars' (1988) Global Workspace model. Baars' model is certainly highly valuable in explaining a number of cognitive processes such as the subject's access to information, the influence of unconscious processors, voluntary control, reportability, etc. However, as Chalmers (1996) observes, 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.

The information-processing approach cannot account for the emergence of the sense of self because its main concern is to analyze the *piece of information* processed by the person, or *how* this piece of information is transformed, rather than to analyze what it means for a *person* to consciously experience the piece of information that he/she is processing.

Adopting Negrotti's terminology (1997, 1999), we can say that the observation level of the information-processing approach is that of the *information* processed, or that of the *process* involved in processing information, not that of the *person* processing the information. As such, the information-processing approach cannot account for how a person (and his/her self) emerges, develops, changes and transforms by and through consciously processing information, but only for how some parts of a person's organism - sense organs, attention, memory, central processor, and so on - process information.

As various researchers (Cisek, 1999; Edelman, 1989; Freeman, 1999; Harnad, 1990; Searle, 1980, 1984, 1992) have highlighted, most of the problems raised by the information-processing approach are due to the fact that this approach considers information as made up of ready-made symbols

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as well as of self-consciousness and the other possible manifestations of the sense of owning or being the subject of one's own conscious experiences.

representing the external world, whose meanings derive not so much from the history of the person, the importance they have for the person, his/her relations with other entities[6], but from the researcher's research goals.

Therefore, if we want to study consciousness, we have to change or perspective and no longer consider information, as well as the person processing it, as ready-made entities. On the contrary, we need to investigate how a person develops, changes and transforms by processing information, why and how something becomes "information" for a person, how something acquires a meaning for a person.

As we will see, and as I have tried to show elsewhere (Marchetti, 2010), by investigating this, we will find that both the person and information are the outcome of a continuous activity of differentiation carried out by an organism by applying its nervous energy to itself. In relating the organism to other entities, this activity allows the person and the other entities to co-emerge and come into existence.

The main tool that an organism possesses to carry out this activity of differentiation from other entities and emerge as a person, is consciousness. By making the organism directly experience how other entities relate to it (and how other entities relate to each other), consciousness is the privileged means by means of which an organism determines what relations exist between it and other entities, acquires a knowledge of itself and other entities, assigns a meaning to itself and other entities, and defines its own boundaries and shape, thus emerging as a differentiated entity: a person.

Summarizing, then, in order to fully account for the role that consciousness plays in a person's behavior, emergence and development, it is necessary to move the scientific analysis from an investigation of the difference that it makes for *information* to be consciously (vs. unconsciously) processed, to an investigation of the difference that it makes for a *person* to consciously (vs. unconsciously) process information.

THE SENSE OF SELF

An appeal to change the direction of scientific investigation on consciousness from an information-processing to a person approach has been

[6] By "other entities" I mean not only the objects, beings, organisms and events of the environment, but also the products of the very organism's activities, such as its movements, thoughts, plans, etc.

made by Cleeremans (2008, 2011)[7]. Cleeremans answers the question about what the notion of conscious subjective experience or *quale* means, by rejecting proposals such as Tononi's (2007), which, in analyzing conscious experience as a rather abstract dimension or aspect of information, would seem to overlook fundamental facts about experience. "Experience – *what it feels like*" observes Cleeremans "is anything but abstract. On the contrary, what we mean when we say that seeing a patch of red elicits an 'experience' is that the seeing *does something to us*" (Cleeremans, 2008, p. 20).

Cleeremans' proposal about what conscious subjective experience does to us, includes three main elements: memory, emotion and the sense of being the subject of one's experiences. In my view, the first two elements - memory and emotion -, while certainly identifying some important aspects, are not strictly necessary to qualify conscious subjective experience. Firstly, these two characteristics can also be elicited by unconscious processing. For example, emotional responses such as fear can occur without any awareness of their triggering stimuli (Tsuchiya and Adolphs, 2007). Secondly, these two characteristics seem to describe byproducts or second-order, albeit important, effects of conscious subjective experience, instead of grasping the fundamental differences that conscious (vs. unconscious) experience makes to a person and that characterize all conscious experiences. Not all our conscious experiences are accompanied by emotion or memories, which, on the contrary and most of the times, are consequent upon and triggered by a given conscious experience. Thirdly, there is no reason why some other equally important aspects or processes that usually characterize subjective experience should be ruled out. Examples of these are perceptions and thought, as well as all those processes listed by Baars (1988), or Seth (2009).

