

lead to the erroneous conclusion that there is such a thing as a consciousness center. Likely, there are many levels of consciousness, depending on the levels of processing. Dealing with the conflicting data from the older perceptual defence experiments, Erdelyi (1974, p. 20) already referred to the several levels of processing, and to partial or full analysis: "If, because of its emotionality, some information in raw storage fails to be encoded into more permanent memory (short-term storage), the critical information becomes irretrievably lost to the perceiver after the rapid fading of the icon (or echo). The perceiver can be said to have defended against the input since it is quite unavailable to him beyond a fleeting moment. Yet, at a different level, he did "perceive" it in that it was available, if very briefly, in iconic or echoic storage during partial or full analysis by long-term memory. Thus, not quite so paradoxically, he both perceived and defended himself against perceiving (further) the very same input.

One further comment is on the scope of Umiltà's proposal. He states that conscious experience is only an enhanced activity in one of the perceptual cortical areas, depending on attention. This is surely an attractive pro-

posal that will readily be accepted by those scientists (including myself) who work in the field of perception and memory. But what about the conscious experience of some internal emotional states? What about the awareness of our goal strivings and other motivational states? Can his proposal be extended beyond our cognitive activities?

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## Dissociating Components in Conscious Experience

Luis J. Fuentes

University of Almeria, Spain

As it happens with most cognitive systems, the study of consciousness has benefited from the interdisciplinary contribution of different fields. The author nicely combines the contribution of cognitive psychology with respect to the dissociation between conscious/unconscious processes; the contribution of cognitive neuropsychology with respect to the breakdown of conscious processing as the result of brain damage; and the contribution of recent neuroimaging techniques that allow us to observe the pattern of activation in different brain areas while the subject performs cognitive tasks. A detailed analysis of the main contributions in these fields has led the author to conclude that:

1. Attention is the mediator of conscious experience.
2. The main role of attention in consciousness is to enhance representation activation in different perceptual domains as to exceed a critical threshold for awareness.

3. Because attentional processing is the consequence of preparing a motor program to execute a determined action and because there are as many programs as effectors, there are also multiple consciousness systems that are distributed in many independent cortical areas.

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Luis J. Fuentes is currently head of the Department of Experimental Psychology and Psychobiology at the University of Almeria, Spain, where he has been professor since 1989. He gained his PhD in psychology from the University of Granada in 1987. His main fields of interest are attention deficits in psychiatric and neurological patients as well as inhibitory processing in visual attention.

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Correspondence concerning this commentary should be addressed to Luis J. Fuentes, Department of Experimental Psychology and Psychobiology, University of Almeria, La Canada de San Urbano, E-04120 Almeria, Spain (tel./fax +34 950 215473, E-mail lfuentes@ualm.es).

Given the dependence of conscious experience on attention, it is clear that his view about consciousness is greatly influenced by how he conceives of attention. However, in this comment I will adopt a different view of attention and therefore of consciousness. Concretely, I will argue that like attention consciousness is not an unitary phenomenon, but rather there may be different components of conscious experience that should be taken into consideration. Importantly, a different neural circuitry might be involved in each component. In my view, consciousness is not just the product of certain kind of processing; rather, it must be thought of as a complex structure that allows the organism to be aware of stimulation, to attend to and to communicate certain contents of objects or thoughts, and to have self-consciousness, a kind of representation that allows the individual to differentiate his/her own intentions from the intentions of others.

Everyone has probably had the experience of being immersed in his/her own thoughts in such a way that stimuli coming from other sources fail to produce the usual reaction. If you are reading an interesting novel, you can miss your partner's call that dinner is ready. Upon query, our personal experience is that we indeed heard our partner's voice (awareness of stimulation), but we did not react properly because we did not catch the meaning of the words (awareness of the content). Concentration on a source of information may render stimulation coming from other sources only partially detected. This and many other similar situations from daily life suggest that we are very limited in the amount of "contents" we can be conscious of in a given moment, though awareness of stimulation is probably not subject to such strict limitations. Let me support those contentions by describing some studies we conducted a few years ago.

In one study (Fuentes, Cartrona, Agis, & Catena, 1994), we asked participants to perform lexical decisions on targets in a semantic priming paradigm. Prime displays contained two words, one presented in the fovea and the other far away in the parafovea. Semantic priming was observed in both cases, but the effect was greater in the former than in the latter. In the other condition, participants performed the lexical decision task (the visual task) together with a shadowing task (the auditory task). This auditory task is very attention demanding, and positron emission tomography (PET) studies have shown that shadowing activates some regions of the prefrontal medial cortex, concretely the anterior cingulate, which seems to form part of what has been called executive attention (for a review, see Posner & Raichle, 1994).

