Letters

Attention in the absence of consciousness?

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Christof Koch and Naotsugu Tsuchiya claim in a recent article [1] that 'top-down attention and consciousness are distinct phenomena that need not occur together'. To support this claim, they assemble evidence purportedly showing that (i) there can be consciousness without attention and (ii) there can be attention without consciousness. There is a fallacy in their argument for the second of these claims.

The fallacy arises from a failure to distinguish between the following hypotheses:

(i) It is possible to attend to a thing (or location) without consciously experiencing some of the properties of that thing (or objects at that location).

(ii) It is possible to attend to some thing (or location) without consciously experiencing *that very thing* (or location).

The first of these hypotheses is uncontroversial. Attending to something clearly does not guarantee awareness of its every feature. The second hypothesis is what Koch and Tsuchiya are trying to establish. The problem is that the first hypothesis is sufficient to explain the evidence they cite.

One can see this by considering what happens in standard demonstrations of the retinal blindspot. When locating the blindspot one attends to a location in the visual field and finds that one is no longer experiencing the dot that is presented there. It would obviously be a mistake to invoke the second hypothesis to account for this. One is not conscious of the dot, but neither is one attending to it – after all, no information from the dot is entering the nervous system. One *is* attending to the location that falls within the blindspot, but one *does* have a conscious experience of that location – after all, it is conscious experience of the location that notifies one of the dot's disappearance.

The weak hypothesis, not the strong one, accounts for failures of awareness during attention to the location of the blindspot. The crucial feature of the case is that subjects attend to a *location*, while failing to see an *object* presented at that location. The problem for Koch and Tsuchiya is that the same feature is found in the experiments that they cite. Those experiments show (in Koch and Tsuchiya's own words) that 'subjects can attend *to a location* for many seconds and yet fail to see one or more *attributes of an object at that location*' [my italics] [1]. As in the blindspot case, the weak hypothesis is able to account for this.

Some of the cases that Koch and Tsuchiya discuss are surprising ones, in which the unexperienced objects at attended locations (or unexperienced properties of attended objects) can be shown to elicit priming effects and where these priming effects are attention dependent [2,3]. Such cases demonstrate that information from attended locations can fail to reach awareness, even when represented in the brain. More complicated mechanisms are needed to account for this than those responsible for the retinal blindspot. But the effects can nonetheless be accounted for without recourse to the hypothesis that attention can be given to items that do not figure in conscious experience.

References

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2 Naccache, L. *et al.* (2002) Unconscious masked priming depends on temporal attention. *Psychol. Sci.* 13, 416–424

3 Jiang, Y. *et al.* (2006) A gender- and sexual orientation-dependent spatial attentional effect of invisible images. *Proc. Natl Acad. Sci. USA* 103, 17048–17052

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Letter Response

Response to Mole: Subjects can attend to completely invisible objects

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Mole [1] raises an interesting point that we did not address in our original publication [2]. However, he never states what exactly he means by 'that very thing (or location)' in his second hypothesis. We take this claim to mean 'the possibility of attending to any feature or the location of an object without consciously experiencing any of its attri-

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butes, including the location and other attendant features of that object'. In that sense the studies we cite in our article do show the possibility of attending to some thing without consciously experiencing that very thing or location.

Take the two experiments that Mole cites. When combining forward and backward masking, the digit can be rendered totally invisible [3], with an associated $d' = 0$, the toughest measure of non-discriminability. Yet subjects still have to pay attention to the spatiotemporal location of this masked digit to obtain the priming effect. In other words, non-conscious priming requires attention, even though subjects do not experience any features that can be used for the discrimination of the prime digit. They do not even experience a blurry 'something' at the location of the invisible mask but see the previous and following masks.

Or consider intraocular masking that is at the heart of continuous flash suppression [4]. This technique is used in Ref. [5] to demonstrate that completely invisible nude male or female images still attract attention. Yet in a two alternative forced choice task, subjects cannot discriminate the location of the nude from that of the scrambled nude. Subjects are simply not conscious of any attributes associated with the nude picture – not its location, its color, its content, the gender of the nude or anything else – because otherwise they could tap into this information to obtain a $d' > 0$. That is, attention is directed at a thing without the subject consciously experiencing any of its attributes. What they do see instead is a series of flashing, colored rectangles.

Mole's argument concerning the blindspot is specious. Not having any representation for something is very different from having a suppressed representation [3–5]. Cloaking visual stimuli is a powerful experimental strategy; in combination with functional magnetic resonance imaging (fMRI) it can be used to infer that attentional modulation of an invisible object is happening somewhere in the visual processing hierarchy, far away from the retina [6,7].

References

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2 Koch, C. and Tsuchiya, N. (2007) Attention and consciousness: two distinct brain processes. *Trends Cogn. Sci.* 11, 16–22
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Letters

Music, language and cognition: unresolved issues

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Recent research has examined links between exposure to music and cognitive abilities [1–7]. Although the effects of listening to music (e.g. the so-called 'Mozart effect') stem from the listener's emotional state, byproducts of formal training in music on language and other aspects of cognition are poorly understood [1]. Nonetheless, speculation abounds about the nature of the observed associations [2–6]. Here, we highlight five issues that remain unresolved.

One issue concerns related but not identical concepts: musical aptitude, music lessons and musicianship. Aptitude refers to 'raw' (untutored) abilities, obviously music lessons involve learning, whereas musicianship is likely to be a consequence of aptitude and training combined with other factors. Duration of music lessons predicts cognitive abilities – including language – among children in primary school (aged 6–11) and university undergraduates who do not necessarily self-identify as musicians [1]. Such effects are not due to confounding variables such as family income or parents' education [1]. By contrast, comparisons of musicians and non-musicians yield null or inconsistent results [7]. Similarly problematic is the failure to account for musical training when studying aptitude [3,4], because musical training improves performance on tests of musical aptitude. In other words, the observed associations could be either genetic or the consequence of music lessons.

A second, related issue involves inferences of causation [2–5], which are unfounded in correlational studies. Although isolated experimental evidence indicates that music lessons have cognitive transfer effects [1], additional studies with random assignment and appropriate control conditions are essential for setting the record straight.

A third issue concerns the nature and specificity of associations between musical experience and cognition. Discussion of 'special links' with language [3–5] is misleading when associations between musical training and cognitive abilities are much more general, extending to working memory and mathematical and spatial abilities

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