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Measuring consciousness: Is one measure better than the other?

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ABSTRACT

What is the best way of assessing the extent to which people are aware of a stimulus? Here, using a masked visual identification task, we compared three measures of subjective awareness: The Perceptual Awareness Scale (PAS), through which participants are asked to rate the clarity of their visual experience; confidence ratings (CR), through which participants express their confidence in their identification decisions, and Post-decision wagering (PDW), in which participants place a monetary wager on their decisions. We conducted detailed explorations of the relationships between awareness and identification performance, looking to determine (1) which scale best correlates with performance, and (2) whether we can detect performance in the absence of awareness and how the scales differ from each other in terms of revealing such unconscious processing. Based on these findings we discuss whether perceptual awareness should be considered graded or dichotomous. Results showed that PAS showed a much stronger performance-awareness correlation than either CR or PDW, particularly for low stimulus intensities. In general, all scales indicated above-chance performance when participants claimed not to have seen anything. However, such above-chance performance only showed when we also observed a correlation between awareness and performance. Thus (1) PAS seems to be the most exhaustive measure of awareness, and (2) we find support for above-chance performance in the absence of subjective awareness, but such unconscious knowledge only contributes to performance when we observe conscious knowledge as well. Similarities and differences between scales are discussed in the light of consciousness theories and response strategies.

1. Introduction

A systematic comparison of measures of subjective awareness is long overdue (see also Dienes and Seth (2010), Wierzchoń, Taraday, Hawrot, and Asanowicz (2009)) since such measures are currently widely used in consciousness research (for an overview, see Seth, Dienes, Cleeremans, Overgaard, and Pessoa (2008)). For instance, the search for the neural correlates of consciousness typically involves contrasting brain activation during task performance with and without awareness (Baars, 1988; see e.g. Christensen, Ramsøy, Lund, Madsen, and Rowe (2006), Lau and Passingham (2006); but see Lamme (2006), for a different view). In this paper, we compare three currently popular measures of subjective awareness and assess how well each correlates with performance in a masked identification task. The Perceptual Awareness Scale (PAS; (Ramsøy & Overgaard, 2004)) is a purely introspective measure that requires participants to indicate the clarity of their experience of a stimulus. Confidence ratings (CR; e.g. (Cheesman & Merikle, 1986; Dienes, Altmann, Kwan, &

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Goode, 1995) require participants to indicate their confidence in their decisions. Finally, post-decision wagering (PDW; Persaud, McLeod, & Cowey, 2007) requires participants to place a monetary wager on the accuracy of their decisions (i.e., stimulus identification). All three measures potentially present substantial advantages over other methods aimed at assessing the relationships between awareness and task performance. In particular the measures can be collected almost concurrently with decisions and can thus be correlated with task performance on a trial-by-trial basis, hence addressing Shanks and St. John's "retrospective assessment" problem (1994). However, it is unclear which method is most sensitive, that is, which method shows the best relationship between task performance and self-reported awareness. Likewise, it is unclear which measure is most exhaustive, that is, which method reveals the most conscious processing (Reingold & Merikle, 1988).

Dienes et al. (1995) have proposed the "zero-correlation criterion" (see also Chan (1992)) and the "guessing criterion" as tests for such conscious and unconscious processing, i.e. how sensitive and exhaustive the measures are. When analyzing using the zero-correlation criterion one looks for correlations between performance (an objective measure) and self-reported awareness or confidence in being correct (a subjective measure) across different conditions of task difficulty (e.g. various stimulus durations). Any positive relationship between performance and awareness suggests the involvement of at least some conscious knowledge in determining performance. However, the involvement of conscious processes does not exclude the involvement of unconscious processes. To examine these, the "guessing criterion" is used. Using this, performance is assessed for those cases where participants claim to be guessing (that is, when they claim to be performing randomly). If participants' performance is at chance, there is no knowledge contributing to the task, unconscious or otherwise, and subjective and objective thresholds are identical. If, however, participants who claim to be guessing perform above chance, then one would conclude that their performance is based on knowledge they are not aware of possessing, that is, on unconscious knowledge. An important caveat to this reasoning is that above-chance performance can also be the consequence of the test failing to be exhaustive when subjects claim to be guessing, meaning that participants fail to be complete in their report about their conscious contents. Given this state of affairs, the best one can do is to consider that if one scale indicates less unconscious processing than another, then that scale should be taken to be more exhaustive than the others, all else being equal (that is, assuming that there are no differences in the extent to which each scale promotes awareness in and of itself, and in the extent to which the different scales erroneously labels some unconscious knowledge as conscious knowledge). One should thus look for the scale that is simultaneously most sensitive and most exhaustive. In other words, the most promising scale is the one that (a) shows better correlation than others between performance and awareness at different levels of difficulty (the zero-correlation criterion), and (b) shows the least above-chance performance for trials on which participants claim to be guessing (the guessing criterion).

The current study was thus motivated by two simple goals. First, we aimed at determining whether the three measures predict the same relative contribution of conscious and unconscious processing. To this end, we determined the relationship between performance and awareness at different levels of task difficulty. Additionally, we explored the extent to which each scale indicates the same level of above-chance performance in the absence of awareness, if any (for an overview of this debate, see Kouider and Dehaene (2007), or Overgaard and Timmermans, 2009). The second goal was to explore whether perceptual awareness should best be considered as graded or as dichotomous (e.g., Overgaard, Rote, Mouridsen, & Ramsøy, 2006; Sergent & Dehaene, 2004). Though there are theoretical complications, comparing the three scales in this light should be informative.

1.1. Three awareness scales

In the current experiment, we compare three scales, each of which measures awareness in a different way. Each of these scales has a number of claimed advantages and disadvantages. Even though some of these are difficult to validate empirically, they will be mentioned in the following as they may still influence the evaluation of the scales.

1.2. Perceptual awareness scale

When using PAS, participants report on the quality of their subjective experience directly. PAS was originally created by the participants in an experiment by Ramsøy and Overgaard (2004). In this experiment, participants were asked to describe the quality of their visual experience as they looked at briefly displayed stimuli, using a scale they had created themselves. It was suggested to participants that they start the scale with 'No experience' and ended it with 'A clear image', but they were free not to follow the suggestion and/or to use any number of categories. All five participants ended up using a 4-point scale with the elements (1) 'No experience', (2) 'Brief glimpse', (3) 'Almost clear image', and (4) 'Absolutely clear image'. Although the participants differed in their labeling of the categories, they agreed in their definitions of the categories.

PAS can be claimed to be intuitive in that the categories used are created not by an experimenter, but by other research participants evaluating their conscious experience (Ramsøy & Overgaard, 2004). In addition, as it is not related to a participant's evaluation of how good their answer is (as is post-decision wagering), PAS and other direct measures of conscious experience can easily be used in tasks in which there is no "correct" answer such as the perception of an ambiguous figure or binocular rivalry. Finally, Persaud and colleagues (2007) have argued that participants using numerical confidence ratings may withhold knowledge, as they have no motivation to reveal it. This criticism also applies to PAS.