Original Article

The Role of Experience in Demonstrative Thought

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Abstract:

Attention plays a role in demonstrative thought: it sets the targets. Visual experience also plays a role. I argue here that it makes visual information available for use in the voluntary control of focal attention. To do so I use both introspection and neurophysiological evidence from projections between areas of attentional control and NCCs. Campbell and Smithies also identify roles for experience, but they further argue that only experience can play those roles. In contrast, I argue that experience is not the only way in which visual information could be accessed for the voluntary control of attention.

Keywords:

attention, demonstrative thought, experience, neural correlates, access consciousness

1. INTRODUCTION

Seeing an object allows you to think of it directly, in a way that doesn't require conceptualizing it or thinking of it via a name or description (see, e.g., Campbell, 2002; Pylyshyn, 2007). For example, say you have a clear view of a red ball.[1] Just by focusing your attention on the ball you seem thereby to be able to think about it. These thoughts would naturally be expressed with a demonstrative term like 'that'. For example, you might judge '*That's* red', wonder 'Whose is *that*?', or believe '*That's* my lost ball' (all said while pointing to the ball). These are often called *demonstrative thoughts*, but I will call them *vision-based thoughts* to avoid suggesting that the thoughts themselves involve demonstrative-like mental representations. Although a common view, it is controversial (Millikan, 2012).

Seeing is typically conscious: it typically involves a visual experience of the seen object. Often this is referred to as 'phenomenal consciousness'; you (in alternative jargon) are *phenomenally conscious of* the seen object, you *consciously* perceive it visually, or are *visually aware* of it. For example, you have a visual experience of some particular red ball when you see

[1] Although my discussion is framed in terms of seeing objects, it's meant to apply to seeing properties, events, locations, and whatever else is perceptible through vision.

it and there's something it's like to see it, or (alternatively put) there's some way the red ball is (or *looks*) to you visually. Visual experience involves a subjective felt quality. To help further narrow down the experiential aspects, we can note that your visual experience of the ball (what it's like to see it) changes depending on the lighting, your relative position, and other contextual factors. Likewise, consciously seeing two objects that differ in color or shape (to give two examples) will, unsurprisingly, lead to visual experiences that differ in corresponding ways. Phenomenal consciousness is, of course, different from access and self-consciousness.

A plausible suggestion is that visual experience plays some functional role in vision-based thought. This is plausible, on a first pass, because vision-based thought does not seem possible in known cases of unconscious seeing, specifically blindsight. A second plausible suggestion is that voluntary focal attention plays a role as well.[2] Specifically, in many cases voluntary focal attention plays the target-setting role in vision-based thought: you set the targets of vision-based thought by voluntarily and focally attending to them.[3] In this paper I give and defend an account of visual experience's role in vision-based thought, situating it within the broader role of voluntary focal attention. My view is that the functional role of visual experience is to make visual information available for use in the voluntary control of focal attention.[4] While my claim that visual experience plays this attention-guiding role is likely to be accepted by many, I make three contributions.

First, I articulate the claim more clearly and in a more neutral way than before. So far as I am aware, only John Campbell (2011) has explicitly suggested that visual experience plays the attention-guiding role. His discussion is situated within a particular theory of visual attention and focuses on the extraneous question of whether visual experience is rich or sparse and on its epistemic role. Second, I present introspective and neurophysiological evidence for the claim which has not been discussed before. These two lines of evidence dovetail to make a compelling case for the claim that visual experience plays the attention-guiding role. Third, I highlight an important feature of the attention-guiding role. Campbell (as just mentioned) and Declan Smithies have well known work in which they also present a view on the functional role of visual experience in vision-based thought. On their views, the role of visual experience can *only* be filled by visual experience, thus making it necessary for vision-based thought (Campbell, 2002; Smithies, 2011a, 2011b).[5] I shall argue that other things besides visual experience can fill the attention-guiding role. Thus, if visual experience is necessary for vision-based thought, it's not necessary because of its attention-guiding role. I will not argue here that visual experience only plays the attention-guiding role or that it's not necessary for vision-based thought.

The structure of this paper is as follows. First, §2 overviews the claim that voluntary focal attention sets the targets of vision-based thought. Then §3 explains how blindsight cases suggest that visual experience plays a role at all in vision-based thought. Next, §4 presents introspective and neurophysiological evidence that visual experience plays the attention-guiding role. After that §5 raises and responds to two objections. My proposal is contrasted with

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[2] The term 'focal attention' is from Pylyshyn (2007, p. 59). It's attention which is focused on a single object, as opposed to being divided among several objects.
[3] I've adopted the term 'target' from Johnston (2011, p. 173). Talk of the 'target-setting role' I've taken from Smithies (2011b, p. 15).
[4] Kriegel (2004) and Milner and Goodale (2006) have made the more general claim that experience makes perceptual information available for use in cognitive functions.
[5] Valberg (1992), Johnston (2006), Siegel (2006) and Dickie (2011) all also suggest that visual experience is necessary for vision-based thought. Kelly (2004) and Wu (2011b) reject this necessity claim.

Campbell and Smithies' proposals in §6. Finally, §7 turns to the question of whether only experience can play the attention-guiding role.

2. PRELIMINARIES: ATTENTION AND TARGET SETTING

Seeing an object normally allows you to think of it in the sense that it allows you to *select* it for thought. Of course, the selecting isn't intentional or its own deliberate act. When you look at a red ball and think the thought naturally expressed '*That*'s red' you don't first do the separate act of selecting the ball. You just look at the ball and think the thought. But there must be something which fixes the ball as the target, or subject, to which the property *red* is predicated. It's your voluntary focal attention to the ball which fixes it as that target.

Seeing an object allows you to think of it directly. In some thoughts the target is selected indirectly. The thought involves a concept with descriptive content (e.g., the-red-ball-two-feet-to-the-left) and what fixes an object as the target is that it satisfies the conditions encoded in that description. But vision-based thought is different. When you think the thought expressed by '*That's* red' what makes the seen ball the target is not that it satisfies some encoded description. Instead, it's that it stands in some relation to you. Vision-based thought is what's often called relational, or singular, thought (Jeshion, 2010a). So voluntary focal attention sets the targets of vision-based thought by being the relation in virtue of which an object is the target of a vision-based thought.