The main findings were that semantic priming from parafoveal primes remained intact, but the effect from foveal primes reduced drastically up to the level of parafoveal primes. That is, when executive attention was allocated to the auditory task, the visual task reflected only automatic processing from both foveal and parafoveal primes. For the present purpose, I claim that in the single-task condition participants were aware of the content (i. e., the meaning) of the foveal prime and aware of stimulation (i. e., its presence) of the parafoveal prime; in the dual-task condition, however, they were aware only of the *presence* of stimulation. Thus, executive attention seems to be involved in awareness of content but not in awareness of stimulation.

In a second experiment, Fuentes et al. (1994) found a similar reduction in semantic priming when participants performed only the lexical decision task but primes were masked. Once again, semantic priming from foveal words reached the level shown in the dual-task condition and did not vary from that reached by parafoveal primes in all three conditions (single, dual, and masking conditions). That is, although executive attention was available for the visual task, the mask prevented it from being involved in semantic processing from foveal primes. We argued that automatic processing accounted for the semantic priming effect in that case. It seems, therefore, that awareness of stimulation is necessary for awareness of content to occur.

A more compelling piece of evidence that executive attention requires awareness of stimulation comes from a study that assessed negative priming in a neglect patient (Fuentes & Humphreys, 1996). We presented the patient with prime and probe displays containing two letters, one at fixation (the target), the other to the left or right of fixation (the distractor). The distractor could be presented, therefore, to the "good visual field" or the "bad visual field." Negative priming was observed only when the distractor was presented to the "good field." When it was presented to the "bad field," positive instead of negative priming was found. Explicit tests showed that the patient was aware of the presence of the distractor only when it was presented to the "good field" but totally unaware of it when presented to the "bad field." This suggests that inhibitory processes—likely dependent on executive attention—are applied only when there is awareness of stimulation. When the patient was unaware of the distractor, automatic priming was then observed.

Taken together, these results suggest that awareness of stimulation is a necessary condition for executive attention to operate, and that executive attention is the

mechanism for awareness of content. Thus, both kinds of awareness may be components of our conscious experience, but they have to be dissociated. Awareness of stimulation might arise when representations in the different cortical perceptual areas exceed a critical threshold of activation as the author suggests. This critical level of activation may be reached when attentional orientation mechanisms are engaged either in a bottom-up or top-down way. Awareness of stimulation would be limited by the kind of short-term memory that some authors (e.g., Crick & Koch, 1990) have associated with consciousness, and they would produce integrated perceptual patterns that would serve as the contents of our conscious experience. Binding of disparate neural elements required for object perception may depend upon a neural circuitry in which some portions of the thalamus seem to play a fundamental role. To illustrate, the awareness-of-stimulation processes might produce two different interpretations of the Necker cube, but only one of them will have access to the awareness-of-content processes at a given time.

Awareness of content, on the other hand, seems to reflect the operation of executive attention of the kind proposed by Posner and his colleagues. Like the attentional orientation network, executive attention might be involved in different elementary operations with different brain areas involved. I claim that one of these operations has to do with awareness of content and the anterior cingulate cortex might be one of the main brain areas involved.

Further support for the above dissociation comes from brain-damage studies. As mentioned before, awareness of stimulation can be affected experimentally by the use of a masking procedure. However, both blindsight and neglect syndromes might be characterized as a deficit of awareness of stimulation, albeit for different reasons: Blindsight may reflect a failure to reach the activation level required for awareness because of a lesion in the site of processing (primary visual cortex in this case); neglect patients might fail to reach awareness of stimulation because of a failure in the attentional orientation mechanisms required for enhanced activity. On the other hand, some deficits of face recognition and deficits in explicit memory tasks might be characterized as a failure in controlled processes dependent on executive attention.

A striking characteristic of conscious experience is its reflexive nature. I have not only conscious experience

that now it is raining, I also have knowledge that it is me who is having that experience. This implies a sort of second-order representation that Frith (1992) calls metarepresentation or self-awareness. In Frith's view, metarepresentation is concerned with knowledge about representations of the physical world. A failure in this component might produce a deficit in what has been called "theory of mind," characteristic of autistic children, and may underlie some symptoms of schizophrenic patients (e.g., hallucinations). Information may enter consciousness, but if mechanisms responsible for metarepresentation fail, the agent will attribute such an experience to a third person, producing hallucinations or some kinds of delusions characteristic of schizophrenia. Thus, autism and schizophrenia might be the proper pathologies for a neuropsychological study of this third component of consciousness. Frith (1992) proposes that portions of the dorso-lateral prefrontal cortex may be involved in self-awareness.

