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Nonconscious perception, conscious awareness and attention☆

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Abstract

Because it is unclear how a nonconscious stimulus is cognitively processed, there is uncertainty concerning variables that modulate the processing. In this context recent findings of a set of neuroimaging experiments are important. These findings suggest that conscious and nonconscious stimuli activate same areas of the brain during performance of a similar task. Further, different areas are activated when a task is performed with or without awareness of processing. It appears that the neural network involved in cognitive processing depends on the awareness of processing rather than awareness of perception. Since conscious and nonconscious cognitive processing use separate neural networks, each processing is modulated by different variables. Attention modulates most conscious cognitive processing and most, but not all, nonconscious processing is attention dependent. Nonconscious tasks that require attentional resources, with or without conscious awareness, are processed using the attention dependent system. Further, because attention dependent and attention independent tasks are processed by separate neural networks, the cognitive processing and modulating variables can be understood better if cognitive tasks are defined as attention dependent or attention independent, rather than conscious or nonconscious.

Keywords

Nonconscious cognition; Attention; Conscious awareness; Conscious cognition; Attention dependent processing; Attention independent processing; Subliminal stimuli; Priming; Nonconscious processing; Conscious processing

Most investigators believe that the stimuli perceived without conscious awareness elicit cognitive processing. It is however, unclear how these stimuli are processed and how the processing is modulated. These issues are important to understand significance of the finding of attention independent processing of subliminal priming of faces, reported by Harry, Davis, and Kim (2012).

Investigators have used a variety of techniques to demonstrate that subliminal stimuli elicit cognitive and behavioral modification (Badgaiyan, 2000, 2006; Marcel, 1983). It is however

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not clear whether these stimuli are perceived with or without conscious awareness. Since awareness is subjective and perception is incremental, it is unclear at what level of perception we become consciously aware of a stimulus. As the exposure time of a visual stimulus increases the level of perception changes from detection, to objective identification, and then to subjectively identification (Holender & Duscherer, 2004). Most investigators (including Harry et al.) use a volunteer's account of subjective identification as the measure of conscious awareness in subliminal experiments. But a volunteer's account may not be the real threshold of awareness because it requires explicit expression of awareness, and the expression is processed separately and has its own threshold (Sperry, 1961). Thus, a volunteer may be consciously aware of a stimulus at a much shorter exposure time than the time at which he/she is able to express awareness. It implies that the claims of unawareness based on volunteers' expression may not be accurate.

Even though much of the debate on subliminal processing is centered on awareness, it appears that the level of awareness does not significantly affect cognitive processing. In imaging studies visual stimuli, whether or not consciously perceived (subjectively identified), activate the same brain areas in similar cognitive tasks. In one of our priming experiments (Badgaiyan, 2000) subliminally presented (nonconscious) cues reduced activation in the same extrastriate area (area V3A) where supraliminal stimuli attenuated activation in similar experiments (Badgaiyan & Posner, 1997; Badgaiyan, Schacter, & Alpert, 1999, 2001; Schacter, Badgaiyan, & Alpert, 1999). In another experiment subliminal and supraliminal stimuli activated the same areas of prefrontal cortex and hippocampus in an explicit memory task (Badgaiyan, 2006). It therefore appears that the level of perception is not a critical variable for cognitive processing.

It is however, important to make a distinction between awareness of perception and awareness of cognition. We know that a number of cognitive tasks are performed without conscious awareness. In priming experiments for example, studied items are retrieved without conscious awareness of recall. Nonconscious retrieval occurs even when volunteers have complete perceptual awareness of the stimulus (Schacter & Badgaiyan, 2001). On the contrary, in explicit memory experiments volunteers are aware of the recall of stimuli that may or may not be perceptually identifiable at the conscious level. Further, even though same stimuli are retrieved under conscious and nonconscious conditions, the processing involves different neural networks. During conscious recall the medial temporal lobe and prefrontal cortex are activated (Badgaiyan, 2006; Badgaiyan & Posner, 1997) but during nonconscious recall activation in the area V3A of extrastriate cortex is attenuated (Badgaiyan, 2000; Badgaiyan & Posner, 1996, 1997; Badgaiyan et al., 1999; Schacter & Badgaiyan, 2001; Schacter et al., 1999). Thus, unlike perceptual awareness, the awareness of cognitive processing is an important variable. It helps the brain select a neural network for processing.

Further, because activity of each network is modulated separately, different variables modulate conscious and nonconscious cognitive processing. In this context finding of Harry et al. (2012) is important. They found no effect of attention on subliminal priming of faces. It appears to contradict previous observations of attentional modulation of priming (Lachter, Forster, & Ruthruff, 2004). A look at the experimental design however, explains the reason

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for divergent finding. Harry et al. used either the same or different views of a face as prime and target stimuli. They did not find an effect of attention when views were same, but attention modulated the priming when views of non-famous faces were changed. It suggests that the same and different view conditions are processed by separate neural networks – one is attention independent and the other is attention dependent. Neuroimaging experiments have confirmed that the same and different view conditions are processed by separate neural networks. These experiments have reported activation of different brain areas in priming experiments that used the same or different views of an object as prime and target (Vuilleumier, Henson, Driver, & Dolan, 2002).

Thus, cognitive processing in the same view condition is carried out at perceptual level using an attention independent system but the different view condition is processed using the attention dependent system because volunteers need attentional resources (with or without conscious awareness) to 'reconfigure' the target to match with the prime stimulus. The different view (non-famous faces) condition of Harry et al.'s study is similar to the earlier study in which priming was modified by attention (Lachter et al., 2004). In this study volunteers had to reconfigure upper case target to match with the lower case prime. Therefore, attention dependent system was activated in both experiments.

It appears that the neural processing and modulating variables of cognitive tasks could be understood better if these tasks are defined in term of their dependence on attention (attention dependent or attention independent), rather than in terms of perceptual or cognitive awareness (conscious or nonconscious). This strategy would separate not only the attention dependent conscious cognition from attention independent nonconscious cognition but also the attention dependent and independent nonconscious tasks. Separation of nonconscious tasks is important because while conscious cognitive tasks are attention dependent, not all nonconscious tasks are attention independent. Most priming tasks that use perceptual processing are processed using the attention independent system but (as discussed above) priming tasks that require attentional resources (with or without conscious awareness) are processed using the attention dependent system.

Thus, the effect of attention in a priming experiment depends on the nature of task, rather than perceptual or cognitive awareness (conscious or nonconscious). Since perceptual processing uses the attention independent system, Harry et al. (2012) did not find an effect of attention when the prime and target had the same or known (famous face) views of the face. However, when the view of target was changed, volunteers had to use attentional resources to reconfigure the target to match with the prime. Processing in this condition therefore involved the attention dependent system.

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