Although seeing also relates you to the objects seen, at any one time you usually are seeing more than one object. Hence, at any one time you will stand in the seeing relation to multiple objects; so the seeing relation will not fix a unique target of thought. Joseph Levine has suggested that a similar problem arises with attention (2010, p. 178). He points out that attention is often directed towards multiple objects at once. There's good evidence that even when we try to focus attention on one object, our attention spreads over multiple objects. This evidence includes fMRI data on neural modulation (Datta & DeYoe, 2009) and behavioral data on reaction time (Kravitz & Behrmann, 2011). The way around this problem is to distinguish between voluntary and involuntary attention. The evidence from neural modulation and reaction time all concerns involuntary attention. There is no evidence that the attention we voluntarily control cannot be focused on a single object. Although we can divide voluntary attention over multiple objects (Pylyshyn, 2007), simple introspection of our everyday abilities suggests that it can also be focused on one.

Attention can be allocated to objects (and properties of objects and locations) deliberately, or an object might involuntarily 'grab' attention.[6] The first case, usually called *endogenous* or *voluntary* attention, is exemplified in visual search tasks. For example, you might voluntarily shift attention between objects (e.g., a mix of red and blue 'A' and 'B') in a display looking for those with some distinguishing features (e.g., a blue 'B'). The second case, usually called *exogenous* or *involuntary* attention, is exemplified in cases in which you are distracted by a sudden bright flash or loud bang. Here the object grabs attention because of high salience or sudden movement. There's substantial theoretical work on the differences between these two modes of attention, but they aren't pertinent here (see, e.g., Carrasco, 2011, pp. 1485—89).

[6] Attention is a state or action of an organism directed at some target (Allport, 2011). Attention functions as a means of selecting (Carrasco, 2011; Pylyshyn, 2007), divides the visual field into foreground and background (Watzl, 2011), and increases the apparent contrast of what's seen (Carrasco et al., 2004; Wu, 2011b). Attention itself should be distinguished from cognitive and neural processes which underlie it (Mole et al., 2011).

From here on I will assume that voluntary focal attention is the target-setting relation exploited in vision-based thought. There are some who would likely take issue with the claim (Levine, 2010, p. 178), but many endorse it (Campbell, 2002; Dickie, 2011; Wu, 2011a). The main alternative is the dominant causal source view (Evans, 1982; Raftopoulos & Müller, 2006), although most proponents of this view run the two together. It holds that vision-based thought involves the tokening of a mental demonstrative which is, or is a label for, a mental file (Bach, 1987; Dickie, 2010; Jeshion, 2010b; Recanati, 2012). A *mental file* is functionally defined as a collection of information or beliefs which our cognitive processes treat as being about the same thing (Dickie, 2010, p. 222). A mental file refers to what it's about, and it's usually assumed to be about the dominant causal source of information in the file. On one possible view there is a special-purpose temporary file that's opened to store incoming perceptual information and closed (and reopened) as what's being perceived changes. This file is the mental demonstrative tokened (by closing and opening the file) in vision-based thought. Being the dominant causal source of information contained in it is a way of relating to this special-purpose file, i.e. this vision-based mental demonstrative. This relation, according to the dominant causal source view, is what's exploited in perception-based thought (see also Barkasi, 2015, p. 49).

3. PRELIMINARIES: ACTUAL BLINDSIGHTERS AND INITIAL MOTIVATION

Granting that voluntary focal attention is the target-setting relation exploited in vision-based thought, why think that visual experience plays a role at all? Initial motivation comes from the fact that nonconscious seeing—seeing without visual experience—doesn't seem to allow for vision-based thought. Nonconscious seeing is just seeing without accompanying visual experience of the seen object. But it might be difficult to imagine what this would be like, or if the idea is even coherent. If there's no visual experience, then in what sense is the object seen? It turns out there are individuals with a condition, called blindsight, giving them something very much like nonconscious seeing (Brogaard, 2011).[7]

What is blindsight?[8] In humans and other primates about 90% of the ganglion cells projecting from the retina synapse into the dorsal lateral geniculate nucleus, which in turn projects into V1, the primary visual cortex (Weiskrantz, 2009, p. 67). This is called the central visual or geniculo-striate pathway. V1 itself is just the start of a large network of interconnected cortical areas responsible for processing visual information. As Weiskrantz reports (2009, p. 69), in humans 'destruction of [V1] — through strokes, tumours, disease, or accident — characteristically causes blindness in that part of the visual field' to which the damaged portion of V1 maps topographically. But in cases in which the damage is restricted to V1 (leaving the areas of visual processing beyond it intact) some residual visual functioning sometimes still remains, leading to a loose collection of abilities (2009, p. 52). *Blindsight* cases are ones that involve this residual functioning despite a loss of visual experience from V1 damage.[9]

For example, in some experiments D.B. (one of the original patients, studied by Weiskrantz) was shown a flash in the blind patch of his visual field. Although he could not see the flash, afterwards he was asked to *guess* its location by either directing his gaze or pointing to

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[7] More controversial examples of nonconscious seeing include unilateral neglect, attentional blink, and inattentional blindness (Prinz, 2011).

[8] This material is based on (Weiskrantz, 2009).

[9] It should be noted that this isn't an uncontroversial interpretation of blindsight. As Phillips (2016) and others discuss, there is reason to doubt that blindsighters really lack all visual experience of things in their blind field. If these criticisms are correct, then blindsight won't be a case of nonconscious seeing. Weiskrantz replies to some of these issues (2009, pp. 21, 57, 208).

it (Weiskrantz, 2009, p. 87). Similarly, in another set of experiments D.B. was asked to guess the orientation of lines that were flashed in his blindspot. D.B. could do the location tasks with ‘striking’ accuracy (2009, p. 90) and the orientation task ‘well above chance levels’ (2009, p. 91). These and similar results have been replicated many times both with D.B. and with other patients with blindness caused by V1 damage. When prompted to guess from a limited set of choices these blindsighters can reliably identify the ‘orientation, location, spatial frequency, wavelength, movement, and flicker’ of objects in their blindspots (2009, p. 53), along with color (2009, p. 40) and perhaps form and shape as well (2009, p. 17).

