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Supracortical consciousness: Insights from temporal dynamics, processing-content, and olfaction

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Abstract

To further illuminate the nature of conscious states, it may be progressive to integrate Merker's important contribution with what is known regarding (a) the temporal relation between conscious states and activation of the mesodiencephalic system; (b) the nature of the information (e.g., perceptual vs. premotor) involved in conscious integration; and (c) the neural correlates of olfactory consciousness.

Evidence from diverse sources has led to the consensus that conscious states integrate neural activities and information-processing structures that would otherwise be independent (Baars 2002; see review by Morsella 2005), but no such agreement has been reached regarding which neuroanatomical regions underlie this special form of integration. By reexamining long-overlooked neurological findings, Merker elegantly isolates subcortical regions that may give rise to these elusive states. With this important contribution in mind, it may be progressive to evaluate whether the temporal dynamics of these subcortical (albeit "supracortical") events are consistent with what has been documented regarding the substantial delay between afference from exteroceptors and its consciously experienced effects (see review by Libet 2005). Does activation from a supraliminal stimulus influence the mesodiencephalic system at the same time that an associated change in consciousness is predicted to occur (e.g., several hundred milliseconds following stimulus presentation; Libet 1986)? Given how much is known regarding the processing speed of the hardware at hand (e.g., neurons and synapses) and about the timings of different *stages-of-processing* as gleaned from psychophysiological recordings, answering this question may be a feasible way to obtain additional corroboratory evidence for Merker's framework. Moreover, such evidence may be in agreement with the claim that the contents of conscious states reflect the final product of a relatively timely process in which multiple, consciously impenetrable interpretations or "drafts" of sensory afference and other forms of information are entertained and evaluated (Dennett 1991).

In addition, it may be informative to evaluate whether the nature (e.g., perceptual, semantic, premotor, or motor) of the kinds of processes occurring in these integrative, supracortical regions is consistent with the view that conscious states are necessary to integrate only certain kinds of information. It is clear that many kinds of information can be integrated without these states. For example, consciously impenetrable interactions are exemplified in countless intersensory phenomena, including McGurk (McGurk & MacDonald 1976) and ventriloquism effects (Vroomen & de Gelder 2003). Indeed, it has been recently proposed that neocortical operations are essentially multisensory in nature (Ghazanfar & Schroeder 2006). That such neocortical interactions can be unconscious is consistent with Merker's proposal that cortical processes are not the seat of conscious states.

In line with Merker's "premotor" characterization of these supracortical processes and with his characterization of the "final common path," Supramodular Interaction Theory (SIT; Morsella 2005) proposes that conscious states are necessary to integrate specific, multimodal systems that are unique in that they may conflict with skeletal muscle plans, as described by the *principle of parallel responses into skeletal muscle* (PRISM). In harmony with Merker's account, these systems are defined by their concerns (e.g., bodily needs) and skeletomotor goals rather than by their sensory afference, the latter being the traditional way in which mental faculties have been characterized (Ghazanfar & Schroeder 2006). SIT illuminates why conscious states are required to integrate some processes (e.g., "pain-for-gain" scenarios as when carrying a hot plate of food or holding one's breath) but not others (e.g., intersensory interactions, peristalsis, and the pupillary reflex), and explains why skeletal muscles have been regarded as "voluntary muscles." Skeletal muscles are at times "consciously controlled" because they are directed by multiple systems that require conscious states in order to interact and collectively influence action. Accordingly, regarding processes such as digestion, one is conscious of only those phases of the processes that require coordination with skeletal muscle plans (e.g., chewing or micturating) and none of those that do not (e.g., peristalsis). Together, these proposals are consistent with the view that the properties of conscious states are intimately related to action production (Barsalou 2003; Glenberg 1997; Hommel et al. 2001; Sperry 1952), a view that challenges traditional accounts that divorce input from output processes (cf. Eimer et al. 1995).

Also consistent with Merker's account is the extensive research on "split-brain" patients and on binocular rivalry (cf. O'Shea & Corballis 2005), which strongly suggest that the minimal anatomy for a conscious brain does not require the cerebral hemispheres, nor the commissures (or transmission processes) connecting them. Moreover, although extirpation of the amygdalae and hippocampi lead to anomalies including severe deficits in affective memory (LeDoux 1996) and episodic memory (Milner 1966), respectively, it seems that an identifiable and reportable form of consciousness persists without either of these structures. It seems as well that such a minimal, conscious brain does not require interactions between the afferent impulses from the sensory organs and the initial "relay" at the thalamus, for one experiences aspects of olfaction consciously even though the signals from the olfactory sensory system bypass the thalamus and directly target regions of the ipsilateral cortex (Shepherd & Greer 1998). Of course, this does not imply that a conscious brain experiencing only olfaction does not require a thalamus. Consistent with Merker's account, in subsequent, postcortical stages of processing, the thalamus does receive inputs from cortical regions that are involved in olfactory processing (Haberly 1998).

Hence, because of its neuroanatomical accessibility and its relatively simplistic and phylogenetically primitive arrangement (Shepherd & Greer 1998), the olfactory system may prove to be a fruitful system in which to further isolate the neural processes giving rise to conscious states within the mesodiencephalic regions already identified by Merker. According to Buck (2000, p. 633), conscious aspects of odor discrimination depend primarily upon the activities of the frontal and orbitofrontal cortices, a proposal which, at least at first glance, seems inconsistent with Merker's primarily "subcortical" account of the neural correlates of conscious states. Additional research on olfactory consciousness and the olfactory components of mesodiencephalic regions may reconcile both views and thus further our understanding regarding the general nature of the physical substrates of conscious states.

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