The third element identified by Cleeremans - the sense of being the subject of one's experiences - seems to be more plausible however: "it does not make any sense to speak of experience without an *experiencer* who experiences the experiences" (*ibid.*, p. 21); a "thermostat fails to be conscious because, despite the fact that it can find itself in different internal states, it lacks the ability to remove itself from the causal chain in which it is embedded. In other words, it lacks knowledge *that* it can find itself in different states; (…) there is no one home to be the *subject* of these experiences" (*ibid.*,

[7] Some other researchers have also proposed, each in their own way, changing approach and adopting a view that is more centered on the self and the person: see, for example, Damasio (1999, 2000), Evans' (1970) proposal of the "self-approach", Metzinger's (2000) "phenomenal self-model", Varela's (1996, 1999) and Varela and Shear's (1999) proposal to reconcile the first- and the third-person approach to consciousness.

p. 21). All of our conscious experiences are indeed accompanied – either at the time we have them or at a later stage - by the feeling that they belong to us, in the sense that we feel that it is we, and not someone else, who are experiencing them (Thompson, 2007).

This feeling, which I term the sense of self, is continuously brought about and reinforced (Fingelkurts and Fingelkurts, 2011) every time: we (decide/are able to) recall our past conscious experiences and experience them again; we decide to stop having a given conscious experience and start having another one; we realize that a conscious experience modifies and changes as we modify and change (for example, our conscious experience of duration changes with our age, psychological state, the kind of activity we are performing, etc.: see Flaherty, 1999; Marchetti, 2009); we observe that the conscious experience we are having is a precise and specific one, which differs from other ones.

The sense of self is dynamic, not singular but multiple, emerging chronologically in development "like onions, layers after layers, in a cumulative consolidation" (Rochat, 2003, p. 730).

Therefore, one of the main differences when a person consciously (vs. unconsciously) processes information, is definitely that it provides him/her with the sense of self. How does this sense of self affect and characterize a person's conscious experiences?

Firstly, a person's conscious experiences are characterized by the sense that they primarily originate from and refer to him/herself: what the person feels depends on him/her. This is quite patent when the person's actions and thoughts are involved. Yet it is also evident with other kinds of conscious experiences: there is no perception which does not originate from or is related to the person's specific sense-organs, body, position in space, way of looking at and conceiving the world, etc.

Secondly, it makes a person feel that the conscious experiences he/she has, have a direct effect on him/her, in the sense that every conscious experience directly affects, changes, modifies or transforms him/her: what a person feels has an effect on him/her. The most obvious examples of these effects are extreme and acute sensations such as pain, effort, exhaustion, pleasure, gratification, relief, thirst, hunger, etc., but there are also countless examples in the various sensory domains represented by sensations having intermediate or minor effects.

Thirdly, it provides a person with the sense of being a persistent, coherent entity, self or agent. Even if a person undergoes changes and various experiences, he/she continues to exist as a unified and coherent whole, on and

from which all his/her actions and experiences center and evolve: what the person feels makes him/her experience to be a consistent, persistent, unique agent.

Fourthly, it makes a person understand that he/she can directly control and guide the course of his/her own actions by means of his/her conscious activity. One a person has understood this – or, paraphrasing Cleeremans (2008), once he/she has "learnt to be conscious" -, he/she equips him/herself with the capacity to regulate him/herself. This means setting his/her own aims and objectives, taking decisions, evaluating events and situations, learning new strategies, adapting to changes, etc. Simply put, being self-conscious. From that moment on, a person's actions are primarily and directly governed not so much by innate instincts as by what happens in the person's consciousness, even though the latter can be occasioned by the former.

According to Vogeley et al. (2004) and Schilbach et al. (2008), the neurophysiological basis of self-consciousness or the sense of "being a self" is provided by the default-mode network (DMN). Fingelkurts and Fingelkurts' work (2011) brings further support to this hypothesis. By showing that the integrity of DMN persists unchanged across a variety of different cognitive tasks - and therefore is task-unrelated -, they can account for the fact that a subject that experiences phenomenal self-consciousness *always* feels directly present in the centre of a multimodal perceptual reality.

