Type-2 Blindsight: Empirical and Philosophical Perspectives

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The articles in this special issue on type-2 blindsight all arose from a three-day workshop at University College Dublin in May 2013. The project brought together empirical researchers and philosophers to address the often-overlooked issue of residual awareness in blindsight (type-2 blindsight). The result is a collection of papers that not only present an overview of the current empirical and theoretical work on type-2 blindsight, but also raise important questions for our understanding of methodological and conceptual issues concerning the attribution of awareness in psychophysics, the nature of visual perception and experience, and their underlying mechanisms. In this introduction, we first give a brief overview of the history of research into residual awareness following striate cortical damage and then summarize the contributions to this special issue.

For well over 100 years, damage to the striate cortex (V1) has been known to result in severe impairments to vision, typically regarded as blindness. William James (1890) observed that: "Hemiopic disturbance comes from lesion of either one of [the striate cortices], and total blindness, sensorial as well as psychic, from destruction of both" (p. 47). Early studies into residual vision in cases of cortical blindness focused on remaining conscious experience. George Riddoch (1917) showed that soldiers who were clinically blind in a part of their visual field after a bullet wound had caused damage to their visual cortex were conscious of high-contrast moving or flickering stimuli in their blind field (the 'Riddoch phenomenon'). It was claimed by some that there was always some residual functioning following damage to V1 (Poppelreuter, 1917) but the assumption was that this was always associated with preserved visual experience.

The same assumption was made in the animal literature. Residual visual functioning in monkeys with V1 damage has been systematically studied since the work of Munk in late 19th century Germany. Early studies showed that monkeys could detect, and discriminate between, visual stimuli despite bilateral removal of V1 (Kluver, 1942). Still, despite suggestions to the contrary (Cowey & Weiskrantz, 1963), it was assumed that residual conscious vision was being studied. By contrast, after damage to striate cortex the reports of human subjects was that they were rendered blind and could no longer see anything led to the understandable assumption that humans and monkeys differed with respect to the role of V1 in conscious visual awareness. It was not until the mid-seventies, with the introduction of behavioural experimental methodologies developed for primates, that it was discovered that some hemianopes had residual visual functioning in the absence of reported awareness (Pöppel, Held, & Frost, 1973; Richards, 1973). Weiskrantz and colleagues (Weiskrantz, Warrington, Sanders, & Marshall, 1974) coined the term 'blindsight,' which they defined as "...visual capacity in a field defect in the absence of acknowledged awareness".

The publication of Weiskrantz's findings caused an explosion of interest in blindsight in empirical and philosophical circles. The discovery of blindsight played a major role in undermining the standard assumption that performance and awareness were tightly correlated. It was hotly debated whether blindsight was a genuine phenomenon or merely an artifact of poor experimental methodology (see critiques such as Campion, Latto, & Smith, 1983; Fendrich, Wessinger, & Gazzaniga, 1992; and responses such as those of Azzopardi & Cowey, 1997; Kentridge, Heywood, & Weiskrantz, 1997 and Stoerig, Hübner, & Pöppel, 1985). The extent and complexity of the residual capacities that blindsight subjects could exhibit was also a matter of contention (see Cowey, 2004 for a review). In philosophical circles blindsight became a test case that any theory of the mind would have to be able to account for (e.g., Block, 1995; Churchland, 1980; Dennett, 1991).

The emphasis on residual visual functioning in the absence of acknowledged awareness (type-1 blindsight) often led people to overlook the fact that certain stimuli can elicit awareness in a subject's blind field. This residual visual awareness has become known as 'type-2 blindsight' (Weiskrantz, Barbur, & Sahraie, 1995), and has been interpreted in many different ways. It is still common to make the error of thinking that there are 'type-1 (standard) blindsight subjects', and another subset of people, also with damage to V1, who are 'type-2 blindsight subjects'. However, the proper distinction is not between different subjects, but rather between different conditions of stimulus presentation. Most subjects with blindsight, whose lesions do not extend to the extrastriate cortex, have 'type-1 blindsight' under some stimulus conditions and have 'type-2 blindsight' under others. Variations in the properties of a stimulus such as the contrast it makes with its background, the speed of its onset and offset, and its absolute luminance can result in blindsight subjects reporting awareness of that stimulus when it is presented in their blind field.

One of the major concerns addressed in this special issue is whether type-1 and type-2 blindsight are really distinct phenomena. This raises difficult issues concerning the reliability of the measurement of awareness in empirical studies and the role that different neural areas play in the realization of conscious vision. A growing interest in the neural correlates of consciousness has lead to a particular emphasis on contrastive studies. Dissociations between aware and unaware conditions, with matched task performance, in subjects' blind fields are thought to offer a 'pure contrast' between performance and awareness. Such pure contrasts are thought to be particularly useful for differentiating the brain areas implicated in conscious and unconscious processing (e.g., Sahraie et al., 1997). This approach has also been in evidence in the growing literature on 'blindsight' in normal subjects, which relies on either masking experiments (Kolb & Braun, 1995; Lau & Passingham, 2006) or simulating blindsight by use of transcranial magnetic stimulation (TMS) (Boyer, Harrison, & Ro, 2005; Jolij & Lamme, 2005).