The standard interpretation of blindsight is that the residual visual functioning is explained by the small portion of the optic nerve that lies outside the central visual pathway. Ganglion cells from the retina outside this pathway project to extrastriate cortex (V2—V5), inferior temporal cortex, and subcortical regions via nine or ten other pathways (Weiskrantz, 2009, pp. 51, 69). These pathways bypass the damage in V1 and project directly to higher areas of visual processing. The idea is that V1 must be necessary for conscious seeing, but these additional pathways from the retina to higher visual areas facilitate some level of visual processing. While not leading to conscious seeing, this processing still allows for some limited forms of function. More theoretically, it seems that while objects within the blindspot aren’t consciously seen, there are still visual states which represent those objects and have some influence over behavior (Block, 1995, p. 230). This provides a general way to understand nonconscious seeing: it happens when there’s some level of visual processing of sensory input (leading to what count as visual states with representational content), but that processing for whatever reason does not lead to visual experience of the seen objects.

Imagining what it would be like to be a blindsighter suggests that you cannot have vision-based thoughts about objects in the blindspot (Campbell, 2002; Johnston, 2006; Smithies, 2011b). Imagine that there is an object in front of you that—as it would be natural to say—you could not *see*. More precisely, you have no visual experience of it. In this case it seems clear that you cannot think vision-based thoughts about the object. Now imagine that, like a blindsighter, given choices about basic features of the object and asked to guess you reliably guess the correct answer. Perhaps this happens because, like in blindsight, some amount of visual processing is restored. So, you see the object (you have what count as visual states with representational content) but lack visual experience. It’s plausible that you still cannot have vision-based thoughts about the object (although see Kelly, 2004). But if vision-based thought isn’t possible in these cases, then it’s plausible that visual experience plays some functional role in vision-based thought. Of course, Blindsighters lack both experience and access consciousness, so it might be the lack of access consciousness that’s the problem. Still, these considerations provide some *initial* motivation.

4. EVIDENCE FOR THE ATTENTION-GUIDING ROLE

There is good evidence that visual experience plays the attention-guiding role. That is, visual experience makes visual information available for use in the voluntary control of attention. For example, say you deliberately shift your attention from one seen object to another, or deliberately hold attention on a seen object as it moves past you. It’s your visual experience which makes you aware of the objects as potential targets of attention. You know the direction in which to move your eyes (or your head) to keep the object foveated based on visual experience.

There are two lines of evidence: one introspective, the other neurophysiological. Note that both are merely supportive or suggestive. My claim is not that the attention-guiding role is entailed by this evidence; my aim here is to present two pieces of evidence which, taken separately and together, raise the probability that visual experience plays the attention-guiding role.

4.1. Introspective evidence

Introspecting what it's like in some cases of voluntary attention strongly suggests that you rely on information available from visual experience. Consider two examples. The first is visual search of the kind already mentioned. In searching through a display of a mix of red and blue 'A' and 'B' your attention shifts from one item to another. But each time you make a shift, it seems, you direct the shift to the next item using your visual experience. You know the direction in which to move your eyes based on your visual experience—or so it introspectively seems. What it's like to make the shift is that you have a visual experience of a red 'A' being a few degrees in some direction from your current focus and you shift to *that*, the experienced red 'A'. You know the direction in which to shift, when to stop, and how to hold attention all based on your visual experience of the 'A'. The second example is voluntarily tracking an object, e.g. a red ball as it rolls past you. Tracking the ball requires holding attention on it. But it seems, introspectively, as if you rely on your visual experience of the ball to do that.

But what if you engage in visual search and visual tracking and don't introspectively find any use of experience? In that case Susanna Siegel's method (2007) using contrast cases provides an indirect way to use introspection to support the attention-guiding role. As applied here, in this method a pair of cases is presented which everyone can agree differ introspectively in a specific way. Then it's argued that the best explanation of that agreed introspectable difference presupposes that (in at least one of the two cases) experience provides information you use to guide attention. The contrasting cases along with the best explanation of their introspectable difference support the use of experience-based information in guiding attention in at least one of the cases.

[Figure 1 about here.

FIGURE 1 Array of dots for tasks 1 and 2.]

The contrasting examples I will use each involve a single attentional shift between dots in figure 1. For these tasks the array should be a distance which puts the inner circle with its dots only a few degrees of visual arch from the center dot. So, the dots on the inner circle should be comfortably visible while the dots on the outer circle are towards the edge of your visual periphery. The contrasting examples are:

> **TASK 1:** Foveate the center of the array and hold attention on the center dot. Pick a dot on the inner circle and shift your attention, either covertly or overtly, between the center and that dot.
>
> **TASK 2:** With the array still at the same distance from you, this time pick a dot on the outer circle and shift your attention, either covertly or overtly, between the center and that dot.

The introspectable difference between the two tasks—the way they contrast—is their difficulty. Everyone should agree that shifting attention from the center to a nearby dot (task 1) is easy, while shifting attention from the center to a distant dot on the periphery (task 2) is difficult.[10] The resolution with which you can localize new targets of attention goes down as you go out to the periphery. For example, it's easier to shift attention to the top single peripheral dot than to shift attention to one of the three dots in the lower-left peripheral dot cluster. Of course, we could empirically test these claims about difficulty, but introspection yields robust enough differences to serve the purpose here.

A plausible explanation for this introspectable difference is that you are able to rely on your visual experience of the dots to make the shift to the inner circle. While foveating the center, the dots on the inner circle are all still clearly available in your visual experience, which provides rich, easily accessed information about their location. But as is well known, visual experience in the periphery is much less detailed. This degradation makes it so that you can't rely at all on visual experience to guide the shift to the outer dots, or, if you can, there is simply less information available. What's important is that this explanation presupposes that visual experience plays the attention-guiding role. Visual experience is at least used to guide the short-range shift in task 1 and its degradation towards the periphery explains why the long-range shift in task 2 is more difficult: either experience provides no or very limited information.

