The Case for Characterizing Type-2 Blindsight as a Genuinely Visual Phenomenon
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Abstract

Type-2 blindsight is often characterised as involving a non-visual form of awareness that blindsight subjects experience under certain presentation conditions. This paper evaluates the claim that type-2 awareness is non-visual and the proposal that it is a cognitive form of awareness. It is argued that, contrary to the standard account, type-2 awareness is best characterised as visual both because it satisfies certain criteria for being visual and because it can accommodate facts about the phenomenon that the cognitive account cannot. The conclusion is made that type-2 blindsight is best characterised as involving a form of abnormal, degraded visual awareness.
Introduction

Lawrence Weiskrantz, who coined the term, defines blindsight as “...visual capacity in a field defect in the absence of acknowledged awareness” (Weiskrantz, 1986). While blindsight is often described in this way, the majority of research into it has focused on examining the residual capacities of people who have damage to their striate cortex (V1). These subjects (henceforth, hemianopes) are clinically blind in the area of their visual field corresponding to the V1 damage, and yet often retain the capacity to perform above chance in forced choice guessing tasks and other experimental conditions (type-1 blindsight [Weiskrantz, 1998]). The claim that hemianopes are clinically blind can be misleading. In experimental conditions, they often report awareness correlated with the presentation of moving stimuli in their blind field. This residual awareness of motion in hemianopes, commonly called type-2 blindsight in the literature (Weiskrantz, 1998), was known about long before blindsight was discovered (Riddoch, 1917).

It is a common mistake to think that there are some subjects who can be categorised as having type-1 blindsight and some who have type-2 blindsight. This is not the case. Rather, the majority of hemianopes with damage that is largely restricted to V1 (i.e., does not extend to the extrastriate cortex) exhibit both type-1 and type-2 blindsight depending upon the experimental conditions. Minor changes to features of a stimulus, such as luminance contrast between stimulus and background, speed of onset and offset, and changes in luminance, can result in hemianopes who are participating in a blindsight study (henceforth, blindsight subjects) reporting awareness that is correlated with the presentation of a stimulus in their blind field (see Weiskrantz et al., 1995). Thus the awareness that blindsight subjects have in type-2 cases (type-2 awareness) is not limited to moving stimuli.

The fact that blindsight subjects will often report some awareness associated with the stimulus presentation, unless the stimuli presented in experimental conditions are carefully controlled, has often been overlooked in discussions of blindsight. Although early experiments on GY (the most frequently studied blindsight subject) were mainly in ‘type-2’ conditions (in which he reported some awareness of the stimuli), it was not until the end of the last century that type-2 blindsight began to be seen as a phenomenon for investigation in and of itself (see for example: Barbur, Watson, Frackowiak, & Zeki, 1993; 1

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1 See the introduction to this special issue for an in-depth discussion of how type-1 and type-2 blindsight are defined in the literature.
Increased interest in the scientific study of consciousness has led to speculation that comparisons between type-1 and type-2 conditions in blindsight might serve to inform investigations into the neural correlates of consciousness (see Silvanto, n.d.). Given that a blindsight subject’s performance can be held constant while their awareness of the stimulus varies (Weiskrantz, 1995), it is sometimes thought that comparisons between type-1 and type-2 blindsight may constitute a case of ‘pure contrast’ between consciousness and function (for a recent critical discussion of such issues, see Overgaard [2011]). Various imaging techniques (such as: fMRI, MEG, EEG, and PET) have been used to compare the areas of activation in blindsight subjects’ ipsilateral field when they report awareness, or the lack thereof, of a stimulus (e.g., Goebel et al., 2001; Sahraie et al., 1997; Schurger, Cowey, Cohen, Treisman, & Tallon-Baudry, 2008). However, as Sahraie and colleagues (2010) note, there are very few studies that actually meet the precondition of matching performance across aware and unaware trials.

Such studies assume that they are investigating a contrast between conscious and unconscious visual processing. However, the standard characterisation of type-2 blindsight is that it is not a case of “genuine” visual awareness (or “seeing”). Rather, type-2 blindsight is generally characterised as being a non-visual form of awareness (Weiskrantz, 2009; Cowey, 2010). Alternatives to characterising type-2 awareness as visual have often been left unspecified, but a recent account suggests that it is best understood as a form of cognitive awareness of guessing performance (Brogaard, 2011a). What is at stake here can be unclear, but if type-2 blindsight is not actually a genuine case of visual awareness, then studies that compare type-1 and type-2 blindsight would not provide the right sort of contrast to inform the pursuit of the neural correlates of visual consciousness.