THE MAIN ACTIVITY THAT CONSCIOUSNESS ALLOWS A PERSON TO DO

But what are the conditions necessary for the sense of self to emerge and take shape? A very plausible answer comes from developmental psychology when it describes how the subject forms and develops. As Piaget (1974, pp. 281-282) has suggested, the subject (in my terminology, the person) only learns to know himself when acting on the object (in my terminology, other entities), and the latter can become known only as a result of progress of the actions carried out on it. In other words, by continuously acting, the subject *differentiates* him-herself from the object and emerges as a cognizing agent: this process allows the subject to define him-herself and its own boundaries while also defining the boundaries of the object. It should be noted here that "object" refers to both inanimate and animate entities. In fact, according to various researchers, in order to emerge, a person's higher-order cognitive

processes, such as those involving meta-representational self-consciousness (Newen and Vogeley, 2003), require a person to interact with other persons, so that the person can compare and distinguish his/her own cognitive states with those of others (Decety and Chaminade, 2003; Newen and Vogeley, 2003; Schilbach et al., 2008).

The process of differentiation which allows the subject to emerge is based on a very general activity: the possibility for the subject *to relate* to other entities. This activity includes not only very basic and simple ways of relating - such as the same/different distinction, symmetry, repetition, etc. - but also more complex and abstract ones. In the differentiation process, the person comes to learn and understand: how, when, where and why he/she relates with other entities; the value and functions that other entities have for him/her; how the person can affect or change other entities; how other entities affect him/her and make him/her change or not change. Subsequently, and on the basis of this first-level knowledge of the relations between him/her and other entities, the person can build a second-level knowledge of the relations existing between other entities.

In my view, this is precisely the main activity that consciousness allows the person to perform: that is, *it allows the person to relate him-herself to other entities* and therefore to understand what the relations between him/her and other entities. Consciousness, making the person experience directly what he/she is doing, the results of his/her activity, how he/she can affect other entities (and vice versa), how other entities limit him/her, etc., is the privileged way a person has of recognizing the relation between him-herself and objects and therefore of defining him-herself and other entities.

Some could argue that because animals can also perform elementary tasks of relational learning, and because it is questionable whether animals have any form of consciousness, consciousness is not necessary in order to (learn how to) place entities in relation to each other.

Apart from the plausibility of the claim that animals do not possess any form of consciousness (see Northoff and Panksepp, 2008; Panksepp, 2005), the argument that consciousness is not necessary to learn and place entities in relation to each other can be refuted on the grounds that there is abundant evidence showing the opposite, at least as far as more complex forms of relations are involved.

Firstly, Sackur and Dehaene (2009, experiment 4) have shown that while simple tasks - such as performing an arithmetical operation on a target number or comparing the target number to a reference number – can be performed even when the target number is masked and cannot be consciously perceived,

a chained (or composite) task made of two simple tasks on one target number cannot be performed in the absence of consciousness.

Secondly, classical conditioning studies show that "awareness is a prerequisite for successful trace conditioning" (Clark and Squire, 1998, p. 79). According to Clark and Squire, the more complex condition involved in trace conditioning vs. a simpler form of conditioning such as delay conditioning, would require consciousness to represent and remember the temporal conditioned stimulus-unconditioned stimulus relationship (for similar considerations in a Pavlovian conditioning study but involving a *detection* task vs. an *identification* task, Núñez and de Vincente, 2004).

Thirdly, in fear conditioning studies, a similar view on the role of consciousness has been expressed by Knight et al. (2006, p. 160), who found that awareness is necessary for conditional responding during trace, but not delay, fear conditioning (see also Carter et al., 2003).

Fourthly, the psychology of perception shows that the order of perceived events is highly dependent on whether or not their duration falls inside the "phenomenal present" (*Präsenzzeit*) (Stern, 1897), that is, the interval of physical time that, despite being composed of non-contemporaneous parts, is perceived as a unitary and unique act of consciousness (for a discussion, see Fingelkurts et al., 2010). As Vicario (2005) extensively shows, when all the single phases of a sequence fall into the phenomenal present, the sequence can undergo some kind of restructuring (according to certain Gestalt principles of organization) irrespective of the physical temporal contiguity of the stimuli. On the contrary, if the single phases of a sequence occupy a whole phenomenal present, the sequence of stimuli cannot undergo any kind of restructuring and the sequence of the perceived stimuli will be the same as the sequence of physical stimuli. The phenomenon of "temporal displacement" investigated by Vicario (1963), as well as other phenomena such as "continuous displacement", "tunnel effect", "Renard effect", "window effect" and "phi phenomenon", show that how relations between objects and events appear to us is strongly determined by the very features of the conscious working (such as the duration of the phenomenal present), to the extent that the order of perceived events does not correspond to that of the physical events.