What are the alternatives? Plausibly, any explanation will have to ground the difficulty in the source of information guiding the shifts. There are three possible sources: (1) information from visual experience, (2) nonconscious visual information, the kind processed in the dorsal stream and used to execute visually guided movements, and (3) previous visual information from memory. A preliminary point is that while nonconscious visual information also degrades in the periphery, it doesn't degrade as much. Support for this comes from studies which show that visually guided action (e.g., reaching and grasping), which is supported by this nonconscious visual information, degrades less than visually guided judgments (e.g., estimating object size), which is supported by visual experience (Brown et al., 2005). In addition, it's known that the dorsal stream, which underlies nonconscious visual processing, devotes proportionately more cortical area to the periphery than does the ventral stream, which underlies visual experience (Gattass et al., 2005; Sheth & Young, 2016).

So it's possible to explain the difference in difficulty by appealing to nonconscious visual information, since it too degrades. But whether this explanation is plausible will depend on just how much nonconscious visual information degrades at the periphery. How that degradation compares to the degradation seen in visual experience and how the two curves compare to the increase in difficulty of the task will also matter. So far as I know this sort of experimental data isn't available. So we're left to speculate, but given that the degradation is *less* for nonconscious visual information and the long-range shift is *much* more difficult, there's reason to think that the experience-based explanation is more plausible than one appealing only to nonconscious visual information.

That leaves previous visual information stored in memory and some combination of memory and nonconscious visual information. It's implausible from the start that stored visual information guides voluntary attention in the short-range shift. With an abundance of both conscious and nonconscious visual information available, why think you make no use of it and instead use information stored in memory? But if the short-range shift of task 1 isn't guided by

[10] It's easy to shift attention in the rough direction of the peripheral dots. With the peripheral dots then in center view you can easily attend to one of them. But this shift-then-select strategy isn't task 2; task 2 is to shift directly to the dots.

stored visual information, we're left with the above considerations which slightly favor the experience-based explanation.

A final consideration is that the difference in difficulty might have nothing to do with the source of information guiding the shifts. Perhaps the phenomenology of attentional shifts is just such that longer shifts feel more difficult. While this suggestion might account for the general increase in difficulty from short- to long-range shifts, it doesn't account for the changes in difficulty in resolving dots at the same distance. The long-range shift to the single dot at the top of the outer circles feels harder than the short-range shift to the single dot at the bottom of the inner circle. But also the long-range shift to one of the three dots in the cluster on the bottom-left of the outer circle feels harder than the long-range shift to the single dot at the top of the outer circle. If there was a bare phenomenal feel of difficulty that varies with the range of the shift, then we would expect shifts to any dot on the outer circle to feel equally difficult. That long-range shifts to dots crowded in clusters feel harder than long-range shifts to lone dots suggests that the difficulty is explained by the source of information; the less information available for the long-range shift is more of a problem, leading to more exertion, when you also have to shift to a crowded dot in the cluster.

4.2. Neurophysiological evidence

The second line of evidence comes from work on the neural correlates of visual experience and attentional control in Macaque monkeys. The cortical regions in the brain primarily responsible for the voluntary control of attention are the frontal eye fields (FEF). There is a topographic mapping between the ventrolateral-to-dorsomedial direction of the FEF and the amplitude, or size, of attentional shifts. Roughly, the more dorsomedial regions of the FEF control larger amplitude attentional shifts (attentional shifts to the periphery of the visual field) while more ventrolateral regions control smaller amplitude attentional shifts. Both dorsomedial and ventrolateral FEF receive projections from the dorsal visual stream. Crucially, while the dorsomedial FEF don't receive projections from the ventral visual stream, the ventral visual stream does project to the ventrolateral FEF. Because the ventral stream is associated with conscious seeing, its projecting into the FEF suggests that conscious seeing does provide visual information for use in the voluntary control of attention. The absence of projections from the ventral stream into the dorsomedial FEF further dovetails with the explanation given above for the difference in difficulty. Short-range shifts are guided by information from both ventral and dorsal visual streams (hence, conscious information), while long-range shifts are guided only by dorsal stream information. Now for the details.

The FEF are defined as the areas of cortex in which low-current electrical stimulation (≤ 50μA) produces saccadic eye movements (Bruce et al., 1985, p. 714). In each hemisphere the FEF is located in Walker's areas 8A and 45, within the prearcuate sulcus (Stanton et al., 1989, 416) (see figure 2). Bruce et al. (1985) suggest that its location is restricted to area 45 and only a portion of area 8A, what they call 8Ac. The overall structure and activity of neurons in the FEF support the conclusion that it's one of the primary regions of cortex involved in the voluntary control of eye movements (saccades), but not involved in involuntary eye movement (for one modern study, see Bruce & Goldberg, 1985). The dorsomedial regions of FEF (area 8Ac) are associated with large-amplitude saccades, while the ventrolateral regions (area 45) are associated with small-amplitude saccades (Bruce et al., 1985, pp. 714, 730; Stanton et al., 1989, p. 426). There's no sharp divide between the two regions and their functioning; instead it's a continuous topographic mapping in which areas of the FEF more dorsomedial control longer amplitude saccades than those less dorsomedial.

More importantly, recent work strongly suggests that the FEF are involved not only in saccades, but also in the voluntary control of attentional shifts (Cohen et al., 2009a, 2009b; Heitz et al., 2010; Lee et al., 2012; Ronconi et al., 2014; Schall, 2004; Thompson & Bichot, 2005; Thompson et al., 2005). Some of the neurons in the FEF which respond before saccades make a salience map of the visual field. Bruce and Goldberg (1985) call these *visual cells*, since (1) they respond before a saccade (to their receptive field) only if there's also a visual stimulus within their receptive field, and (2) they also respond to visual stimuli within their receptive fields even when there is no saccade.[11] Unlike other areas of the visual system in which neurons respond selectively to a given feature (e.g., color or edges of certain orientations), these visual neurons respond to visual stimuli based on their salience or behavioral relevance (Thompson & Bichot, 2005). The highest neural responses in these visual neurons correspond to the most salient or relevant stimuli. So the visual neurons within the FEF form a map of the visual field,[12] a given neuron responding to a stimulus within its receptive field when that stimulus is *attended*. The highest responses within this map are from neurons with receptive fields which cover the attended target. This salience map makes the FEF a prime candidate as the main neural region facilitating the voluntary control of attention.