On the other hand, if type-2 blindsight is characterised by genuinely visual awareness, there are a few interesting potential implications. First of all, it suggests that striate cortical processing is not necessary for all forms of visual awareness (contra Lamme, 2001; Tong, 2003). Secondly, it may raise problems for certain accounts of qualia (Foley, 2011), or of the necessity of certain features of visual experience (Brogaard, n.d.; Macpherson, n.d.). Thirdly, if the subject’s awareness is simply of a property (such as movement) independent of any object, as some recent experiments suggest (see the discussion of Azzopardi and Hock [2011] below), it could undermine the claim that binding is a necessary condition of all visual experience (contra Matthen, 2005; and Treisman, 1996). Finally, if type-2 awareness is genuinely visual, it may pose a challenge to the standard interpretation of blindsight: Critical accounts of blindsight have long claimed that blindsight is the result of experimental artefacts and that blindsight subjects’ above chance performance might be correlated with weak, unreported visual awareness (Campion, Latto, & Smith, 1983; Ffytche & Zeki, 2011; Kolb &

While it is not within the scope of this article to address the complex issues related to such debates, the relevance of type-2 blindsight to them cannot be determined without first resolving the question of whether type-2 awareness is visual. Answering this question is, as it turns out, also a rather difficult conceptual and empirical issue. This paper makes the case that type-2 blindsight is, on current evidence, best characterised as a form of abnormal visual awareness. This is both because there are good reasons to believe that type-2 awareness is visual, and because the standard arguments to the contrary do not offer compelling reasons to accept the characterisation of it as non-visual. In addition, the major alternative account of type-2 blindsight a form of cognitive awareness cannot account for important facets of the phenomenon.

1. Objective and Subjective Criteria for Individuating the Senses

That blindsight subjects are aware of something under type-2 conditions (where ‘aware of’ is understood as the availability of information to the subject for use in the selection and control of goal directed behaviour and report), is not in question: they report awareness associated with the presentation of the stimulus; their awareness covaries with features of the stimuli presented in their blind field (such as direction of motion), and they can describe or draw features of the stimuli (Ffytche and Zeki, 2011); they know that their awareness corresponds with a visually presented object; they can spontaneously react to the stimuli and direct their attention toward or away from the stimulus (Kentridge et al., 1999); and they can compare stimuli in their intact and blind fields and rate them for similarity (Morland et al., 1999; Stoerig and Barth, 2001). Thus it seems uncontentious that they are aware. What is at issue is whether the awareness that blindsight subjects exhibit in these conditions counts as visual.

It can be unclear what warrants the claim, often made in the literature, that type-2 blindsight does not involve genuine visual awareness: Blindsight subjects have been characterised as being “aware of the occurrence of a visual event, though they could not see it” (Sahraie et al., 1996, cited in Zeki & Ffytche, 1998, p. 39), or as being consciously aware in the absence of “phenomenal vision” (Stoerig & Cowey, 1997). They have also been

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2 The results of the Stoerig and Barth study are sometimes questioned. However, even if no genuine match was found between the stimuli presented in the intact and damaged fields, this does not undermine the point here. The fact that GY was able to make a same/different comparison at all shows that he was aware of the stimuli presented in his blind field.
characterised as being aware without seeing due to the absence of “visual content” (Weiskrantz, 1998), of “qualia” (Persaud & Lau, 2008), or of “necessary forms of visual processing” (Brogaard, 2011a, 2011b, 2011c). Thus type-2 awareness is often characterised as being “quasi-visual”, “non-visual”, a “hunch”, or a “feeling”, but there is rarely any explanation provided of what is meant by these claims, what they entail, or why they are justified.

The question of how to determine whether a given experience is properly attributable to a particular sensory modality is a difficult one (see Macpherson, 2011a). Answering it seems to require providing an account of what it is for some token experience to belong to a particular sensory type. This question is, in turn, related to issues about how one should distinguish different sensory modalities; an issue in the philosophy of perception that dates back to Aristotle’s attempt to differentiate the five senses (see Sorabji, 1971). It will help us to understand what an answer to the question of whether type-2 blindsight is genuinely visual would look like if we take some time to understand the different approaches commonly taken to individuating the senses.

Standard attempts to differentiate sensory modalities can be divided into four approaches:

*The proximal stimulus criterion (PSC):* says that we can individuate the senses by reference to the proximal physical stimuli that impinge on the sense organ. Thus vision is the detection of differences in (a certain range of) electromagnetic waves.

*The sense organ criterion (SOC):* says that we can distinguish between the different sensory modalities on the basis of the sense organ that is involved. So, vision is what we do with our eyes.

*The phenomenal character criterion (PCC):* says that it is in virtue of the unique sensory character of an experience that we distinguish the senses. That is, that there is some special introspectible quality of our experience that allows us to identify all visual experiences as being visual (rather than, for example, auditory).

*The representational criterion (RC):* says that we can individuate the senses on the basis of the contents that are represented in an experience of a particular sensory kind. One version of RC claims that the senses can be distinguished by their “proper sensibles”, that is, by features that only the sensory modality in question can represent. So, only vision provides us with colour information and only hearing provides us with information about degrees of loudness.
Each of these criteria purport to offer different necessary and sufficient conditions to distinguish between sensory modalities. PSC and SOC rely on physical factors (objective criteria), whereas RC and PCC can be grouped together as relying on the subjects’ experiences (subjective criteria) to discriminate between modalities (Grice [1962] argues convincingly that RC and PCC are actually interdependent). While these accounts seek to individuate the different sense modalities, our concern here is with vision. As such, we will focus on how these criteria relate to vision, not to all of the senses (much of the recent debate about the individuation of the senses centres on atypical instances of sensing, such as bat echolocation, tactile visual sensory substitution (TVSS), magnetoception, the vomeronasal system, and other phenomena that are difficult to classify according to the above criteria. See Macpherson [2011a] for an in-depth account of these four criteria. For a collection of recent papers, see Macpherson [2011b]).