However, the clearest evidence that a person must be conscious in order to create and place entities in relation to each other, is definitely represented by the extensive creation and use of natural and formal languages by human beings (Chafe, 1994). This is a prerogative which does not belong to other

species that posses simpler forms of consciousness or do not possess consciousness at all.

Artificial and natural languages provide a wide and specialized variety of ways of connecting and correlating real and abstract objects and events, as exemplified by logical connectives, mathematical operators and "grammatical" words and morphemes (Benedetti, 2009, 2010, Ceccato and Zonta, 1980). The fact that language represents a unique and specialized tool in connecting objects and events is further exemplified by the evidence reported by Conway and Christiansen (2001) of the strong connection between language and the ability to encode and represent the order of discrete elements occurring in a sequence (sequential learning).

The hypothesis that the main feature of consciousness is to allow a person to (learn how to) place entities in relation to each other, can also be criticized by saying that it is too restrictive and does not account for everything that consciousness allows a person to do.

Undeniably, such a criticism would seem more than reasonable if one considers, for instance, the eighteen functions listed by Baars (1988). The variety of these functions however can be reduced to the one I propose inasmuch as they let the person relate him-herself to other entities.

Summarizing then, what makes the sense of self possible is the fact that a person can, by means of his/her consciousness, place entities in relation to each other, and that, by means of placing entities in relation, he/she can differentiate him-herself from other entities. But how does this activity of placing things in relations with each other through consciousness occur? What mechanism allows consciousness to do this? More in general, what is the underlying mechanism of consciousness?

THE UNDERLYING MECHANISM OF CONSCIOUSNESS

My main hypothesis is that consciousness is the result of a person's attentional activity - that is, the continuous use and application of his/her attention - and that through his/her attentional activity, a person understands what relations exist between him/her and other entities, what his/her own boundaries and limits are, and therefore the limits and boundaries of other entities.

The hypothesis is based on six fundamental tenets, which I will describe here briefly. The reader can find a detailed presentation and discussion of supporting empirical evidence in Marchetti (2010).

Firstly, attention is the core element necessary, even if not sufficient, for consciousness: without attentional activity, there cannot be consciousness. The position about whether attention is necessary for consciousness ranges from those who maintain that attention and consciousness are distinct phenomena that need not occur together (Koch and Tsuchiya, 2006, Lamme, 2003) to those who maintain that the two are inextricably linked (De Brigard and Prinz, 2010, Mack and Rock, 1998, Posner, 1994). As I have tried to show (Marchetti, 2010), the view that in general there can be consciousness without attention originates primarily from the failure to notice the varieties of forms and levels of attention (Chun et al., 2011; Demeyere and Humphreys, 2007; La Berge, 1995; Lavie, 1995; Nakayama and Mackeben, 1989; Pashler, 1998) and consciousness (Bartolomeo, 2008; Edelman, 1989; Iwasaki, 1993; Vandekerckhove and Panksepp, 2009). Not all forms of attention produce the same kind of consciousness, and vice versa not all forms of consciousness are produced by the same kind of attention. Overlooking this fact may lead to the wrong view that there can be consciousness without any form of attention (for a similar criticism, see Kouider et al., 2010, Srinivasan, 2008).

Secondly, attentional activity can be performed because of the nervous energy that is supplied by the organ of attention. The concept of "nervous energy" implies the ideas that nervous energy is a pool that allows us to perform a certain kind of work, is limited, runs out, is replenished, and can be used in a flexible way. The concept of nervous energy – for which alternative terms, such as "psychic energy", "limited capacity processor", "resource", and "effort" have also been used – has been analyzed in various ways in relation to attention by many researchers and authors (Csikszentmihalyi, 1992; Kahneman, 1973; Mach, 1890; Wickens, 1984). More in general, the notion of energy is currently used and investigated in relation to brain activity (Laughlin, 2001, Laughlin and Sejnoiwski, 2003, Shulman et al., 2009a, 2009b). As to the "organ of attention", many scientists have started investigating its physical substrate (Crick 1994, Crick and Koch, 2003; Mesulam, 1990; La Berge, 1995; Posner 1990, 1995; Posner and Petersen 1990; Knudsen, 2007).