[Figure 2 about here

FIGURE 2 Diagram of Macaque monkey brain showing major areas of visual processing along with dorsal and ventral streams. Frontal eye fields are shaded gray. Adapted from schematic brain outline made available by Ryosuke Niimi on http://rnpsychology.org/demo/index.htm. Labeling based on Schall et al. (1995, fig. 17) and Kravitz et al. (2013, fig. 1).]

V1 is the start of an interconnected set of visual processing areas which divide into two fairly distinct 'streams': a dorsal stream running from V1 in the occipital lobe up into the parietal lobe and a ventral stream running down into the temporal lobe (Goodale & Milner, 1992; Milner & Goodale, 2006; see also Kravitz et al., 2011, 2013) (see figure 2). The dorsal stream processes visuospatial information that's not directly part of the content of visual experience, but still used in the visual guidance of action. The ventral stream, on the other hand, processes object-form information that is part of the content of visual experience (Milner & Goodale, 2006, pp. 221—28). The highest regions of the ventral stream in the IT cortex (areas TEO, TE, and the superior temporal sulcus, STS) are especially good candidate sites for neural correlates of visual experience. For example, in an important single-cell recording study of Macaque monkeys, Sheinberg and Logothetis (1997) showed that the activity of 90% of recorded cells in these areas reliably predicted the visual experience of the animal in cases of binocular rivalry. In contrast, previous studies had showed that activity in only 18% of recorded cells in V1 and 20% and 25% in MT and V4 predicted the animals' visual experience (Sheinberg & Logothetis, 1997, p. 3413; see also Crick & Koch, 1995). Similarly, visual experience in binocular rivalry does not appear to be predicted by activity in the dorsal stream (Milner & Goodale, 2006, p. 225).

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[11] In their survey of 752 FEF neurons, Bruce and Goldberg (1985, p. 608) found that 409, or 54.3%, of the neurons had presaccadic responses. Of these presaccadic cells they studied 115 extensively, finding 46, or 40%, were specifically visual cells.

[12] As noted, this map is topographically organized with respect to the amplitude of the shifts. There is some local organization with respect to shift direction, although no such global organization.

The FEF receive and send projections to numerous cortical and subcortical areas. But what is most relevant here is the distribution of relatively direct projections into the FEF from cortical visual areas, since this gives some indication of the visual information used in the voluntary control of attention. As noted above, the key result is that the highest regions of the ventral stream (IT cortex) project into the FEF at all, specifically to the ventrolateral FEF (area 45) although not into the dorsomedial FEF (area 8Ac) (Kravitz et al., 2013, p. 41). For example, in one tracer study Schall and colleagues found projections into area 45 from ventral stream areas TEa, TE3, TEm, TF, and TEO (Schall et al., 1995, pp. 4466, 4484; see also Schall, 1995, pp. 70, 76). The projection of the highest regions of the ventral stream into the FEF is significant. It suggests information from conscious visual processing is available to the visual neurons within the FEF which select targets of attention. So, it suggests that information from conscious seeing is available and used in the voluntary control of attention. It could have turned out—but didn't—that only dorsal stream areas projected into the FEF.

The dorsal stream projects into the FEF as well, both into the ventrolateral and dorsomedial FEF. The same study found that dorsal stream areas LIPv and LIPd project into both areas 8Ac and 45 (Schall et al., 1995, p. 4483; see also Schall, 1995, p. 70). This is an interesting difference from the ventral stream. No projections into area 8Ac (the dorsomedial FEF) from higher ventral stream areas were found. So it turns out that while both ventral and dorsal stream project into the part of the FEF responsible for short-range shifts, only the dorsal stream projects into the part of the FEF responsible for long-range shifts. This result dovetails with what's seen in the phenomenal contrast. At the neurological level there *is* some difference in the kind of information available for short- and long-range shifts. Perhaps the long-range shift (task 2) is more difficult than the short-range shift (task 1) not only because visual information in general is more degraded at the periphery, but also because content from visual experience isn't available to guide the long-range shift.

It doesn't matter if it turns out the dorsal stream also underlies some parts of conscious visual experience. For example, Wayne Wu (2014) has argued that the egocentric spatial content of visual experience is derived from the dorsal stream. More generally there's long been controversy over whether, and to what extent, the dorsal dream contributes to visual experience. What would tell against the attention-guiding role of visual experience would be for there to be no direct connections between neural correlates of visual experience the neural correlate of voluntary attentional control.

It's also worth noting that the support of these neurophysiological considerations doesn't depend on strong assumptions about the neural correlates of visual experience. For example, although it must be assumed that the IT cortex is in some important way associated with conscious seeing, there's no need to assume that any given visual experience can be localized as activity of just a certain sort within some small region. Likewise, it need not be assumed that the content of a given visual experience matches or is grounded in specific, localizable neural representations within the IT cortex (e.g., Prinz, 2006). The structure of connections between areas of visual processing and the FEF provide support even if the neural correlates of visual experience are widely distributed and visual experience content can't be matched to localizable neural representations.

4.3. A direct test?

Whether visual experience plays the attention-guiding role might be more directly tested. If so, then we should expect inhibition of, or damage to, the ventral stream to correlate with degradation of voluntary control of short-range attentional shifting. This inhibition might also be expected to leave the capacity for voluntary long-range attentional shifting intact. Although there are not, to my knowledge, any present studies along these lines, there are studies of the effects of damage to V4 and (crucially) TEO, the posterior region of the IT cortex, on attention. One study (Buffalo et al., 2005) found that damage to V4 and TEO in Macaques lead to behavioral and neurological changes consistent with a loss in ability to focus attention voluntarily. Specifically, the damage nearly doubled object discrimination thresholds when there were distracters near the target but had no effect on object discrimination thresholds when there were no distracters. Similarly, the same study found that damage to V4 and TEO lead to a loss of attentional filtering effects in area TE (anterior IT cortex) typically observed during attention to an object surrounded by distracters.

