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Metacognitive sensitivity of subjective reports of decisional confidence and visual experience ☆

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ABSTRACT

Previous studies provided contradicting results regarding metacognitive sensitivity estimated from subjective reports of confidence in comparison to subjective reports of visual experience. We investigated whether this effect of content of subjective reports is influenced by the statistical method to quantify metacognitive sensitivity. Comparing logistic regression and meta-d in a masked orientation task, a masked shape task, and a random-dot motion task, we observed metacognitive sensitivity of reports regarding decisional confidence was greater than of reports about visual experience irrespective of mathematical procedures. However, the relationship between subjective reports and the logistic transform of accuracy was often not linear, implying that logistic regression is not a consistent measure of metacognitive sensitivity. We argue that a science of consciousness would benefit from the assessment of both visual experience and decisional confidence, and recommend meta-d as measure of metacognitive sensitivity for future studies.

1. Introduction

Empirical approaches to human consciousness crucially rely on measures to determine whether or not an observer is conscious of a stimulus (Chalmers, 1998). Many researchers prefer objective measures, where conscious awareness is ascribed based on performance in a discrimination task (e.g. Eriksen, 1960; Hannula, Simons, & Cohen, 2005; Schmidt & Vorberg, 2006). However, at least two popular theoretical perspectives imply that conscious awareness ought to be measured by subjective reports: First, according to higher-order theories, perception of a stimulus is conscious only if it is associated with a higher-order representation, i.e. a representation of oneself as perceiving the stimulus (Carruthers, 2011; Lau & Rosenthal, 2011). While discrimination performance is not necessarily accompanied by a corresponding higher-order representation, a subjective report does require some higher-order knowledge (participants need to know that they are aware of the stimulus in order to report that they are aware) and are thus considered more valid measures of conscious awareness than discrimination performance (Dienes, 2004, 2008; Lau, 2008). Second, according to the perspective of heterophenomenology, participants' verbal reports about their subjective experience are themselves objects of study in consciousness research (Dennett, 2003, 2007) and are thus the appropriate raw data that needs to be recorded and explained (Dehaene, 2010; Dehaene & Naccache, 2001).

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1.1. Visual experience and confidence as content of subjective reports

A consequence of these theoretical reasons for using subjective measures of conscious awareness is the need of appropriate scales to record subjective reports. One characteristic of subjective reports that requires special consideration is *the content of subjective report*, i.e. what the subjective report is about. The contents queried in visual awareness experiments fall into two categories depending on whether participants are asked to make a report about their experience of the stimulus, or about the accuracy of a discrimination task response (Zehetleitner & Rausch, 2013). We will refer to the first kind of content as "visual experience", and the second kind as "confidence". Examples for scales with visual experience as content of subjective reports are ratings how visible the stimulus was (Sergent & Dehaene, 2004) or how clear a specific stimulus feature was experienced (Rausch & Zehetleitner, 2014). Examples for the discrimination response as content are reports of how confident participants were about the preceding task response (Peirce & Jastrow, 1884), or whether the last task response was made by guessing or based on knowledge (Zehetleitner & Rausch, 2013).

Aiming to identify the best scale to measure conscious awareness empirically, a series of previous studies has compared subjective reports collected with different scales (Dienes & Seth, 2010; Rausch & Zehetleitner, 2014; Sandberg, Timmermans, Overgaard, & Cleeremans, 2010; Szczepanowski, Traczyk, Wierzchoń, & Cleeremans, 2013; Wierzchoń, Asanowicz, Paulewicz, & Cleeremans, 2012; Wierzchoń, Paulewicz, Asanowicz, Timmermans, & Cleeremans, 2014). As subjective scales are often used to determine whether performance in a specific task is conscious or unconscious, the scales were compared by examining the correlation between subjective reports and task accuracy: On the assumption that the correlation between reports and accuracy is mediated by conscious processes, if one scale was found to predict accuracy better than the other scales, it was concluded that this scale is more sensitive in detecting conscious processes (that the other scales miss) and is thus closer to being an exhaustive measure of conscious awareness (Overgaard & Sandberg, 2012). This reasoning rests on the assumption that the scales under comparison are equally valid from a conceptual point of view, but some are more suitable research instruments than others.

In contrast to the assumption that all scales are a priori valid measurements of conscious experience, we have proposed that which content of subjective reports is appropriate depends on the set of conscious experiences relevant to a specific research question (Rausch & Zehetleitner, 2014). The reason is that participants might already experience some conscious intuition about being correct in a discrimination task while not yet consciously seeing the stimulus feature relevant for the task judgment (Zehetleitner & Rausch, 2013). A similar dissociation between knowledge about the accuracy of task decisions and the knowledge underlying those task decisions was shown for artificial grammar tasks (Dienes & Scott, 2005). These observations suggest that studies investigating the neural correlates of a specific visual content (such as the redness of an apple) may encounter false positives if they rely on confidence judgments because confidence may not necessarily require a conscious visual experience of the relevant stimulus feature. On the other hand, if the full set of experiences during visual perception is of theoretical interest to a specific study, the use of a scale that measures only visual experience of one specific feature leaves out subjective feelings of confidence (Zehetleitner & Rausch, 2013), and possibly other qualitatively different experiences along the unawareness/awareness continuum, such as awareness of an event without a phenomenology of seeing, as reported by some blindsight patients (Sahraie, Weiskrantz, Trevethan, Cruce, & Murray, 2002), or experiences without any content (Ramsøy & Overgaard, 2004). Finally, if a study investigates whether performance in a specific task is conscious, confidence ratings are a convenient choice since participants should consider all their conscious experiences relevant for their performance in this case (Dienes, 2008). Overall, should reliable differences between subjective scales with different contents exist, then researchers would have to decide which set of conscious experiences is relevant to their particular research questions, and choose a measure accordingly.

1.2. Type 2 signal detection theory

As subjective reports entail making a decision for one out of the several response alternatives offered by the scale, it is legitimate to apply theories of decision making to subjective reports. One of the most prominent theories of decision making under uncertainty is signal detection theory (SDT, Green & Swets, 1966; Macmillan & Creelman, 2005; Wickens, 2002). According to SDT, when observers decide which out of two possible event types occurred, their perceptual systems create sensory evidence delineating the two response options. As there is noise in the system, the sensory evidence is not constant, but a random sample out of a distribution for each of the two event types. Participants select a response by comparing the sensory evidence with a response criterion, choosing one option if the sensory evidence is greater than the criterion and the other option otherwise. SDT allows distinguishing between two aspects of decision making: sensitivity and bias. The more sensitive an observers is, the smaller is the overlap between the two distributions of evidence created by the two events. Bias toward one response options however depends on the position of the response criterion (see Fig. 1a).

SDT tasks can be classified based on the events participants have to discriminate: In type 1 tasks, the standard application of SDT, participants differentiate between two different kinds of stimulation (e.g. two distinct stimuli, or the presence or absence of the stimulus). However, SDT can also be applied to type 2 tasks, where the task is to differentiate correct and incorrect responses to a type 1 task (Galvin, Podd, Drga, & Whitmore, 2003). Type 2 tasks allow the assessment of sensitivity and bias just as in type 1 tasks (see Fig. 1b): *Metacognitive sensitivity*, the sensitivity in type 2 tasks, is defined as the extent to which the observers' type 2 responses differentiate between correct and incorrect type 1 responses. *Metacognitive bias* indicates how liberal or conservative participants' type 2 responses are with respect to their task performance (Fleming & Lau,

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