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A comparison between a visual analogue scale and a four point scale as measures of conscious experience of motion

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ABSTRACT

Can participants make use of the large number of response alternatives of visual analogue scales (VAS) when reporting their subjective experience of motion? In a new paradigm, participants adjusted a comparison according to random dot kinematograms with the direction of motion varying between 0° and 360°. After each discrimination response, they reported how clearly they experienced the global motion either using a VAS or a discrete scale with four scale steps. We observed that both scales were internally consistent and were used gradually. The visual analogue scale was more efficient in predicting discrimination error but this effect was mediated by longer report times and was no longer observed when the VAS was discretized into four bins. These observations are consistent with the interpretation that VAS and discrete scales are associated with a comparable degree of metacognitive sensitivity, although the VAS provides a greater amount of information.

1. Introduction

The lack of an established measurement for conscious experience is a key challenge to the prosperity of an empirical science of consciousness (Chalmers, 1998). The choice of an adequate measure is delicate because different theoretical perspectives on consciousness can imply different measurements. Some theorists are critical about the use of subjective reports because they assume participants might have conscious experiences they are unable to report (Block, 2005) or they do not report because their criterion is too conservative (Hannula, Simons, & Cohen, 2005). In contrast, proponents of higher-order thought theories often argue that subjective reports are more valid than objective measures because unconscious processes might drive objective performance as well (Dienes, 2004; Lau, 2008). However, as subjective experiences cannot be observed from the third-person point of view (Jackson, 1982; Nagel, 1974), it is impossible to test empirically whether subjective measures of consciousness leave out conscious experiences that observers are unable to report, or whether objective measures suggest falsely that performance in a task is conscious. However, some researchers decide a priori to adopt a perspective that requires the use of subjective reports, either because they endorse a higher-order perspective on consciousness (Cleeremans, 2011; Lau & Rosenthal, 2011), or because they consider subjective reports themselves as the subject of their scientific investigations (Dennett, 2003, 2007); if they do so, the empirical question arises how a scale needs to be designed given the metacognitive abilities of humans to obtain as much information from participants as possible.

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1.1. The content of subjective scales

Subjective scales designed to measure conscious experience are constituted out of at least two components: (i) the question participants are instructed to answer and (ii) the way participants deliver their subjective report. Concerning the question, we proposed a classification of subjective scales on the event in the world subjective reports refer to, specifically whether subjective reports refer to the stimulus or to the discrimination response (Zehetleitner & Rausch, 2013). Examples for stimulus-related scales would be to ask participants how visible the stimulus was (Sergent & Dehaene, 2004), to rate clarity of the response defining feature (Zehetleitner & Rausch, 2013), or to report both the experience of specific features as well as feelings of something being shown (Ramsøy & Overgaard, 2004, p. 12). Decision-related scales may ask participants to report how confident they are about the preceding objective task response (Peirce & Jastrow, 1884), whether they attribute their objective task response to guessing, intuition, memory, or knowledge (Dienes & Scott, 2005), how much money they would wager on the accuracy of the objective task response (Persaud, McLeod, & Cowey, 2007), or whether they experienced a "feeling-of-warmth" with respect to the previous task response (Wierzchoń, Asanowicz, Paulewicz, & Cleeremans, 2012).

Several studies compared subjective scales with different questions participants were asked to respond to: Dienes and Seth (2010) reported that wagering was biased by the participants' risk-aversion, but there were no differences between confidence and wagering after the possibility of loss had been eliminated from wagering. Sandberg, Timmermans, Overgaard, and Cleeremans (2010) observed in a masked object identification task that the perceptual awareness scale (PAS) predicted task performance more efficiently than confidence and wagering did. In an artificial grammar task, it was reported that confidence ratings predicted objective performance more efficiently than ratings of awareness of the artificial grammar rule (Wierzchoń et al., 2012). Szczepanowski, Traczyk, Wierzchoń, and Cleeremans (2013) reported that confidence ratings were more closely correlated with performance than ratings of subjective awareness and wagering, although a recent reanalysis of the data found no significant differences between subjective awareness and confidence (Sandberg, Bibby, & Overgaard, 2013). Finally, subjective reports of visual experience were less strongly correlated with objective performance in masked orientation discrimination tasks or random motion discrimination tasks, but no substantial differences were observed in a masked form discrimination task. In addition, confidence ratings were associated with more liberal thresholds than reports of visual experience across all three visual tasks, and confidence and wagering were more strongly correlated with each other than with reports of visual experience (Zehetleitner & Rausch, 2013).

Four different lines of interpretation for empirical differences between subjective scales with different questions have been suggested: First, it has been assumed (at least for the purpose of a comparison between measurements) that different kinds of subjective reports are equal except the sensitivity (Dienes & Seth, 2010) and the exhaustiveness of the scale (Sandberg et al., 2010). The second suggestion was that different scales might encourage participants to access their conscious contents in different ways: In introspective judgments, participants just directly report their conscious experiences a s they have them; in metacognitive judgments however, participant use their conscious experiences to make more complex cognitive judgments about processes engaged in the objective task (Overgaard & Sandberg, 2012). Third, it has been proposed that different subjective scales might alter the quality of conscious experience itself: Some scales such as wagering might be more motivating for the participants, making them more attentive, and thus cause participants to experience the stimulus more distinctively (Szczepanowski et al., 2013). Finally, it was suggested that different questions may relate to different processes during the task: Stimulus-related reports may be informed by processes involved in stimulus representation, and decision-related reports by processes involved in decision making (Zehetleitner & Rausch, 2013).

1.2. Visual analogue vs. discrete scales

The present study investigated the response format as the second component of subjective scales, specifically whether responses to the same question are more conveniently recorded by a discrete scale or a visual analogue scale (VAS). From the viewpoint of information theory (Shannon, 1948), subjective reports should be collected with a maximum number of scale steps because the maximal amount of information recorded by one report is bounded by number of options provided to the participant. Specifically, as the maximum information is computed as the binary logarithm of the number of options, a binary scale records the information of 1 bit in one trial, 4 scale points 2 bits, 8 scale points 3 bits, etc. The information conveyed by a VAS, where the response is selected along a continuum, would theoretically depend on the number of scale positions differentiated by the equipment (between 2^8 and 2^{16} with custom joysticks), but is in practice limited by the number of positions that participants can differentiate on the continuum, which classical studies estimated to be at least 10 positions (Hake & Garner, 1951).

From the viewpoint of signal detection theory (SDT) (Green & Swets, 1966; Macmillan & Creelman, 2005; Wickens, 2002) however, the use of a high number of scale steps is only feasible if two requirements are met: (i) participants need to be able to maintain a sufficient number of criteria, and (ii) participants' type 2 sensitivity (Galvin, Podd, Drga, & Whitmore, 2003), i.e. their degree of access to their own task performance, should not be impaired by a great number of options. The recent literature has raised doubts about both requirements for high-precision usage of VASs: Overgaard, Rote, Mouridsen, and Ramsøy (2006) proposed that VASs tend to be used like binary judgments: As only the extreme ends of the scale are labelled, reports may be dragged towards the extremes, reducing the number of criteria participants effectively use to two. In