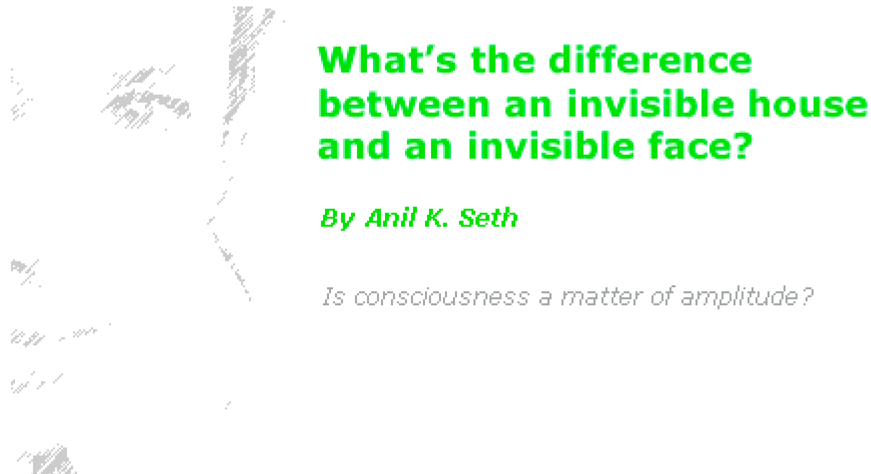
What's the difference between an invisible house and an invisible face?

Posted By virgil on May 1st 2003 @ 19:59 in SCR Feature, fMRI, binocular rivalry | No Comments



Plenty, according to a recent study by (Moutoussis & Zeki, 2002). They used so-called 'invisible stimuli' to probe what happens when a visual image is consciously perceived. They exploited 'binocular fusion', the process by which images from each eye are combined to produce a single, integrated perception. To the left eye, they presented a picture of a red house on a green background. To the right eye, a green house on a red background. If both images were carefully lined up, equally bright, and presented only briefly, something strange took place - subjects saw no house at all, just a uniform yellow color field. The opposite color contrast effectively made the house 'invisible' (see Figure 1).

Figure 1: Top row: Dichoptically presented stimuli of opposite color contrast between the two eyes are invisible. Bottom row: Identical stimuli of the same color contrast are perceived. Figure adapted from (Moutoussis & Zeki, 2002).

By monitoring brain activity while subjects viewed these 'invisible' stimuli, Moutoussis and Zeki were able to explore the relationship between presentation of a visual stimulus and its conscious perception. Using fMRI, they compared brain activity generated by viewing an invisible house with a control condition in which uniform yellow color fields were presented to each eye. In both cases, the subjects saw the same thing – plain yellow - yet brain activity in the first condition was much more widespread than in the second. In fact the distribution of activity was strikingly similar when subjects could actually see the house. Only the amount of activity differed; invisible houses evoked less overall brain activity than visible houses. (To allow subjects to see the house, each eye was presented with house images of the same color contrast.)They did not stop at houses. Invisible faces led to the same overall pattern of results, with one important exception. The cerebral cortex contains regions known to be particularly sensitive to images of places (the parahippocampal gyrus, PPA) and faces (the fusiform gyrus, FFA). Moutoussis and Zeki found that invisible houses and faces continued to generate activity in their respective specialized areas. Again, just the amplitude of the brain response differed; visible houses and faces generated larger signals than their invisible counterparts.

The authors claim that these findings are the opposite of those obtained from studies involving 'binocular rivalry', in which, instead of being fused together, images presented to each eye compete for perceptual dominance. Measurements of brain activity during binocular rivalry have reliably found that responses in 'higher' regions of visual cortex (including the PPA and FFA) correlate strongly with the reported perception (Tong, Nakayama, Vaughan, & Kanwisher, 1998). But in Moutoussis and Zeki's study, brain activity seems to correlate with the stimulus; house-related activity is recorded regardless of whether houses are actually seen by the subject.

These findings may seem contradictory, but in fact they are not. Binocular rivalry experiments compare brain activity evoked by a perceived image to that evoked by a suppressed alternative. Moutoussis and Zeki, however, had no way of identifying brain activity that corresponded to conscious perception during the presentation of their invisible stimuli. It may be that neural responses to the perceived yellow color field far outweighed responses to the (invisible) house. If so (and their results cannot indicate either way) we are left with much the situation as in binocular rivalry; a majority of activity in favor of the percept.
Despite this, Moutoussis and Zeki are right to point out the impressive similarity in brain activity evoked by consciously perceived and invisible stimuli, especially in higher regions of visual cortex. In contrast, binocular rivalry experiments have found little if any activity corresponding to non-perceived images in these regions (Blake & Logothetis, 2002). This has led some to speculate that even low levels of activity in higher visual cortex would be sufficient for conscious perception. The fact that invisible stimuli evoke activity in the PPA and FFA, without accompanying conscious perceptions of places and faces, strongly suggests that this is not the case.

What, then, does determine whether a stimulus evokes a conscious perception? One simple possibility, suggested by the results of Moutoussis and Zeki, is that it is simply a matter of amplitude, that activity in the PPA above a certain threshold would be sufficient to evoke a conscious image of a house.

Unfortunately things are rarely so straightforward, and while fMRI signal amplitude may often correlate with consciousness, it is likely that other neurophysiological features are more directly implicated. Three such features have been gaining a growing consensus. First, waking consciousness seems to be associated with irregular gamma-range activity in cortex. Consciousness also appears to depend critically on the integrity of the thalamus (for the maintenance of the conscious state, i.e. being awake) and the cortex (for the population of the conscious state with its various features: houses, faces, etc.). Lastly, consciousness is associated with widespread and coherent thalamocortical activity related to conscious contents. It is quite possible that these physiological features acting together lead to the amplitude effects observed by Moutoussis and Zeki.

Either way, Moutoussis and Zeki have demonstrated an original, useful, and subjectively arresting methodology for teasing apart the relationship between sensation and perception. It is likely that further investigations using invisible stimuli, perhaps in conjunction with other brain imaging techniques such as electroencephalography (EEG) or magnetoencephalography (MEG), will be of great interest.

Author Information

Anil K. Seth
The Neurosciences Institute
La Jolla, CA 92121
USA

The support of the Neurosciences Research Foundation is gratefully acknowledged.

References

1. Blake, R., & Logothetis, N. K. (2002). Visual competition. Nat Rev Neurosci, 3(1), 13-21.
2. Moutoussis, K., & Zeki, S. (2002). The relationship between cortical activation and perception investigated withinvisible stimuli. Proc Natl Acad Sci U S A, 99(14), 9527-9532.
3. Tong, F., Nakayama, K., Vaughan, J. T., & Kanwisher, N. (1998). Binocular rivalry and visual awareness in humanextrastriate cortex. Neuron, 21(4), 753-759.

Post URL:
http://sci-con.org/2003/05/whats-the-difference-between-an-invisible-house-and-an-invisible-face/