To summarize, I have proposed here that what we call consciousness might be the result of the coordinated work of at least three components: awareness of stimulation, awareness of content, and self-awareness. Awareness of stimulation may involve multiple and independent neural networks as the author suggests, however, I propose that mechanisms responsible for awareness of content and self-awareness may be more localized in specific areas of the brain. The way these components are related to each other is not completely clear yet, but may be crucial to account for how our conscious experience takes place.

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## Out of Many Comes One—or Two or More?

John Taylor

King's College, London, UK

This succinctly reasoned paper by Carlo Umiltà presents strong evidence for the need for multiple systems in the brain involved in the creation of conscious experience. It commences by presenting a breadth of experimental data that supports the requirement "... for the existence of nonconscious cognitive processes..." as the author states at the end of the first section of his paper. This is shown very effectively from cases of cortical blindness, prosopagnosia, neglect, and amnesia. The three models then described do not address the question of a unitary consciousness center versus many such centers, the central problem addressed by the paper. The author then considers models that posit a unitary information-processing center, especially that of Jeffrey Gray, based on the subiculum. The nub of the argument against such models is then stated: Loss of such a unitary region should produce patients with loss of explicit processing in a number of modalities—they would appear like the zombie beloved of philosophers. Lack of discovery of such patients argues strongly against such a unitary neural basis for consciousness, so it is claimed by the author. Instead a localized approach is taken, in which "conscious experience arises when representations in any cortical perceptual area exceed a critical threshold of activation." Attention is then brought in by the author as the extra quantity to help a representation achieve the required threshold. The attentional activations are then required to be distributed using the premotor theory of attention of Rizzolatti et al.

This is an attractive approach that, however, has a problem as big as that for the unitary theories. The game seems to be given away when the author states "when a location or object is selected for action." How does the attentional system decide to give more activation to one location or object than another? From recent brain imaging results this is achieved by activity in a limited set of modules, based on the parietal-prefrontal-cingulate axis. Even the choice between object and space has to be reached. How is this to be arrived at? The use of a distributed set of areas, as the author suggests, seems to be consistent with brain-imaging results, but these need to be involved in some overall competition. This "unitary" character is supported by numerous neural models of the process: The overall attentional selection process

arises by means of a competition between a limited number of modules.

This "gluing together" of the activities of the modules in the attentional network is necessary to have such a competitive process, and is along the lines I outlined, as part of the "competitive relational mind," in my recent book (Taylor, 1999). Such a distributed but connected network is not part of the model envisaged by the author. But without it the activity in one of his pragmatic maps—not closely correlated with that of the other maps—is not helped by the attentional framework. What does it matter that such a pragmatic map has activity above a threshold if there is no decision process to admit that most activated map into consciousness? Without some overall decision process, consciousness does get multiplied in the manner the author rightly wishes to avoid.

However, the title for my commentary goes beyond this initial story of an overall competition between a set of working memory/attentional modules to attain consciousness (and thence allow for report to other working memory sites as to the content of the winner). Having reached the first stage of consciousness (the second stage of overall cortical processing) I would claim that there is at least one (if not several) further stages that need to be considered (Taylor et al., 1998) in terms of a third stage—beyond the first (nonconscious processing) and second (just conscious processing). This third stage enters as part of the inner "observer" of control theory, with much evidence for its existence from corollary discharge

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John Taylor received a BA and PhD in mathematics from the University of Cambridge and is presently Emeritus Professor of Mathematics and Director of the Centre for Neural Networks at King's College, London. He was President of the European Neural Network Society in 1993/1994 and President of the International Neural Network Society in 1995. He is presently European Editor-in-Chief of the journal *Neural Networks*. His current research interests are building a model of the global brain from brain-imaging data and neural modeling techniques, applying it to develop intelligent systems, and understanding how consciousness could arise in ourselves and ultimately in intelligent machines.

Correspondence concerning this commentary should be addressed to John G. Taylor, King's College, Department of Mathematics, Strand, London, WC2 R2LS, UK (tel. +44 181 848-2214, fax +44 181 848-2017, E-mail john.g.taylor@kcl.ac.uk).