Due to the complexities involved in individuating the senses, providing a positive argument for the claim that type-2 awareness is necessarily visual is an improbable task. However, for our current purposes, it does not really matter whether any combination of these four criteria provide us with necessary and sufficient criteria for distinguishing between sensory modalities. Instead we can, as Macpherson (2011a) proposes, take all of the above criteria to be guidelines that can help in the proper classification of the senses and hence serve as defeasible criteria by which we can judge whether some token experience counts as an instance of visual experience or not. This approach can provide us with a framework for evaluating the case for and against characterizing type-2 awareness as visual.

2. Type-2 blindsight and subjective criteria

As was mentioned above, it is commonly held that type-2 awareness is not visual. The two most common arguments, which I call here, ‘the argument from subjective report’ and ‘the argument from the contents of subjects’ experience’ are based on the subjective criteria outlined above. These arguments are often implicitly appealed to in the empirical literature, but are rarely made explicit. If either of them holds up to scrutiny then they provide us with some basis for concluding that type-2 blindsight is not a genuinely visual phenomenon.

2.1 The argument from Subjective Report

Perhaps the most common reason for believing that blindsight subjects are not genuinely visually aware in type-2 scenarios is on the basis of their introspective reports. blindsight subjects generally report that while they are
aware of something in their blind field in type-2 scenarios, they do not “see” anything. GY, when pressed, described his awareness as being “...a ‘feeling’ that a stimulus was approaching or receding, or was ‘smooth’ or ‘jagged’” (Weiskrantz, 1986/2009, p.31), but claimed not to be able to describe any conscious perception. Similarly, Persaud and Lau (2008) found that GY claimed not to have any qualia in his blind field in type-2 cases (he initially said that he only sometimes had qualia in his blind field, and only when pressed said that he lacked them entirely). Thus, on the basis of such reports, it is argued that type-2 blindsight is not visual. Intuitively, this approach makes perfect sense. After all, surely the person who is having an experience is best positioned to know whether it is visual or not.

Subjects with brain damage are notoriously unreliable reporters, however, and blindsight subjects’ descriptions of their residual awareness can differ quite significantly. ffytche and Zeki (2011) note that GY’s reports tend to vary according to the trial or circumstances. We should also be concerned about possible confounding factors that may influence the subjects reports, such as, the subjects’ knowledge about their own condition, and the expectations of the experimenters (see Overgaard & Grünbaum [2011] for more on this point). In addition, although blindsight subjects tend to deny that they see the stimulus, describing it more as a feeling, they generally use visual language when asked to describe what their awareness is like (Barbur, 1980; Ffytche & Zeki, 2011; Perenin & Jeannerod, 1979; Richards, 1973; Weiskrantz, 2009; Whitwell, Striemer, Nicolle, & Goodale, 2011).

Of course, blindsight subjects’ use of visual language to describe their experiences does not entail that they actually are visual. After all, visual language is commonly used to describe many different kinds of experiences. On the other hand, blindsight subjects’ denials that they see should not be treated as canonical: In addition to the concerns raised above, it is possible that their visual awareness is so radically altered from normal visual awareness due to the significant degradation, both quantitative and qualitative, of their visual processing. That is, it is a live possibility that blindsight subjects are simply mistaken in their judgement that their awareness is not visual.

This alternative account makes sense when we consider what we know about the residual visual functioning that subserves type-2 blindsight. Blindsight subjects’ visual processing is radically altered from normal visual processing. They have severe retrograde degeneration all the way back from V1 to the

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3 The use of the term qualitative here, and throughout this paper, is meant in the technical neuropsychological sense, not the philosophical sense. Qualitative degradation here means that the subject’s visual system has changed in terms of the type of processing it can perform (e.g., chromatic contrast), not in terms of a difference in visual experience.
retina, and the almost total loss of the M and P projections to the cortex via the LGN. Only a small number of K projections to the LGN, and from there to the extrastriate cortex, remain (see Cowey, Alexander, & Stoerig, 2011; Cowey, 2010; and Leopold, 2012, for good summaries.). In addition, the projections from the retina to the superior colliculus are not responsive to short wavelengths, suggesting that there are no koniocellular-like projections to the SC (see Hall & Colby [2011], however, for evidence of koniocellular-like projections to the SC). The cells in the superior colliculus, which is the locus of much of the residual processing that subserves blindsight, have far lower resolution (due to their wider receptive fields) than those in the laminar layers of the LGN and the retinotopic map in V1 (Chalupa & Werner, 2004, Chapter 98). In addition, there is evidence that wavelength information, shape information, and other features of the stimulus do not feature as contents of the subjects’ awareness (Azzopardi & Hock, 2011; Weiskrantz et al., 1995).

Given what we know about the residual processing that subserves blindsight, any visual experience blindsight subjects might have would be very blurry and non-specific: lacking in shape information, colour information, contour information, and other features of the object normally represented in visual experience (see Kentridge, this issue, for a good discussion of the qualitative differences between residual processing that subserves blindsight and normal visual processing). This would lead to any awareness that subjects have being very unusual, explaining why they might judge themselves not to be seeing. Thus the radically altered nature of blindsight subjects’ residual processing provides us with a good explanation as to why they would report that any visual experiences they were having were not genuinely visual experiences: Blindsight subjects’ residual visual processing lacks important features of normal visual processing, and therefore of normal visual experience. This leads them to mistakenly deny that they are having visual experiences of the stimuli presented to them. That is, one of the consequences of having such radically degraded abnormal vision is that one might mistakenly judge one’s experiences not to be visual. Thus, given the fact that an equally compelling case can be made for the opposing position, the argument from subjective reports does not provide us with a strong case in favour of concluding that type-2 blindsight is not visual.