The contributors to this issue have addressed four broad themes in their papers. The problem of measuring awareness (Heeks & Azzopardi, this issue; Balsdon & Azzopardi, this issue; Celeghin et al, this issue); the problem of determining whether an experience is visual in nature (Kentridge, this issue; Foley, this issue; MacPherson, this issue; Overgaard & Mogensen, this issue; Brogaard, this issue); the implication of type-2 blindsight for the philosophy of perception (MacPherson, this issue; Brogaard, this issue) and the anatomical bases of residual function and residual experience in blindsight (Silvanto, this issue; Celeghin et al, this issue; Elliot et al, this issue). We now summarise these contributions.

Tarryn Balsdon and Paul Azzopardi (this issue) focus on methodological issues in a study by Lau & Passingham (2006) that claimed to show a dissociation between awareness and performance, similar to that found in blindsight patients, in normal subjects. Balsdon and Azzopardi provide compelling evidence that, once bias free measures of performance and awareness are used, there is no dissociation between awareness and performance in normal subjects. These concerns also relate to an attempt to investigate a pure contrast between type-1 and type-2 blindsight in patient GY (Sahraie et al., 1997) , which is susceptible to the same methodological criticism. Balsdon and Azzopardi cite earlier studies showing that while dissociations between performance and awareness with static stimuli could not be accounted for entirely in terms of bias, this was not the case with moving stimuli. This suggests that while type-1 and type-2 blindsight may be separable phenomena in studies presenting static stimuli, response bias might account for the dissociation between awareness and performance with moving stimuli.

Frances Heeks and Paul Azzopardi (this issue) raise similar methodological concerns regarding claims that performance and awareness can be dissociated when it comes to masked facial expressions. This study shows that the apparent dissociation between performance and perception of facial expression is also an artifact of response bias. Heeks and Azzopardi argue that these findings may undermine the now prevalent assumption that there are separate pathways mediating performance and awareness. This finding puts pressure on the idea that visual function and awareness can dissociate in normal subjects as they do in blindsight subjects. In turn, this suggests that there is something especially unusual about the mechanisms that subserve blindsight subjects' residual capacities.

The work of Azzopardi and his colleagues highlights just how critical the choice of measurement technique is in establishing awareness or its absence. The methods used to establish whether a visual stimulus can systematically influence behavior are also critical. Recent experiments, using methods for assessing awareness similar to those advocated by Azzopardi and his colleagues, apparently do demonstrate a blindsight-like dissociation between performance and awareness in normal observers (e.g. Norman, Heywood & Kentridge, 2013, in press). The masking methods in Norman's studies are quite different from those employed by Azzopardi and, perhaps more importantly, evidence for processing of unseen stimuli is revealed indirectly through effects on priming or the modulation of attention rather than directly through questioning subjects about the nature of the masked stimuli. The precise details of masking and directness of the method used to establish processing of the masked stimuli may be critically important.

It is not at all clear that blindsight subjects' residual experiences are visual in nature. Significant differences are seen in subject's descriptions of their residual awareness. They have variously described their experiences as: a "feeling"; "as if a finger is pointing through the screen"; "as if there were a black shadow against a black background"; as "dark shadows"; "visual pin pricks"; "white halos"; or as being "similar to when you wave your hand in front of your closed eyes". In characterizing blindsight subjects' residual awareness, it is worth emphasizing that, while they often use visual terms to explain their experiences, they also often explicitly deny that their residual awareness is visual, or a genuine case of 'seeing.' Thus there is even disagreement on whether type-2 blindsight is a case of visual awareness or not. Type-2 blindsight is generally considered to be some form of non-visual (e.g., cognitive) awareness. This issue has raised debate in recent years (Brogaard, 2011; ffytche & Zeki, 2011; Overgaard & Grünbaum, 2011; Weiskrantz, 2009) and four articles in this special issue specifically address this question.

Robert Kentridge (this issue) argues, on the basis of evidence about the residual visual processing that subserves type-1 blindsight, that type-2 blindsight should not be considered a case of residual visual experience. His central claim is that the residual processing that subserves type-1 blindsight is qualitatively very different from that which subserves normal visual experience. Because of this, it is very unlikely that any residual experience would be in any way similar to that of normal visual experience. As a result, Kentridge argues, there is no good reason to hold that type-2 blindsight is a form of degraded normal visual experience.