5. TWO OBJECTIONS TO THE ATTENTION-GUIDING ROLE

5.1. Access consciousness

An alternative way to put the claim that visual experience plays the attention-guiding role is to say that visual experience provides access consciousness to visual states. At least, it's natural to hear the claim in this way. I think it's a reasonable and convenient interpretation, although once the claim is reframed in terms of access consciousness an immediate problem arises: hasn't Ned Block given cases that involve visual experience without access consciousness? Wouldn't these cases thus show that visual experience does not play the attention-guiding role?

As Block defines it (1995, p. 231), a mental state is *access conscious* if its content is available for use in (1) reasoning, (2) the rational control of action, and (3) the rational control of speech. The claim that visual experience plays the attention-guiding role amounts to saying that visual experience makes the content of your visual states available for use in the rational (or voluntary, as I put it) control of attention. While attention doesn't obviously fall under one of Block's three categories, it is something you do. It's an action that involves both physical and mental components, such as eye movement and mental focus. It's natural to relax Block's criteria and say that a state is access conscious whenever its content is available for use in the rational control of some physical or mental action.[13] In that case, providing visual information for use in the voluntary control of focal attention will count as a form of access consciousness.[14]

Block has given cases that seem to involve visual experience without access consciousness. He suggests that, in Sperling's now well-known experiment, participants have experience, but not access consciousness, of all the letters in the display jointly (Block, 1995, p. 244, but see Prinz, 2011, p. 190). Inattentional and change blindness (see Mack & Rock, 1998; Rensink et al., 1997, 2000) provide other potential examples of experience without access consciousness. In these cases (the suggestion goes) you still have visual experience of the unattended object or masked change, but fail to notice it because the visual state is not access conscious.

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[13] Reasoning is a mental action, and speech is plausibly an action that involves both physical and mental components. As written, Block's criteria makes availability for reasoning specifically a necessary criterion, so dropping that is part of the relaxation.

[14] Nothing here depends on understanding the claim that visual experience plays the attention-guiding role in this way. I mention it because I imagine this interpretation will occur to many readers and the objection that there are cases of visual experience without access consciousness will naturally come to mind.

The objection presses that if these are cases of visual experience without access consciousness, then my proposal is wrong; the cases show that visual experience doesn't provide access consciousness. The reply is that these cases only show that visual experience doesn't provide access consciousness for the specific tasks involved in them. Access consciousness need not be all or nothing (Block, 1995, p. 232). Consider inattentional and change blindness. It might be that visual experience of an unattended object affords a mode of access to the visual content that makes it available for the voluntary control of focal attention, but not available to the cognitive processes involved in these tasks, e.g. working memory. The idea is that a mode of access to visual content might make that content available for some tasks (e.g., the voluntary control of focal attention) but not others (e.g., detecting scene changes). What would be problematic for my proposal is a case in which there's visual experience of seen objects, but no visual information is available for voluntarily guiding attention.

The objection might be pressed one step further. You might ask whether the content of visual experience really is available for the voluntary control of focal attention in cases of inattentional and change blindness. In inattentional blindness it seems that the consciously seen object which you don't notice isn't something to which you can voluntarily attend. Likewise, in a case of change blindness the object you didn't notice (the one introduced in the masked change) is still, presumably, part of your visual experience, but doesn't seem available to voluntary attention.

The reply is that visual experience might make visual information available for use in the voluntary control of attention only once some other preconditions are met. To *voluntarily* attend to an object you have to be able to act deliberately towards it, form some intention about it, or (to put it a third way) already have it in mind. So in cases of inattentional and change blindness visual experience does make objects available for attentional selection, once those objects are noticed in a way which allows you to intend them as the target of attention. (Noticing the object doesn't require voluntary attention to it; you may notice it through involuntary attention.) There are preconditions for any voluntary act and the control of attention is no different. It might be that visual experience of an object doesn't automatically satisfy all these preconditions, e.g. it may not guarantee that working memory has access to the relevant visual content. But once those preconditions are satisfied, it's visual experience which makes seen objects available for voluntary attention.

5.2. Phenomenal properties

It might be objected that the presented evidence only supports that the higher regions of the ventral stream play the attention-guiding role. It's a further step to say that visual experiences correlating with neural activity in these areas themselves play the attention-guiding role. And, even if the neurophysiological evidence did show that visual experiences play the attention-guiding role, there would still be a problem. As Kriegel (2004) points out, showing that visual experiences play a given functional role is not enough to show that they do so in virtue of their experiential aspects. There is a difference between a visual experience and its *phenomenal properties*. The phenomenal properties of a visual experience are those features of it in virtue of which it's phenomenally conscious (Chalmers, 2006). Even if it's granted that visual experiences themselves fill the attention-guiding role, it may be in virtue of other features (e.g., their underlying neurophysiology) that they manage to make visual information available for use in the voluntary control of attention. The phenomenal properties of visual experiences may be idle with respect to this functional role.

The objection raises a serious issue, but is aimed at a strawman. Recall that the neurophysiological evidence isn't being given as part of a deductive argument for the attention-guiding role of visual experience. Instead, the neurophysiological facts are presented here as interesting and compelling evidence that visual experience plays the attention-guiding role. Even acknowledging the gap between the neural correlates of visual experience and visual experience itself, and the further gap between visual experiences and their phenomenal properties, the neurophysiological facts *do* support visual experiences and their phenomenal properties playing the attention-guiding role. That the neurophysiological facts dovetail with the introspective evidence, both suggesting a difference in how short-vs-long attention shifts are controlled, makes the evidence all the more compelling.