2.2 The Argument from the Content of Subjects’ Experience

As we saw in the previous section, it is not at all clear that we should accept blindsight subjects’ reports as evidence that their residual awareness is not visual. An alternative line of argument, which also relies on the subjective criteria, is that it is in virtue of lacking certain contents (such as colour and shape) that type-2 awareness should not be counted as visual. This approach, which is perhaps the second most common reason for believing that type-2
blindsight is not genuinely visual, commits its proponents to the claim that there are certain contents that must be represented in experience for that experience to count as visual.

In a highly influential paper, Weiskrantz and colleagues claim that GY's residual awareness does not count as seeing because “...his residual capacity depends on content, but it is perceptually contentless” (Weiskrantz, Cowey, & Barbur, 1999, p. 1537). This somewhat cryptic claim is based on evidence that GY is not aware of specific features of the stimuli presented to him, such as: its shape; texture, colour; or any other features of the object that normally form part of the contents of our visual experience. Instead, GY is simply aware as a result of onset or offset, luminance contrast, motion, or other low-level features of the stimulus that make it salient. Thus, the argument goes, type-2 blindsight is not a genuine case of visual awareness because it lacks the contents normally associated with visual awareness.

Note, however, that this claim is ambiguous. On one version, the claim that blindsight is not normal visual awareness is uncontentious: As discussed in the previous section, blindsight subjects' residual processing obviously differs both qualitatively and quantitatively from normal vision, and so it makes sense that their residual visual awareness is radically altered (for more on how radically altered visual processing is in blindsight see Kentridge, n.d.). But this weaker claim does not warrant the conclusion that type-2 awareness is not visual, only that it is unlike normal visual awareness. In order for the argument from the contents of blindsight subjects' experiences to work, the case must be made that the contents present in normal vision and lacking in blindsight are somehow essential to genuine visual awareness.

Furthermore, the fact that blindsight subjects can draw pictures of their experiences that represent certain features of the stimuli (ffytche & Zeki, 2011), and that their awareness is of something (such as movement in a direction) correlated with features of the stimuli (Azzopardi & Hock, 2011), makes it clear that blindsight subjects' awareness is not contentless. That these contents are radically different than those normally represented in visual awareness, may support the claim that blindsight subjects' residual processing is not normal visual processing in the weak sense that it differs both qualitatively and quantitatively from normal visual processing. But admitting this does not warrant the claim that type-2 awareness is not visual.

Rather, such arguments from the content of blindsight subjects' residual awareness, rest implicitly on the much stronger claim that if their awareness lacks certain paradigmatically visual contents, we should conclude that it is not visual. However, absent an argument in favour of the claim that certain contents are necessary features of experience; there is little reason to accept this (see Macpherson [this issue] for a more developed discussion of this
issue). In the absence of a strong a priori argument in favour of certain contents being necessary features of visual awareness, it is always possible simply to conclude that type-2 blindsight provides a counter-example to the claim that such contents are necessary features of visual awareness. Thus, while it may support the weaker conclusion that type-2 awareness differs from normal visual awareness, the argument from the content of subjects’ experience does not provide us with any basis for concluding that type-2 blindsight is not visual, since any claim that certain contents are necessary for an experience to count as visual could just as easily be taken to be undermined by the case at hand.

3. Type-2 Blindsight and Objective Criteria

Given that equally plausible alternative interpretations can be presented for the opposing view, the standard arguments against type-2 blindsight being characterized as a genuinely visual phenomenon are not compelling. We can now turn to the objective criteria, which have been appealed to in support of the opposing point of view that type-2 blindsight can be characterized as a genuinely visual phenomenon (see, e.g., Overgaard & Grünbaum, 2011 and Brogaard, 2011, 2012 for a recent discussion of these issues).

Appeal to objective criteria can be made in various ways, the most basic of which is simply by appealing to the PSC: In the case of type-2 blindsight we could stipulate that the subject’s awareness is visual if it is based on the appropriate proximal stimulus – in the case of human vision this would be electromagnetic energy of the appropriate range of the spectrum (around 380-750nm). That type-2 blindsight meets PSC is uncontroversial: Type-2 awareness is clearly based on the same proximal stimulus as normal vision. It has also recently been argued that type-2 awareness is visual on the basis of a combination of PSC and SOC: that is, that type-2 awareness is visual because it is based on the appropriate proximal stimulus being processed by the eye (Overgaard & Grünbaum, 2011).

However, the fact that electromagnetic energy is processed by the eye does not entail that any awareness the subject may have as a result of this would be visual. Consider, for example, that light taken in through the eye plays a role in regulating our circadian rhythms. We can imagine a subject who might, through some form of interoception, become aware of the effect of light on the mechanism responsible for regulating their circadian rhythms. Now suppose that this subject were, in virtue of feeling more or less tired, able to tell whether or not a light was on in a room, all the while denying that they saw anything at all. Despite the fact that the subject based their performance on the appropriate proximal stimulus (electromagnetic energy), which was processed by the appropriate sense organ (the eye), we would not want to say that they were visually aware of the light. Rather, their
awareness would be a form of interoception, which was guiding their capacity to judge whether or not the light was on in the room.

