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Absolute and relative blindsight

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ABSTRACT

The concept of relative blindsight, referring to a difference in conscious awareness between conditions otherwise matched for performance, was introduced by Lau and Passingham (2006) as a way of identifying the neural correlates of consciousness (NCC) in fMRI experiments. By analogy, absolute blindsight refers to a difference between performance and awareness regardless of whether it is possible to match performance across conditions. Here, we address the question of whether relative and absolute blindsight in normal observers can be accounted for by response bias. In our replication of Lau and Passingham's experiment, the relative blindsight effect was abolished when performance was assessed by means of a bias-free 2AFC task or when the criterion for awareness was varied. Furthermore, there was no evidence of either relative or absolute blindsight when both performance and awareness were assessed with bias-free measures derived from confidence ratings using signal detection theory. This suggests that both relative and absolute blindsight in normal observers amount to no more than variations in response bias in the assessment of performance and awareness. Consideration of the properties of psychometric functions reveals a number of ways in which relative and absolute blindsight could arise trivially and elucidates a basis for the distinction between Type 1 and Type 2 blindsight.

1. Introduction

In the study of conscious awareness, the possibility of identifying a neural correlate of consciousness (NCC) is regarded as one of the more achievable objectives and therefore has considerable appeal. The NCC refers to 'the minimal set of neural events and mechanisms jointly sufficient for a specific conscious percept' (Koch, 2004). In theory, there is a simple test to identify a NCC: Compare neural activity across conditions that differ only in the observer's conscious awareness. This would throw light on important questions, such as, how much processing is needed for awareness, whether it depends on global or local processes, and whether there are different forms of awareness.

In order to compare conditions differing only in awareness, it is necessary to dissociate performance from awareness. There are many neuropsychological conditions, such as blindsight, amnesia, achromatopsia, propospagnosia, anosognosia, and neglect, that are associated with this kind of dissociation. In each case, patients exhibit some residual ability to perform tasks in which they are ordinarily impaired. For example, amnesic patients are able to perform well above chance in forced-choice recognition (e.g. Voss, Baym, & Paller, 2008) despite claiming to have no memory for the stimuli being tested. In such cases, subtractive designs could be used to identify the NCC.

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Of all such examples, blindsight seems to be the most clear-cut. Blindsight has been defined as 'visual capacity in a field defect in the absence of acknowledged awareness' (Weiskrantz, 1986), reflecting the fact that patients who are clinically blind are capable of detecting and discriminating stimuli presented in their field defects when forced choice procedures are used. Because the extent of the field defect is often restricted to part of the visual field (*e.g.* hemianopia and quadrantanopia), it is possible to make straightforward, within-subject comparisons of conditions with and without awareness. On the other hand, the rarity of blindsight patients makes them less convenient in the study of the NCC.

Many researchers have tried to emulate blindsight in normal observers by manipulating the detectability of visual stimuli using paradigms such as backward masking, but unfortunately it has proven difficult to produce dissociations between performance and awareness that are not entirely due to differences in response bias over forced-choice and yes–no tests (see Heeks & Azzopardi, this issue, for example). An interesting approach was devised by Lau and Passingham (2006), who showed a relative difference in the level of conscious awareness of normal observers between two conditions in which the performance was otherwise matched, which they referred to as 'relative blindsight'. By implication, 'absolute blindsight' refers to a straightforward dissociation between performance and awareness regardless of whether performance is matched across conditions.

Lau and Passingham used a metacontrast masking procedure in which performance followed a U-shaped function, *i.e.* decreasing and then increasing as a function of the temporal asynchrony between target and mask, and took advantage of this to identify two stimulus onset asynchronies (SOAs) at which percent correct detection was matched, yet where there was a difference between them in the rate of reported awareness (Fig. 1). By comparing neural activity in these two conditions by means of fMRI, Lau and Passingham found activity in the dorsolateral prefrontal cortex (area 46) to correlate with awareness. This finding is in agreement with a previous finding from blindsight, that area 46 forms at least part of the NCC (Sahraie, Weiskrantz, Barbur, Simmons, & Williams, 1997). That this approach reveals dissociations in performance and awareness between conditions otherwise matched for performance makes it particularly attractive in the context of fMRI, where differences in performance can be associated with different baselines of activity.

Despite the elegance of this approach, a number of potential issues have since been identified (Jannati & Di Lollo, 2012). First, the stimulus actually *looks* different at shorter SOAs than at longer SOAs due to the relatively poor temporal resolution

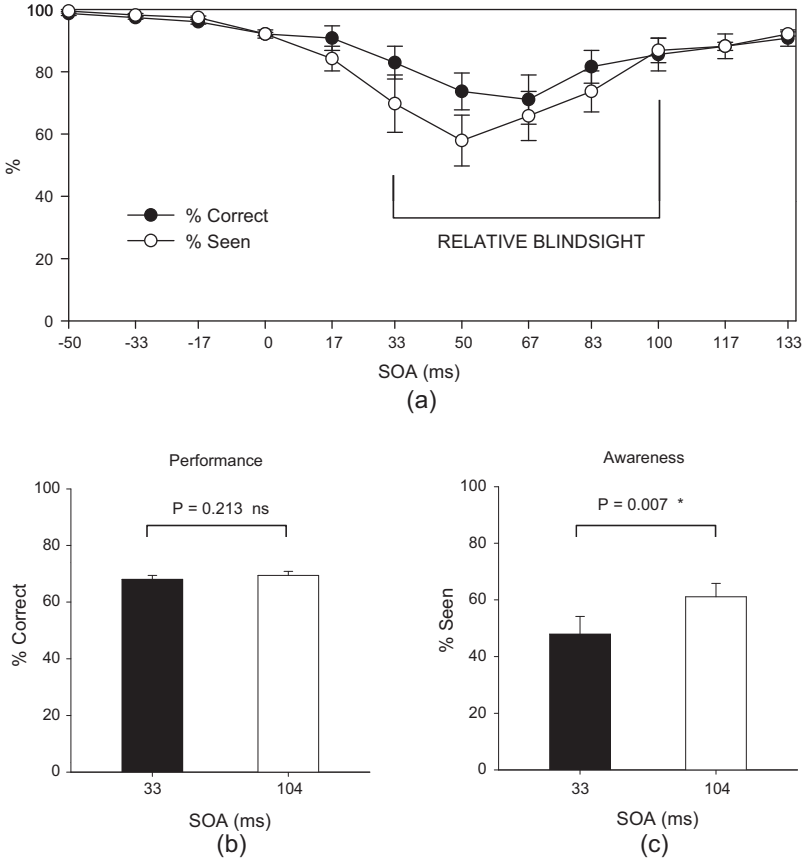

Fig. 1. Relative blindsight (replotted from Lau and Passingham (2006)). (a) Percent scores for performance (% Correct) and awareness (% Seen) as a function of stimulus onset asynchrony (SOA) in a detection task with metacontrast masking. Relative blindsight is demonstrated between two SOAs in which performance is the same, but awareness is different. (b) There is no significant difference in performance between the shorter and the longer SOA. (c) There is a significant difference in awareness between the shorter and longer SOA.

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