Thirdly, attentional activity consists in 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, that is, a repetition of successive acts of focalization each of which has a specific minimal and maximal duration. The hypothesis of the cyclical dynamics of attention (Buschman and Miller, 2010; Large and Jones, 1999;

VanRullen et al., 2007; Ward, 2003) 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).

Fourthly, attentional activity allows a person to perform actions that can directly vary his/her own state of nervous energy. This variation constitutes the phenomenal aspect of consciousness, or qualia. I have partly derived this idea from Valéry's (1973) observation that sensation is a variation of the state of energy of a closed system. Other suggestions indicating that consciousness results from a variation of the organism's internal state can also be found in Damasio's (1999) work. 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 partly captured by Haikonen (2003), who argues that some basic conscious states (pain pleasure, good and bad) derive from the modulation of attention.

Fifthly, by acting attentionally, a variation in the state of nervous energy is induced. This produces a conscious experience in the form of either a certain level of constraint or of non-constraints (to act in general). The constraints that a person experiences when acting attentionally are determined by the level of attention applied, the specific structure of his/her body and the relations resulting from the interaction between his/her body and other entities. This aspect was conveyed very well by Piaget (1937), who – in describing how the idea, or concept, of an object is built up during the first stages of intellectual development - observed that the subject recognizes his own reaction before he recognizes the object as such.

Sixthly, these constraints – which are the basic elements of conscious perception - consist precisely of the interruption, hindrance, slowing down, facilitation, stimulation, acceleration, and so on, of attentional activity. Whenever a person finds an obstacle or cannot extend his/her limbs beyond a certain length or cannot make a movement, his/her attentional activity, and all his/her being along with it, 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.

A very interesting, albeit partial, exemplification of the mechanism by means of which attentional activity induces a variation in the state of nervous energy, is represented by Cabanac and Russek's (2000) model of regulated biological systems (for a discussion, see Marchetti, 2010). By offering a model of representation for both human consciousness and the other main

physiological functions (such as pulmonary ventilation, blood circulation, etc.), Cabanac and Russek also gives biological plausibility, from an evolutionary point of view, to my model of consciousness as being the evolution of more primitive systems.

Additionally, Cabanac (1996, 2003) puts forward the idea of the affective dimension of human consciousness as being the "common currency" for the trade-offs that take place in the mind to achieve a ranking of priorities. This is consistent with my idea that consciousness is the privileged way of controlling the other organs and systems by means of a unique and common form of energy: nervous energy[8].

The constraints a person experiences every time he/she acts attentionally, represent the basic elements that allow the person to come to know and define him-herself, other entities, and the relations between him-herself and other entities. For instance, the activity a person performs when trying to reach something unsuccessfully has a direct effect on him-herself, in that it modulates 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. This effect, which constitutes a person's conscious experience, immediately gives this person the dimension of his/her effort, helps define the boundaries of both his/her body and the entity he/she tries to reach, and the relations between him-herself and the entity. The information so acquired constantly updates what I have called the "schema of self" in my model of consciousness (Marchetti, 2001, 2010). The schema of self is the system that incorporates and coordinates all the innate and learned values and schemata needed to keep the organism alive, and that provides all the rules which make our organism perceive, move, act in general and interact with other organisms.

On the basis of the initial experiences of his/her own boundaries and those of other entities, a person can subsequently refine the definition of the relations existing between him/her and other entities. As demonstrated by Piaget's (1936, 1937) influential work on developmental psychology, a person's relations are defined through a gradual and continuous process of differentiation and systematization. This is made of different stages that progressively generate and consolidate, among other things, the notions of independent entities (such as "object", "agent", "space", and "time").

As observed by Piaget (1936), the process leading to the definition of a person's relations with other entities requires some inborn behaviors, such as

[8] This aspect is also reminiscent of Ukhtomsky's (1966) principle of "dominanta": for a discussion of Ukhtomsky's principle, see Fingelkurts et al. (2010).

sucking and grasping reflexes, in order to be started. Additionally, it also requires some innately specified processes and principles that help infants direct and coordinate their attention to relevant aspect of the input.