It could be argued that, in the case above, the important difference, which leads us to conclude that they are not aware, is the “indirect” nature of such interoception of circadian function. That is, the mechanisms that process the electromagnetic information for the regulation of circadian function are part of a system that cannot contribute to the contents of a subject’s visual experience by virtue of the fact that they lack the appropriate connections with the areas necessary for visual experience (such as the ventral visual pathway, for example). Rather, the subject’s awareness arises out of their interoceptive monitoring of the normal functioning of the circadian system.\(^4\)

In order to account for such cases, the SOC can be amended to include the relevant neural connections and brain areas. This extended version of the SOC (SOC*) can be combined with the PSC to provide us with a means of assessing whether type-2 blindsight should be counted as a case of visual awareness. If we combine these objective criteria (PSC and SOC*), an experience counts as an instance of visual awareness if it is the result of electromagnetic waves being received through the eye and processed by pathways and brain regions that are normally implicated in visual processing and awareness. Alternatively, an experience is not visual if, despite being based on the appropriate proximal stimulus and being received through the eye, the information the subject is aware of is processed by pathways that cannot contribute to the areas normally involved in visual processing for awareness. On one such account, if information processing in an area cannot contribute to working memory via the right channels, then it cannot become part of the contents of a subject’s visual experience (see Brogaard [2011c], in which the author argues that dorsal processing cannot contribute to the contents of visual experience because the dorsal stream does not have any direct connections with the areas necessary for accessing working memory).

If we evaluate this issue on the basis of this objective criterion, the empirical evidence provides some initial basis for characterizing type-2 awareness as visual: Type-2 blindsight is clearly mediated by information about electromagnetic waves that is received through the eye (thus satisfying the PSC and the narrow version of the SOC). In addition, there is good evidence that type-2 blindsight is subserved by parts of the visual system that are preserved after damage to V1 (such as intact retinal projections to the superior colliculus and the interlaminar layers of the LGN, and their

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4 The concept of someone being directly, rather than indirectly, aware of some kind of processing is a rather difficult one to specify. There are those, such as Daniel Dennett [1991], who explicitly deny such a distinction. For our purposes here, it suffices that many do make such a distinction, and that it could be taken to undermine the claim that type-2 blindsight is visual.
projections to V2 and the extra-striate cortex). Indeed, it seems that both the superior colliculus and the interlaminar layers of the LGN must be intact in order for blindsight subjects to exhibit many of their preserved capacities (see Leopold, 2012, for a good recent review). There is also evidence that regions of the visual cortex and the prefrontal cortex that are associated with visual perception in normal subjects are active in type-2 cases (Goebel, Muckli, Zanella, Singer, & Stoerig, 2001; Sahraie et al., 1997; Schmid, Panagiotaropoulos, Augath, Logothetis, & Smirnakis, 2009). When it comes to awareness of motion in particular, it is highly likely that cortical projections must be implicated, since the superior colliculus is not sensitive to direction of motion (Chalupa & Werner, 2004, Chapter 98). All of this suggests that type-2 awareness is mediated by processing that is carried out by preserved pathways that are part of the visual system which normally play a role in contributing to the contents of visual awareness. Thus the pathways that subs serve type-2 awareness are, at least in principle, capable of subserving visual awareness of an object.

Nonetheless, while the pathways that process the information that subserves type-2 blindsight appear to be implicated in normal vision, it might be questioned whether, after damage to V1, these pathways still perform the kind of processing that they do in normal vision. That is, it is possible that the residual processing that is preserved after damage to V1 is so qualitatively different from the kind of processing that occurs in the intact visual system that it should no longer count as vision. Thus, for example, when a blind subject’s striate cortex is recruited to facilitate echolocation processing (Thaler, Arnott, & Goodale, 2011), we do not conclude that the subject is seeing the sounds. Nor when the cortex of a ferret is rewired such that its visual input is processed by the auditory cortex, do we conclude that the ferret is hearing with its eyes (Sur, 2001). Similarly, if the residual processing that subserves blindsight subjects’ residual awareness were to be of a kind that does not occur, or never reaches awareness, in the normally functioning visual system, then this might warrant the conclusion that type-2 awareness was not visual (Kentridge [this issue] makes a very strong case for this argument).

Again, however, there is some data to suggest that type-2 awareness is based on residual processing of a specific kind that is also found in normal visual processing. Consider the case of motion awareness in blindsight: Hemianopes often experience awareness associated with the presentation of certain kinds of moving stimuli in their blind fields, but that awareness is not mediated by the sort of processing that we might expect it to be. This point has been illustrated very clearly in an intriguing recent study. Azzopardi and Hock (2011) investigated the features of the stimulus on which GY’s residual awareness of motion were based. Using a version of a line-motion illusion, in which a rectangle is presented, followed by the presentation of another rectangle directly above it. A normal subject experiences this as if the first
rectangle were elongating along the line of the second rectangle, creating the illusion of shape change (and therefore of movement). GY was successfully able to discriminate the direction of this illusory shape change in a forced-choice guessing task. Azzopardi and Hock then combined the line-motion illusion with a reverse-phi effect: a motion energy illusion in which two differently coloured rectangles (white and black), were used in the line-motion illusion resulting in a luminance energy change (from dark to light, or light to dark) in the opposite direction from the illusory shape change. Thus, in this second illusion, changes in luminance create the impression of movement in the opposite direction from that created by illusory-shape change (see figure 1). Azzopardi and Hock found that GY’s awareness of illusory motion was based on the energy-motion illusion rather than on the line-motion illusion. That is, GY’s awareness of moving stimuli is not dependent on tracking changes in the position or shape of stimuli presented to the blind field, but rather on spatio-temporal changes in total luminance.

