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Consciousness isn't all-or-none: Evidence for partial awareness during the attentional blink

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ABSTRACT

Alternative views of the nature of consciousness posit that awareness of an object is either an all-or-none phenomenon or that awareness can be partial, occurring independently for different levels of representation. The all-or-none hypothesis predicts that when one feature of an object is identified, all other features should be consciously accessible. The partial awareness hypothesis predicts that one feature may reach consciousness while others do not. These competing predictions were tested in two experiments that presented two targets within a central stream of letters. We used the attentional blink evoked by the first target to assess consciousness for two different features of the second target. The results provide evidence that there can be a severe impairment in conscious access to one feature even when another feature is accurately reported. This behavioral evidence supports the partial awareness hypothesis, showing that consciousness of different features of the same object can be dissociated.

1. Introduction

Pinpointing when and where consciousness occurs in the information processing stream and the nature of this representation are critical steps toward understanding the neurocognitive mechanisms of human awareness. According to proponents of the global workspace theory (Dehaene, Changeux, Naccache, Sackur, & Sergent, 2006) consciousness occurs when an item is available for direct control and manipulation in working memory and this is possible only after extensive information processing. This suggests that consciousness of an object or item is an "all-or-none" phenomenon (Sergent & Dehaene, 2004). However, this view has been challenged by the fact that we seem to be conscious of much more detail than we can report at any given time. In other words, the phenomenology of perceptual experience overflows that which can be accessed (Block, 1995, 2005; Lamme, 2010). The partial awareness hypothesis (Kouider, de Gardelle, Sackur, & Dupoux, 2010) was proposed as a reconciliation between these views and it suggests that consciousness of different levels of representation can occur independently. Therefore, one might be conscious of the color of an object without being able to identify its shape (Breitmeyer, 2014).

In the current study, we used the attentional blink (AB; Raymond, Shapiro, & Arnell, 1992) phenomenon as a tool to compare the all-or-none and partial awareness hypotheses. The AB refers to a decrease in the ability to report a second target object (T2) when it is presented between 200 and 500 ms after a preceding target (T1) in a rapid serial visual presentation

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(RSVP) sequence. The AB is well suited to explore models of consciousness because a stimulus (T2) is presented above sensory threshold but report of the stimulus is often severely impaired. For instance, in a previous investigation, Sergent and Dehaene (2004) examined whether consciousness was an all-or-none phenomenon during the AB. Participants rated the subjective visibility of the T2 stimulus during the AB and it was observed that individuals used only the extreme ends of this scale (i.e., not seen or maximal visibility). This distribution of responses was interpreted as being consistent with an "all-or-none" account of visual consciousness.

Visual masking also can be used to examine the necessary conditions for consciousness. Manipulating the stimulus onset asynchrony (SOA) between a target stimulus and subsequent mask influences the visibility of the target (Bachmann, 2000; Breitmeyer, 1984, 2014). Breitmeyer et al. (2006; see also Breitmeyer, 2014) examined the effect of metacontrast masks on target visibility using two different discriminations. On different trials, participants compared either the luminance or the contour of the target to a sample. It was found that the SOA between the target and the metacontrast mask differently influenced visibility depending on whether the participant was comparing luminance or contour, such that the mask had its peak influence on the contour task at earlier SOAs than in the luminance task (Breitmeyer et al., 2006). Similarly, Hommuk and Bachmann (2009) demonstrated differences in identification and misbinding of the shape and orientation of two stimuli depending on which feature was pre-cued. Both of these experiments suggest that visual masking has distinct influences on different features of the same object. Importantly, though, differences in visual awareness of features doesn't suggest that there is independence in early-stage preconscious processing (Breitmeyer, 2014). To the contrary, there is evidence suggesting that some features, like contour, have a substantial influence on the processing of other stimulus features (Bachmann, 2000; Breitmeyer, 2014). The partial awareness hypothesis extends this work by suggesting that even though parallel unconscious processing of a given feature might depend on the processing of earlier levels or features, the conscious access of a specific feature or level of representation can occur without, or is independent of, conscious access to other levels of representation. Therefore, partial awareness allows for greater richness of perceptual experience at lower levels of the representational hierarchy.

The aim of the present set of experiments is to distinguish between the all-or-none and partial awareness theories of visual consciousness by examining the accuracy of independent discriminations of two features of the same object during the AB. The key assertion of the partial awareness hypothesis is that consciousness occurs for different features and levels of representation independently. Thus, this theory predicts that it should be possible to observe an impairment in accuracy (i.e., an AB) for one T2 feature (e.g., color) even on those trials when another T2 feature (e.g., identity) is accurately reported. In contrast, the all-or-none hypothesis predicts that if there is consciousness of one feature of an object, then one should be able to report other features of the object. The current experiments tested these competing hypotheses by having participants identify two features (color and identity) of T2.

2. Experiment 1

2.1. Methods

2.1.1. Participants

19 undergraduate students from the University of California, Santa Barbara, participated in the experiment for partial fulfillment of a course requirement (11 females, all right handed, mean age = 18.4). Three participants were excluded because of poor performance on the T2 identification task. Based on previous work on the AB (Raymond et al., 1992), a minimum sample size of 16 was set and the final sample size was determined by availability and attendance of participants. The UCSB Human Subjects Committee approved all procedures.

2.1.2. Apparatus and stimuli

Targets and distractors were upper case letters presented on a gray screen in Arial size 32 font ($.51^\circ \times .41^\circ$). T1 was white and T2 was the first non-black (red, green, or blue) letter following T1. All of the distractors prior to the presentation of T2 were black, and those following T2 were either red, green or blue. Stimuli were presented on a 19-in. color CRT monitor positioned 110 cm from the participant. All stimulus presentation, timing, and response acquisition were controlled using the Psychophysics toolbox version 3 (Brainard, 1997).

2.1.3. Design and procedure

Participants initiated each trial by pressing the space bar. Trials began with a 500–1000 ms blank interval during which a fixation cross was on the screen, followed by the RSVP sequence. All items in the RSVP sequence were presented for 96 ms with no interstimulus interval. T1 was always the 10th item. T2 was presented at lag 2, 3, 4, 5, or 9. Both T1 and T2 could be one of 17 letters, excluding B, G, Q, R, V, and W. There were 60 trials per lag, for a total of 300 trials presented in 4 blocks of 75 trials each. After the final RSVP distractor, there was a 500–1000 ms blank interval, followed by the T1 and T2 response screens. Participants were instructed to identify each target by typing the identity using the keyboard and to identify the color of T2 by pressing r, g or b. The order of the response questions was always the same. After the participant responded, the fixation cross reappeared on the screen indicating that the next trial could be initiated when the participant was ready (see Fig. 1).