In this regard, developmental psychologists have put forward various, and sometimes, contrasting, hypotheses (Karmiloff-Smith, 1992). For example, Piaget (1936, 1937) granted the newborn child three domain-general functional processes (assimilation, accommodation and equilibration). Spelke (1990) identified a set of specific principles that serves to guide their perceptual analysis of the physical word: boundedness, cohesion, rigidity and no action at a distance. Mandler (2008, 2010) goes so far as to hypothesize the existence of an innate attentional mechanism (which she calls Perceptual Meaning Analysis, PMA) that records selected aspects of incoming spatial information into an accessible conceptual format. During the first year of life, preverbal infants are able to reduce and redescribe perceptual information into a spatial image-schematic form thanks to the work done by PMA.

Social neuroscientists have also highlighted the importance of specialized neuronal systems that compute socially relevant stimuli (faces, gaze direction, motion of bodies and limbs) in defining a person's relations with other entities. Particularly interesting is Graziano and Kastner's (2011) proposal about the central role they assign to social attention (Birmingham and Kingstone, 2009; Frischen et al., 2007; Nummenmaa and Calder, 2008) in the construction of perceptual models of other minds and one's own mind. According to them, we are endowed with a social perceptual machinery which allows for the predictive modeling of the behavior of individuals. The existence of this machinery is supported by a series of empirical studies (Blakemore et al., 2003; Calder et al., 2002; Gallagher et al. 2000; Grossman et al., 2000; Pelphrey et. al., 2004, 2005, Saxe and Kanwisher, 2003; Saxe and Wexler, 2005; Vogeley et al. 2001). Its main component is the ability to track someone's attention, because it provides critical information for predicting an individual's behavior. Graziano and Kastner identify the superior temporal sulcus (STS) and the right temporoparietal junction (TPJ) as the main areas responsible for building perceptual models of minds. These two areas operate in a cooperative fashion with other areas and networks devoted to social perception: for example, the models generated by STS and TPJ would seem to be used by the mirror-neuron system (Rizzolatti and Sinigalia, 2010) to drive simulations.

It is important to note that while all these hypothetical processes and machineries can explain, for example, a person's capacity to assign the cause of experiencing a certain constraint to an external agent rather than to him-

herself, they cannot explain the experience of constraint itself, that is, how conscious phenomena and experiences generate.

My model of consciousness is not the only one having attention as one of its fundamental components. Other models also include (Baars, 1988; Chella, 2007; Graziano and Kastner, 2011; Haikonen, 2003; Madl et al., 2011; Taylor, 2002, 2007a, 2007b). However, none of these base their explanation of the phenomenal aspect of consciousness on attention (the only partial exception is Haikonen, 2003). In these models, attention is usually a privileged way to access consciousness, or a process that provides the needed information for consciousness, but it does not have any role in generating qualia. For example, for Graziano and Kastner (2011), consciousness is an (imprecise but useful) informational and perceptual representation of the process of attention. Therefore, in order to account for the phenomenal aspect of consciousness, these models need to resort to some additional process (such as perception or representation), thus pushing the explanation back, in an endless regression (how does perception or representation produce consciousness?). On the contrary, my model explains consciousness by means of a very basic process such as attention, without resorting to additional processes.

CONSCIOUSNESS CREATES ORDERS

In my view, the principal way in which the variations in the state of nervous energy (induced by attentional activity) are used to place entities in relation to each other, is by serving as a basis for the construction of possible orders (by "order" I mean all kinds of series, successions, arrangements, sequences, schemas and organizations in general).

Space and time are some typical examples. Once an order is created, it is possible to build various kinds of relations on this: spatial, temporal, causal, logical, physical, etc.

According to my analysis, an order can be created from variations in the state of nervous energy by exploiting some of the characteristics of the organ of attention and working memory, respectively, by applying attention to something in a continuous, incremental and cumulative way (to a certain extent at least), and by keeping track of the results of the work of attention.

In spatial order, the possibility of using working memory to keep track of the various conscious sensations produced by (applying attention to) a moving sense-organ, is fundamental in my opinion. Imagine you are perceiving a

surface by moving your index finger on it. By keeping present in consciousness, in an incremental way, the single sensations that are produced by the index finger while it moves, you create a sequence or succession of sensations, which is the basis for the formation of two-dimensional constructs, such as "path", "line" and "distance". As a result, by exploiting the various features of attention[9], more complex spatial constructions can be developed (for an analysis of how temporal order can be obtained by using the work of attention, see Marchetti, 2009).