Figure 1 about here

This result shows that GY’s awareness of motion is based on changes in luminance energy and not on tracking features of the object such as its shape. This does not, however, warrant the conclusion that GY’s awareness of motion is somehow “indirect”. The fact that most motion discrimination is based on tracking features of an object and their position over time, does not mean that all visual awareness of motion is mediated by such processing. In fact, there is evidence that the fast visual detection system (Bullier, 2001), which is designed for the quick detection of motion in the environment, relies, in part, on total changes in luminance energy. This system is particularly sensitive to low contrast, moving stimuli and depends on luminance information (as we shall see below, there is good reason to believe that type-2 awareness is only elicited by luminance features of stimuli). In addition, there is evidence that, much like the pathway that is believed to subserve most blindsight functioning (see Leopold 2012), this fast system can be mediated by subcortical projections from the retina, via the superior colliculus and the pulvinar, to the extrastriate cortex by-passing V1 (Lyon, Nassi, & Callaway, 2010).

While all of this is admittedly speculative, it does suggest that blindsight subjects’ awareness of motion may be mediated by the residual functioning of a fast visual detection system, which is also involved in the detection of motion in normal vision. If this is the case, it would seem that a visual pathway, which is performing a role very similar to the one it performs in the normal visual system, mediates type-2 awareness. This is not to say that the visual processing the system can perform has not been seriously degraded both qualitatively and quantitatively (See section 4 and Kentridge (this issue).
for more detail on the nature of the residual processing that subserves type-2 blindsight). Rather, the evidence seems to favour the conclusion that the visual system retains some of its normal functioning after damage to V1, and that it is this residual functioning that leads to type-2 awareness.

Given these considerations, the case can now be stated for holding that, even according to the most stringent objective criterion considered above, type-2 awareness is genuinely visual:

*Blindsight subjects’ type-2 awareness is based on electromagnetic waves (satisfying PSC) that are received within their blind field, processed by their eyes, and projected via preserved subcortical and cortical visual pathways to parts of the subject’s brain that are implicated in visual processing and awareness in normal subjects (satisfying SOC*). In addition, these pathways appear to be performing a function that they also perform in normal visual processing.*

Of course, the objective criteria appealed to here do not jointly suffice for type-2 awareness being visual. Rather, the case being made is that type-2 blindsight satisfies a demanding version of these objective criteria, and that this provides a good, if defeasible, reason to hold that type-2 awareness is a form of visual awareness (albeit radically different from normal visual awareness).

Perhaps, however, we can provide an account of type-2 blindsight that accommodates all of the features outlined above, and leads us to the conclusion that type-2 awareness is non-visual. If so, then we would be no more warranted in claiming that type-2 blindsight is a genuinely visual phenomenon, than we would be in claiming that the subjective criteria discussed earlier warranted the conclusion that it was not. One such account that can accommodate many of the features of this stringent formulation of the objective criteria, while still holding that type-2 blindsight is not characterised by visual awareness, is the ‘cognitive awareness’ account.

4. **Type-2 Blindsight as a Form of Cognitive Awareness**

Perhaps the most common alternative to the visual awareness account is the cognitive awareness account, which claims that type-2 blindsight is characterised by a purely cognitive form of awareness. This awareness comes in the form of a “presentiment” a “hunch” or a “feeling of knowing”. Probably the most developed version of this account, has recently been argued for by Berit Brogaard (2011a, 2011c). Brogaard claims that type-2 blindsight is not visual because it lacks the qualitative processing necessary
for information to enter into working memory and, therefore, cannot become conscious. Brogaard cites evidence that blindsight subjects cannot process information about colour contrast or shape contours in their blind field, claiming that processing in V1 is necessary for both to occur. According to this account, the fact that the visual information is not processed in this way leads to the extrastriate regions being less responsive to that information. Thus preventing the information from entering into working memory and, therefore, from becoming conscious. Blindsight subjects’ reports are not reports of genuinely visual awareness, but rather the result of the global broadcasting of cognitive information, which “...most plausibly is a kind of consciousness that arises from making a correct guess about the location, orientation or color of the stimulus.” (Brogaard, 2011a, pp. 458-9). Thus, blindsight subjects’ awareness is not visual per se, but rather a form of cognitive awareness that coincides with their above chance performance in guessing tasks.

