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Post-decision wagering measures metacognitive content, not sensory consciousness

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Abstract

A recent report by Persaud et al. [Persaud, N., McLeod, P. & Cowey, A. (2007). Post-decision wagering objectively measures awareness. *Nature Neuroscience 10*, 257–261] addresses a fundamental issue in consciousness science: the experimental measurement of conscious content. The authors propose a novel technique, 'post-decision wagering', in which subjects place bets on the correctness of decisions or discriminations. In this note, I critique the authors' claim that their method ''measures awareness directly''.

Keywords: Methodology; Report; Metacognition; Sensory consciousness; Wagering

1. Introduction

How can we measure whether a particular sensory or cognitive event is consciously experienced or remains unconscious? Such measurements provide the essential data on which a science of consciousness depends, yet there is no clear consensus on how these measurements should be made. In a recent article, Persaud, McLeod, and Cowey (2007) claim that their novel method of post-decision wagering (PDW) ''measures awareness directly'' but, unfortunately, the situation is not as straightforward as they suggest. Conscious scenes can have both sensory content, relating to entities in the world, and metacognitive content, relating to the contents of sensory consciousness or to other mental contents (Seth, Baars, & Edelman, 2005a). Metacognitive conscious content therefore assumes sensory consciousness, but the converse is not true: sensory content need not be overlain by metacognitive content in order to be conscious.

Most human studies of consciousness use methods such as explicit verbal report (e.g., ''I see a red square'') and numerical confidence ratings in order to assess conscious content (Dienes, Altmann, Kwan, & Goode, 1995; Seth et al., 2005a). These methods always involve a metacognitive component because they reflect judgments *about* conscious experiences. The same is true for PDW. In PDW, subjects make a first-order discrimination and then place a wager regarding the outcome of the first-order selection. For example, in one study described by Persaud et al., the 'blindsight' subject GY classified a simple sensory stimulus as either present or

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absent, and then wagered either a small monetary stake or a large stake on the correctness of this classification. Interestingly, although GY made the correct classification on ~70% of trials, he was just as likely to bet low as high on these trials. Other examples described by Persaud et al., involved normal subjects allocating letter strings to one of two artificial grammars, where each grammar was defined by a set of arbitrary rules, and in a third experiment selecting cards from different decks in a version of the Iowa gambling task (Bechara, Damasio, Damasio, & Anderson, 1994), in which each pair of decks provided reward according to a different schedule. In these studies, as with GY, if subjects performed above chance but did not capitalize on this behavior by wagering advantageously, then—according to Persaud et al.—there is evidence for a lack of conscious awareness of the correctness of the first-order discrimination. Conversely, good first-order performance accompanied by advantageous wagering is taken as direct evidence of awareness of the first-order stimuli.

The problem is that absence evidence is not evidence of absence. Absence of advantageous wagering can only exclude wagering-related metacognitive content, not consciousness per se. Moreover, unlike explicit verbal report, wagering is an indirect measure of mental content (Koch & Preuschoff, 2007), and plausibly advantageous wagering could sometimes be learned implicitly, without any accompanying conscious content. A PDW is a second-order judgment of the reliability of a first-order experience—a ''metacognitive comment''—and metacognitive content does not exhaustively describe the rich phenomenology of conscious experience.

The constraints of metacognitive approaches are usefully illustrated by the study of consciousness in non-human animals, where verbal report is usually not available, and where metacognitive capacities are more limited than in humans (Edelman, Baars, & Seth, 2005; Seth et al., 2005a). More than a decade ago, Cowey and Stoerig introduced the 'commentary key' method which allows monkeys to make a second-order discrimination on a previous perceptual discrimination (Cowey & Stoerig, 1995). Following lesions to half of V1, monkeys remained able to make above-chance discriminations in the occluded visual hemifield, however, they were not able to distinguish reliably between a stimulus in the occluded field and a blank display in an intact part of the visual field. More recently, Smith et al., explored methods for 'uncertainty monitoring' which allow animals to make metacognitive confidence judgments about first-order perceptual discriminations (Smith, Shields, & Washburn, 2003). Critically, in neither case does the second-order metacognitive comment suffice to establish the presence or absence of consciousness per se. In the first study, the inference that the monkey does not visually experience the occluded stimuli depends not only on the negative metacognitive comment, but also on the many homologies between monkey and human neurophysiology and neuroanatomy, as well as on the fact that humans with similar cortical damage—such as GY—verbally report the absence of visual experience (Weiskrantz, 1998). In the second, the authors assume that consciousness is grounded in terms of metacognition, a position which confuses an epistemological strategy (metacognitive monitoring) with its ontological reality (Seth, Edelman, & Baars, 2005b).

Post-decision wagering is a natural, effective, and easily controllable method for assessing metacognitive content regarding the correctness of a decision, content which in humans may normally be conscious. Critically though, PDW cannot supply a ''direct measure of awareness''. Because conscious content is ontologically subjective, it is a simple fact of the matter that no such direct behavioral measures exist. What is needed instead is a consensus of methods including indirect metacognitive reports (including PDW), neurophysiological and neuroanatomical evidence (Edelman et al., 2005; Seth et al., 2005a) and explicit theoretical frameworks (Crick & Koch, 2003; Seth, Izhikevich, Reeke, & Edelman, 2006; Tononi, 2004), that together point to necessary and sufficient conditions for consciousness in humans and non-humans alike.

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