Fiona Macpherson (this issue) considers the importance of discussions about the structural features of experience for determining whether or not type-2 blindsight is a visual phenomenon. She argues that it is very difficult to establish any structural features of experience and, as such, there is no good reason to hold, on the basis of appeal to putative structural features, that type-2 blindsight is not visual. On the other hand, we cannot claim that type-2 blindsight must be visual purely on the basis of the distal stimulus or the neurophysiological underpinnings of the phenomenon. Macpherson proposes that the experiences associated with type-2 blindsight may be like those associated with amodal completion or phantom boundaries. She concludes that type-2 blindsight is a form of perceptual experience, but not necessarily visual experience. One might, however, contrast this conclusion with reports about another neurological condition which MacPherson discusses. In cerebral achromatopsia patients lose colour vision as a consequence of cortical damage. Despite their loss of colour experience these patients still perceive the boundaries between regions of different colours quite consciously (Kentridge, Heywood & Cowey, 2004), so, at least in this case what might be thought of as a phantom contour, boundaries alone still evokes a clearly visual experience.

Robert Foley (this issue) argues that we should consider type-2 blindsight to be a visual phenomenon. He contends that type-2 blindsight meets a very demanding set of objective criteria for visual awareness. According to these criteria an experience counts as visual if it is: based on the right proximal stimulus; received through the eye; processed by pathways that are implicated in visual processing; and the type of processing also occurs in normal vision. Foley then considers and rejects an alternative account according to which type-2 blindsight is a form of cognitive awareness. He concludes that we have good, if defeasible, reason to hold that type-2 blindsight involves a highly degraded and abnormal form of residual visual awareness.

Morten Overgaard and Jesper Mogensen (this issue) are also concerned with the nature of residual awareness in type-2 blindsight. They present a model (The REF-CON model), which conceives of blindsight as a form of residual visual experience. The model offers an account of blindsight that appeals to the dynamic reorganization of levels of processing to explain both subjects' reports that they do not see and the difference between type-1 and type-2 blindsight.

If type-2 blindsight is a form of visual experience, this discovery could have significant consequences for a number of empirical and philosophical hypotheses. Two papers in this special issue focus on some of these consequences. Berit Brogaard (this issue) considers the consequences of type-2 blindsight being a form of veridical visual experience for certain theories in the philosophy of perception. She argues that type-2 blindsight lacks particularity, fine-grainedness and transparency. According to Brogaard, this means that type-2 blindsight offers a counter-example to any form of direct realism that is committed to the claim that the phenomenology of veridical visual experience is object involving, transparent and fine-grained. Finally, Brogaard argues that the phenomenology of type-2 blindsight is best understood as being determinable rather than determinate and that if visual experience can represent determinable properties, this suggests a solution to Block's (2010) challenge to representational theories of perception.

Juha Silvanto (this issue) addresses the question of whether V1 is necessary for visual consciousness. He argues that the evidence from blindsight contradicts both standard hierarchical models and models on which feedback to V1 is necessary for consciousness. Instead Silvanto proposes that the distinction between local and long-range processing can explain blindsight. On this account, the residual visual capacities that blindsight subjects exhibit are due to local processing of visual information in the extrastriate cortex. The lack of attendant conscious experience is the result of the extrastriate neurons being unable to establish inter-areal networks via neural synchrony. He concludes that while extrastriate feedback to V1 is important for awareness, it is not uniquely associated with awareness.

Two articles in this issue offer new insights into the mechanisms that subserve type-1 and type-2 blindsight. Alessia Celeghin and colleagues (this issue) offer a novel approach to investigating residual visual processing after damage to the visual cortex. This method differs from traditional forced-choice and indirect methods of investigating blindsight in that the subjects' fast automatic responses to suddenly appearing visual stimuli were tested. Since the subject is not asked to choose a response, this method has the advantage of being a bias free means of assessing residual capacity. The authors then determine whether the automatic response is subserved by the subject's ipsilesional or contralesional hemisphere. Celeghin and colleagues provide provisional evidence that the subjects' capacity to respond automatically to unconsciously perceived cues is subserved by the contralesional hemisphere. This suggests that cortical or subcortical processing in the intact hemisphere may subserve some blindsight functions.

Mark Elliott and colleagues (this issue) present evidence supporting the significant role that stimuli of a certain frequency play in promoting blindsight performance. They compare the perimetric maps of subjects before and after the presentation of flickering stimuli of the appropriate frequencies. They found that stimulation of the blind field with the appropriate frequency led to temporary increase of intact visual field size. Elliott and colleagues propose that stimulation at rapid frequencies encourages the oscillation, and consequent synchronization, of neurons in the surviving areas of the cortex, thus bringing about the residual visual capacity reported. They conclude that this may indicate that blindsight and normal sight depend on similar mechanisms when it comes to the dynamics of vision. This raises the exciting possibility that blindness resulting from V1 damage could be rehabilitated, resulting in a recovery of normal vision.

We hope that the new work presented in this special issue provides a summary of the many current views of this important phenomenon, and inspires further research that will add to our understanding of the relationship between visually guided behavior and visual experience.

Acknowledgements

The Irish Research Council "New Foundations" award provided funding for the workshop on type-2 blindsight that took place at University College Dublin in March 2013.

We would like to express our thanks to the editors of Consciousness and Cognition for providing us with this prestigious platform and their support in preparing this special issue.

We would also like to thank the contributors and reviewers for their efforts in making this collection possible.

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