Unlike the argument from the contents of subjects’ experience (section 2.2), Brogaard’s cognitive awareness account does not simply stipulate that type-2 blindsight is not visual in virtue of certain kinds of content not being represented in the subjects’ experience. Rather, it rests on an empirically testable hypothesis that visual information cannot enter working memory if it is not processed in the appropriate fashion. This hypothesis has not, to my knowledge, been tested. However, the claim that type-2 blindsight is characterised by a form of cognitive awareness can still be evaluated. In particular, we should ask whether this explanation can account for data on type-2 awareness, which can be accommodated by the abnormal visual awareness account. If it can, then the cognitive awareness account can accommodate the fact that type-2 blindsight satisfies the objective criterion laid out in the previous section, while still warranting the contrary conclusion that type-2 blindsight is not visual.

On the cognitive awareness account, subjects do not base their performance in type-2 scenarios on weak, radically altered visual awareness. Instead, their awareness is purely cognitive (a hunch or a presentiment) that the subject experiences as a result of their reliably above chance performance in forced-choice guessing tasks. In other words, the subjects’ awareness in type-2 cases is not of the visual information that is guiding their guessing performance, but rather of the performance itself. On this picture, the blindsight subject in type-2 conditions is much like our imagined interioceptor. In this case, the blindsight subject is not aware of anything visual, but rather, of their own reliability in guessing performance. The cognitive awareness account has clear virtues, in that it can explain several features of the phenomenon: It explains why subjects’ awareness lacks the fine-grained detail commonly associated with vision; why blindsight subjects deny that their awareness is a case of seeing; and also why subjects are able to use the information in ways that make it so clear that they are aware of it. In these regards, the cognitive
awareness account provides an equally good account of the phenomenon as the residual visual awareness account does.

However, there are some aspects of blindsight that the cognitive awareness account does not explain so well. First of all, if blindsight subjects’ residual awareness is simply awareness associated with guessing capacity, then it should be correlated with their performance. But this is not always the case. For instance, in early trials DB’s (the subject of most of Weiskrantz’s original experiments) residual awareness affected his performance negatively (Weiskrantz, 2009). Most significant for the argument at hand, however, is the fact that the cognitive awareness account does not explain why certain kinds of stimuli elicit type-2 awareness and others do not. For example, wavelength defined (isoluminant) stimuli do not elicit type-2 awareness in blindsight subjects despite the fact that subjects can perform above chance in forced-choice guessing tasks on the basis of such stimuli (Weiskrantz, 1998).

This effect is not limited to chromatic stimuli, there are also other stimuli of which subjects, no matter how good their performance is, do not report awareness. Sahraie and colleagues (2010) have shown that DB’s reported awareness depends on first-order (luminance defined) stimuli, despite the fact that he can perform above chance with second-order (contrast defined) stimuli in a forced-choice discrimination task (see figure 2). While DB reported awareness of the first-order stimuli at a particular level of stimulus salience, he did not become aware of the second-order stimuli, no matter how strong the stimulus salience was (below the luminance level at which the stimulus might be detectable in the subject’s intact visual field due to the diffuse projection of light from the display). Thus it seems that DB can discriminate between both first-order and second-order stimuli in forced-choice guessing tasks, but that he can only become aware of them on the basis of first-order luminance information.

Given that DB can perform above chance on the basis of the presentation of either stimulus, the cognitive account predicts that they would have type-2 experiences of both kinds of stimuli. However, this is not the case. Instead,

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5 First-order stimuli are luminance-defined, while second-order stimuli are contrast-defined: “a second-order contrast modulated grating is formed by imposing a low-frequency contrast variation (the envelope) onto a high-frequency carrier grating” (Bruce, Green, & Georgeson, 1996, p. 243). It controls for luminance, and instead is based on local contrast between the frequency of the contrast variation in the envelope and in the carrier.
despite the fact that DB’s guessing performance in a forced choice task can be the same for both first-order and second-order stimuli, he only ever reports awareness of first-order stimuli. It is not at all clear that the cognitive awareness account can explain this phenomenon. Note the claim here is not that the cognitive capacities exhibited in type-1 and type-2 scenarios are the same. It is obviously not the case that the subject’s cognitive capacities are matched in both type-1 and type-2 cases. Instead, the issue is that, given that it relies on the claim that the awareness associated with type-2 blindsight is an awareness of guessing performance, the cognitive account cannot explain why DB never reports any awareness of second-order stimuli when he is able to perform above chance in guessing tasks with both first-order and second-order stimuli. The significant point here is that if the subject’s awareness were simply awareness of their guessing performance, then they should report awareness corresponding with their above chance performance with both stimuli. Since DB does not have type-2 awareness of second-order stimuli, we must ask: why not?

The fact that certain stimuli do not elicit awareness in blindsight subjects is easily explained by an account of type-2 blindsight that characterises blindsight subjects’ residual awareness as visual. Sahraie and colleagues suggest that DB’s above-chance performance with second-order stimuli may be due to small luminance cues that, while being below threshold for awareness (due to their size), are not below detection threshold. This would explain why DB’s performance is above chance in both cases, but awareness only occurs with first-order stimuli. This interpretation is supported by the fact that when the luminance cues are increased in the second-order stimuli (by increasing the size of the contrast variation patches), DB suddenly had type-2 awareness of the stimuli.