Other researchers base their explanation of the origin of spatial experience on the operations of attention. According to Mandler (2008, 2010), PMA produces a set of spatial primitives, such as PATH, LOCATION, MOTION TRANSFER, which is sufficient to account for the early conceptualizations that preverbal infants use to interpret objects and events. These early conceptualizations are important because they represent the core ontogenetic foundations on which later concepts are built and play a major role in determining the organization of the adult conceptual system.

Carstensen (2007, 2011) shows that selective attention plays a central role in the characterization of spatial relations, and that the representation of attentional aspects leads to the possibility of defining an ontological upper structure which covers both the spatial and temporal domain.

For Scheider and Kuhn (2011), the human being experiences the geometrical and topological structures of the environment by performing and comparing attentional steps. An attentional step is the actual movement of attention from focus *x* to *y*. Scheider and Kuhn put forward an operational model of constructive geometry grounded on primitives of the human attentional apparatus, which allows for the referencing and predication of geometrically relevant Gestalt phenomena in vista environment. In particular, it allows for detecting whether one focus of attention precedes another one (primitive perception of time), whether attention focuses on the same point-like feature, whether a given pair of foci is congruent to another pair, and whether a focus points between two others.

The fact that consciousness allows us to build orders does not rule out that non-conscious systems can also build some kind of order. Artificial neural networks can learn rich structured representations that capture abstract

[9] Primarily, that attention is cyclical in nature, which allows for the realization of mental cognitive operations of increasing complexity (Benedetti et al., 2010; Fingelkurts and Fingelkurts, 2001, 2005, 2006, Fingelkurts et al., 2010). On the advantages offered by discrete neural computations over a continuously evolving system, see also Buschman and Miller, 2010).

dimensions of a given task domain, as a result of merely being required to process exemplars of the domain (Cleeremans, 2011). However, there are at least two important differences between conscious and non-conscious systems. Firstly, while non-conscious systems produce orders that can be successfully used only in the context of performing the particular task for which they were trained, conscious systems produces orders that can be applied without restriction to any domain. Secondly, while non-conscious systems produce orders that cannot be easily modified, consciousness produces orders that can even be completely inverted (for example, we can conceive of time as being reversible).

The experiences of constraints supplies the firm ground on which the person can build orders that allow him/her to create various kinds of relations: spatial, temporal, etc. Consciousness makes it possible to create orders, and to create relations based on these orders. Without consciousness, neither orders nor the relations that can be built on them, would exist. A person's knowledge assumes the form that his/her consciousness allows it to assume. Everything a person knows, he/she comes to know in and through his/her consciousness. A person comes to know the world as it is because of his/her conscious experience. Conscious experience is the only level of reality that a person can directly access. All the other levels can be accessed only indirectly via the privileged medium of consciousness. Consequently, the world appears to the person as his/her consciousness lets him/her experience it and unavoidably bears the hallmark of his/her consciousness. Its qualities and characteristics are the qualities and characteristics of his/her consciousness. The world is ordered according to the principles established by and through a person's consciousness, and has the form that such principles let it assume.

CONCLUSION

This paper shows that consciousness makes a difference to human behaviour, determining and influencing what a person thinks, does, feels, etc. The main difference is that it provides the person with the sense of owning or being the subject of his/her conscious experience, what I have called "the sense of self". A person can have such a sense of self because, in and through consciousness, he/she can relate him-herself to other entities, and therefore understand what relations exist between him/her and other entities. The basic elements that allow a person to relate him-herself to other entities, and more in general to place entities in relation to each other, are the variations of his/her

own state of nervous energy induced by the application of his/her attention. These variations, which constitute the phenomenal aspect of consciousness, or qualia, produce a conscious experience in the form of either a constraint or non-constraint (to act in general). We have also seen that the principal way in which these variations are used to relate things, is by serving as a basis for the construction of possible orders (such as space and time).

Most of the ideas I have put forward here, and more in general my theory of consciousness should be treated as unproven until they are verified. I believe however that they are supported by a bulk of evidence, that they are congruent with many of the current theories and views of consciousness, and that their explicative power can account for many unresolved dilemmas.

ACKNOWLEDGMENTS

I am grateful to Dr. Giulio Benedetti and Drs. Andrew and Alexander Fingelkurts for their constant support and insightful comments, and to Wendy Piemonte for the English revision of the article.

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