The objection also amounts to an unreasonable demand. It uses the two-step gap to undercut neurophysiological evidence for the functional role of visual experience. But the only way to respond to such an objection is to close the gaps by giving some account of the metaphysics of visual experiences and their phenomenal properties. So, if the objection carried weight, that would mean that neurophysiological facts could be relevant to the role of visual experience only if this metaphysical account is already given. But surely that's too strong a demand; using neurophysiological results doesn't require first defending an account of the metaphysics of visual experiences.

6. TWO ALTERNATIVE PROPOSALS

Both Campbell (1997, 2002, 2004, 2011) and Smithies (2011b) have also provided accounts of visual experience's role in vision-based thought. On Smithies' account, experience plays an epistemic role. Specifically, 'it enables subjects to use demonstrative concepts in forming immediately justified beliefs about objects in the world around them' (2011b, p. 19). I'm going to set Smithies' account aside. Even without details it's clear how the account differs from mine: experience plays some role in belief justification, while on mine it sets the targets of thought. Further, the two accounts are not necessarily competing. Experience could play both an epistemic and target-setting role.

On the other hand, Campbell's account (as Smithies notes) also gives experience a target-setting role. A complication is that Campbell often frames his work as explaining how we know the referents of demonstrative terms, instead of how we select targets for vision-based thought. Because he seems to run these two together, for the sake of explication I'll do the same.[15]

His account assumes that your knowledge of the referents of demonstrative terms, and presumably your selection of targets in vision-based thought, 'is what causes and justifies the use of particular procedures to verify and find the implications of propositions containing the demonstrative' (Campbell, 2002, p. 25). So, whatever provides this knowledge, or allows for selection of targets in vision-based thought, must be the sort of thing which can fill this functional role of causing and justifying the use of verification procedures. Campbell claims that what fills this role is 'conscious attention' to the target (2002, p. 25, 2004, p. 268). By 'conscious attention' Campbell seems to mean voluntary attention to consciously seen objects. Hence, it

[15] Campbell oscillates between talking about three distinct things: (1) experience's role in vision-based thought (2002, p. 114), (2) experience's role in providing perception- or acquaintance-based concepts (2002, pp. 123, 138), and (3) experience's role in providing knowledge of the referents of demonstrative terms (2002, p. 8). Some interpret Campbell as having vision-based thought in mind (e.g., Clark, 2006; Smithies, 2011b), while others take him to have in mind experience's role in providing perception- or acquaintance-based concepts (e.g., Cassam, 2011; Roessler, 2011).

follows that voluntary attention to experienced objects provides knowledge of the referents of demonstrative terms and allows for selection in vision-based thought.

So far Campbell's account looks like mine. I also claim that it's voluntary attention to experienced objects which sets the targets of vision-based thought. But because Campbell makes this assumption about the functional role of whatever sets the targets in vision-based thought, he incurs the burden of explaining how voluntary attention to experienced objects causes and justifies verification procedures. To do so, he gives a detailed account of how this happens based on Treisman's work on attention and feature binding (Kahneman et al., 1992; Treisman, 1998; Treisman & Gelade, 1980). My account differs from Campbell's in that I don't accept the assumption that whatever fills the target-setting role must also be what causes and justifies verification procedures. So I don't try to give an account of how voluntary attention to experienced objects might do so, nor does my account assume Treisman's work on feature binding.

At least in his earlier work (2002; 2004), Campbell specifies that voluntary attention to experienced objects plays the target-setting role, but isn't careful to specify the specific role of visual experience itself. I claim that visual experience has the specific role of making information available for use in voluntarily guiding attention. Where Campbell does focus on the role of experience itself,[16] he focuses on its role in providing perception- or acquaintance-based concepts. So, a second way in which our accounts differ is that I further specify the role of experience itself within the broader target-setting role of voluntary attention.

In later work (2011) Campbell does clearly specify the role of experience itself within attention. Here his account sounds similar to mine. He says (2011, p. 330) that 'Experience of [a] property is what makes it possible for that property to be used as the basis for [attentional] selection of a region or object.' While it's not clear that this is the same as saying that visual experience has the attention-guiding role, the differences are not substantial. Still, there are two points of difference worth noting. First, Campbell's discussion is situated within a particular theory of visual attention from Huang and Pashler (2007). I've developed the claim that visual experience plays the attention-guiding role free from any substantial theory of visual attention. Second, Campbell holds that only visual experience can play this attention-guiding role. In contrast, I now argue that nonconscious seeing (as in blindsight) could also play that role as well.

7. IS VISUAL EXPERIENCE NECESSARY?

Given its attention-guiding role, is visual experience necessary for vision-based thought? Or, is access consciousness to visual information enough?[17] More precisely:

> Necessity Question: Relative to some set of counterfactual circumstances, if you take away the experience in some instance of visually perceiving an object, but add back some other mode of access consciousness to the visual content consistent with the counterfactual circumstances, would you restore vision-based thought?

The necessity question has two parameters: (1) the set of counterfactual circumstances which provide the modal force, and (2) the mode of access consciousness being restored. The mode of access consciousness needs to be specified because there are a variety of mechanisms by which you could have access consciousness (Block, 1995, p. 232). Some of these could allow for

[16] See chapter 7 of his (2002).

[17] Smithies (2011b) also clearly separates the question of visual experience's role from the question of whether visual experience is the only thing which could play that role. He argues that his proposed epistemic role can only be played by visual experience (see also his 2011a).

vision-based thought while others do not. The counterfactual circumstances need to be specified because they constrain the modes of access. For example, some modes of access might be metaphysically or conceptually possible, but not possible given human neurophysiological structure and cognitive functioning. In addition, some modes of access may not allow for vision-based thought given actual human neurophysiological structure and cognitive functioning, but may suffice in other circumstances.

Whatever the parameters, the answer to the necessity question will depend on the functional roles played by visual experience. If there's a mode (or modes) of access consciousness which can play all those roles, then you would restore vision-based thought if those (presumably non-actual) modes were added back. In what follows I'll consider only the attention-guiding role and whether there are modes of access consciousness besides visual experience which can fill it.