Thus, In the case of DB’s lack of awareness of second-order stimuli: we can simply say that the subject’s above chance guessing performance is based on luminance information and that, while the luminance cues in the first-order stimuli are sufficiently salient to elicit visual awareness, the cues in the second-order stimuli are only sufficiently salient to facilitate above chance performance in a forced-choice discrimination task. According to this explanation, the reason that the subject cannot have a type-2 experience of the second-order stimulus is because, while the luminance information

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6 The argument here focuses on one study of one patient, but a similar case can be made when it comes to trying to explain why subjects have type-2 awareness of luminance defined, but never of wavelength defined, stimuli.
available is strong enough to guide the subjects’ forced choice guessing performance, it is not sufficiently salient for the subject to be aware of it.

However, this response is not open to proponents of the cognitive awareness account, since type-2 awareness is meant to be associated with guessing performance, not with a threshold for the reportability of the visual information. The hypothesis that the subjects’ awareness is simply cognitive awareness associated with guessing performance, provides no obvious explanation of why second-order stimuli do not elicit awareness. This is because guessing performance can be equally good with both first-order and second-order stimuli. Given the fact that guessing performance is equivalent with both stimuli, the cognitive awareness account predicts that the subject would be aware of both stimuli. Thus, an account of type-2 blindsight as cognitive awareness associated with guessing performance does not explain important details of the phenomenon, which the theory that type-2 awareness is characterized by abnormal visual awareness does.

While the cognitive awareness account purports to offer an alternative to the abnormal visual awareness account, it struggles to accommodate this and other important features of the phenomenon. Thus, although the cognitive awareness account seems to satisfy the objective criteria, outlined in section 3, further investigation suggests that it does not offer a viable alternative to the claim that type-2 blindsight is characterized by abnormal visual awareness and is therefore a genuinely visual phenomenon.

Conclusion

The goal of this paper has not been to argue that type-2 blindsight must be characterised as visual. Rather, the claim has been that, based on our current knowledge, the most parsimonious explanation of the phenomenon is that type-2 awareness is visual. It was argued that type-2 awareness satisfies objective criteria for being visual, while the arguments to the contrary, based on subjective criteria, fail to provide us with a compelling reason to hold that type-2 blindsight should not be counted as visual. In addition, the alternative proposal (that type-2 awareness is a form of cognitive awareness) cannot account for important features of the phenomenon that are easily explained once we accept that type-2 awareness is a form of abnormal visual awareness.

The considerations of the previous sections suggest an interesting possibility: that blindsight capacity is entirely mediated by first-order luminance and wavelength information; and that only luminance information can elicit type-2 awareness in blindsight subjects. There does seem to be converging evidence that, at least following injury to the developed adult brain, damage to V1 can eliminate the capacity to process information that might be
necessary for making discriminations about contour, colour, texture, and figure-ground contrasts (Alexander & Cowey, 2010, 2013; Kentridge, Heywood, & Weiskrantz, 2007; Pavan, Alexander, Campana, & Cowey, 2011; Sahraie, Hibbard, Trevelathan, Ritchie, & Weiskrantz, 2010). If this is the case then it is a very interesting topic for research that could lead to important insights about the phenomenon and the residual processing that subserves blindsight subjects’ capacities. One possibility, discussed briefly in section 3, is that type-2 blindsight might be subserved by processing in a luminance based fast-detection system, which is designed to detect sudden movement in the environment on the basis of changes in luminance rather than shape information. This would suggest that type-2 awareness is a very basic form of visual awareness, of a very specific form of visually processed information, processed for a specialised task (the identification of sudden movement in the environment). However, this is only one possible explanation and it may turn out that type-2 blindsight is not subserved by any such processing.

It could be the case, for example, that type-2 awareness is actually awareness of an efference copy or some other form of motor awareness, and thus genuinely non-visual. But this would have to be determined by further empirical research. As it stands, there is currently more evidence in favour characterising type-2 blindsight as involving visual awareness than for not characterising it as such. What consequences follow from this point is a difficult question, which will have to be addressed elsewhere. As was mentioned in the introduction, important issues hang on whether or not type-2 blindsight is genuinely visual. However, none of these issues are simply resolved by virtue of answering the question of whether type-2 awareness is visual. Instead this paper has sought to lay the foundations on which such investigations can explore the consequences of type-2 blindsight being a genuinely visual phenomenon.

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Bibliography


Macpherson. (n.d.). The Structure of Experience, the Nature of the Visual, and Type 2 Blindsight. *Consciousness and Cognition, (This Issue).*


Silvanto, J. (n.d.). From the Rearview Mirror: blindsight, V1, and visual awareness. *Consciousness and Cognition, (This Issue).*


Figure Legends:

Figure 1:
Two-frame sequences in which motion is specified by shape change or motion energy. Experiment 1: Each panel illustrates the alternatives presented in random order in two-alternative forced-choice trials. Standard line motion stimulus for which the direction of motion specified by shape change and motion energy is the same for trials with shape extension (A) and trials with shape contraction (B). Experiment 2: Reverse-phi version of the line motion stimulus for which shape change and motion energy specify motion in opposite directions for trials with shape extension (C) and trials with shape contraction (D) (from Azzopardi & Hock, 2011).
Figure 2:
Examples of (A) a sine-wave luminance-defined first-order Gabor patch and (B) a second-order contrast-defined stimulus (from Sahraie, Hibbard, Trevethan, Ritchie, & Weiskrantz, 2010)
The Line Motion Illusion

Figure 1: Azzopardi P, and Hock H S PNAS 2011;108:876-881
Figure 2 Sahraie A et al. PNAS 2010;107:21217-21222