Super blindsighters provide a standard way to frame the question and set the parameters (Campbell, 2002). A super blindsighter, as Block images them (1995), is a blindsighter who has access consciousness to visual content from her blindspot. While a normal blindsighter is only able to answer accurately questions about things in her blindspot when given a small set of choices from which to guess, a super blindsighter is able to prompt herself to make spontaneous guesses (i.e., without choices) about what's in her blindspot. The super blindsighter can do this in response to a variety of needs, e.g. as a means to identify what is in the location of her blindspot or as a means to navigate around the environment. So the super blindsighter might simply wonder about what is in her blindspot and answer the question by making a spontaneous guess ('it's a red ball'). Or, she might spontaneously guess about whether and (if so) precisely how to turn to avoid an obstacle.

We can ask whether a super blindsighter could have vision-based thought about objects in her blindspot. Although some disagree (e.g., Kelly, 2004), the usual intuition gotten by imagining what it would be like to be a super blindsighter is that, even allowing for all metaphysically or conceptually possible circumstances, having access to visual content from the blindspot through self-prompted spontaneous guessing would not allow for vision-based thought about objects in the blindspot. Assuming visual experience plays the attention-guiding role, if super blindsighters lack vision-based thought, then it might be because self-prompted spontaneous guessing is not a mode of access consciousness which makes visual information available for use in the voluntary control of attention. I think it's plausible that this is correct. If you imagine what it's like to be a super blindsighter, it doesn't seem possible to focus attention voluntarily on objects within the blind field. Self-prompted spontaneous guessing doesn't make visual information available in that way.

Although self-prompted spontaneous guessing doesn't allow for the use of visual information in the voluntary control of attention, two empirical facts suggest other modes of access consciousness might allow for it. The first is that the FEF receive projections not just from the ventral stream, but also from the dorsal stream. If dorsal stream processing is left intact after a loss of visual experience, then there will still be a source of visual information for the FEF. The second fact is that the areas within the ventral stream itself are heavily interconnected; similarly, the ventral and dorsal streams are heavily interconnected (Kravitz et al., 2013, p. 29). These interconnections suggest that even when conscious seeing is not functioning normally, associated information is still available to the FEF.

The upshot is that the FEF still potentially have access to a wealth of visual information even in the absence of visual experience. Of course, it's true that this potential availability doesn't allow for the voluntary control of attention in blindsight, the known case of nonconscious seeing.[18] But that doesn't preclude the possibility of devising tricks or methods—alternatives to forced-choice guessing and self-prompted spontaneous guessing—which enable blindsighters to use effectively this visual information. What's interesting is that there is the right sort of neural connectivity to the FEF to potentially allow for the voluntary control of attention.

It may be that these dorsal stream and indirect ventral stream connections could not facilitate control of voluntary attention. Perhaps the FEF require direct access to the ventral stream. So far as I know there is no empirical data supporting one side or the other. Still, we might speculate about a mode of access consciousness which could use, or could be facilitated by, these connections. After all, before the forced-choice guessing procedure was developed blindsighters were unable to use their residual visual processing to identify features within their blind field. Perhaps there is a procedure which would allow for voluntary attentional control.

This procedure might be something like forced-attempt attentional shifting. We might imagine asking a blindsighter to shift attention to the highest object in her blind field, or to the middle object. As in real blindsight with forced-choice guessing, the blindsighter will presumably protest that she can't follow the instruction. But we might find that, if she agrees to try anyway, there are real signs of attention. For example, a forced attempt to attend to the highest object might result in cuing affects or other experimentally detectable signs of attention. Of course, by design forced-attempt attentional shifting is a mode of access consciousness which enables the voluntary control of attention. So if it's possible, then it's a mode of access consciousness which would fill the attention-guiding role of visual experience.[19] In any case, there's currently no evidence for or against the possibility of something like forced-attempt attentional shifting, but if we are to take the necessity question seriously we need to consider alternative modes of access consciousness.

The upshot is that although the standard framing of the necessity question in terms of super blindsighters and self-prompted spontaneous guessing might have a negative answer, if the proposal here is correct, then it might have a positive answer when alternative, empirically possible modes of access consciousness are considered. At least, the attention-guiding role of visual experience might be replaceable by modes of access consciousness besides visual experience itself. So perhaps visual experience is not even empirically necessary for vision-based thought.

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[18] There is some work showing involuntary attention in blindsight (Kentridge, 2011), but not the voluntary control of attention.

[19] My intuitions go further. I think that a blindsighter capable of forced-attempt attentional shifting, or perhaps something stronger like self-prompted spontaneous attention-shifting, would be capable of vision-based thought. But this, I'm sure, is a controversial intuition.

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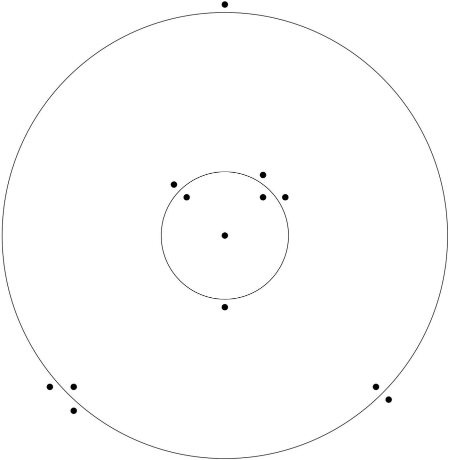
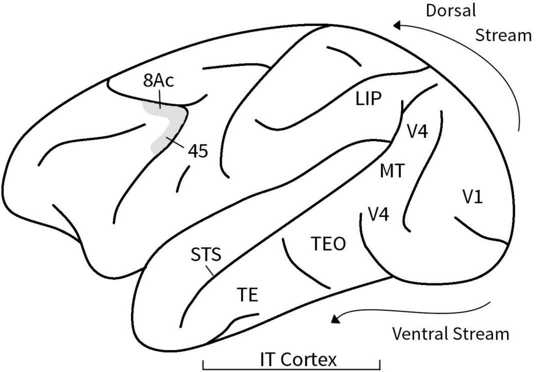
Figures 1 and 2 below:




Dorsal
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