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Consciousness Without Attention

ABSTRACT: *This paper explores whether consciousness can exist without attention. This is a hot topic in philosophy of mind and cognitive science due to the popularity of theories that hold attention to be necessary for consciousness. The discovery of a form of consciousness that exists without the influence of attention would require a change in the way that many global workspace theorists, for example, understand the role and function of consciousness. Against this understanding, at least three forms of consciousness have been argued to exist without attention: perceptual gist, imagistic consciousness, and phenomenal consciousness. After first arguing that the evidence is inconclusive on the question of whether these forms of consciousness exist without attention, I here present a fourth form of consciousness that is likely to be more successful: conscious entrainment. I argue that conscious entrainment is a form of consciousness associated with skilled behavior in which attention is sometimes absent.*

KEYWORDS: attention, consciousness, skill, automaticity, phenomenal consciousness, gist perception

1. Introduction

Although debates concerning attention and consciousness certainly extend beyond the global workspace theory, many philosophers and cognitive scientists have argued that attention is necessary for consciousness (the ‘necessity claim’) by drawing on the success of that theory (Dehaene and Naccache 2001; Grassia 2004; Hine 2010; Prinz 2011). The global workspace theory is a theory of consciousness according to which consciousness results from interconnectivity between brain areas, comprising a ‘global workspace’ of high connectivity. An early global workspace theorist, Baars supplies a theoretical link between attention and consciousness: ‘Thus consciousness is the publicity organ of the brain, one that is used to access all of its functions. If this is the case, then attentional mechanisms exist to control access to this publicity organ, the bright spot on the stage of consciousness’ (1997: 370). Global workspace theorists Dehaene and Naccache link attention and consciousness more stringently by using a taxonomy of evidence to show that reports of consciousness strongly correlate with the markers of serial

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(as opposed to parallel) processing—a type of processing that allows for high connectivity and is thought to be brought about by attention:

This framework postulates that, at any given time, many modular cerebral networks are active in parallel and process information in an unconscious manner. An information becomes conscious, however, if the neural population that represents it is mobilized by top-down attentional amplification into a brain-scale state of coherent activity that involves many neurons distributed throughout the brain. (Dehaene and Naccache 2001: 1)

Most global workspace theorists do not allow for consciousness outside of attention because of their idea that consciousness is inherently linked to high connectivity, which, for them, relies on attention.

What speaks in favor of the necessity claim is that it makes sense of the existence of various attentional phenomena, such as the phenomenon of inattentional blindness (Mack and Rock 1998; Suchy-Dacey 2012). What speaks against the necessity claim is its opponents' argument that high connectivity can be brought about without attention (e.g., Koch and Tsuchiya 2007) and that consciousness does not rely on the high connectivity of access (e.g., Block 2008a). Neither of these opposing positions is without controversy, but they have introduced enough doubt to weaken the claim that attention is necessary for consciousness. The collapse of the necessity claim would require a revision of the notion that consciousness comprises a global workspace that is only accessed through attention, as well as revisions to all other theories of consciousness that rely on the necessity claim (e.g., Prinz 2012).

This paper has two purposes. First, it critically reviews evidence that has been put forward against the necessity claim. Second, and more important, it introduces a new reason to doubt the necessity claim. Namely, I make the case in this paper for a new form of consciousness that can exist without attention, which I call 'conscious entrainment'. Although I am not the first theorist to write about this kind of consciousness, research on the topic has been minimal in both philosophy and cognitive science.

A brief note on terminology: in what follows, when I use the terms 'attention' and 'consciousness', I aim to follow standard usage in these debates. Specifically, I follow both the necessity claim's proponents (e.g., Dehaene and Naccache 2001) and its opponents (e.g., Koch and Tsuchiya 2007) in using 'attention' to stand in for top-down biasing mechanisms (see Jennings 2012 for a more detailed account). Thus, this paper sets aside the question of whether consciousness depends on bottom-up filtering and selection, sometimes called 'bottom-up attention'. 'Consciousness', on the other hand, is often used as a near synonym of 'awareness' (e.g., Laureys 2005) and stands in for temporally extended experience that need not necessarily correspond to self-awareness, situational awareness, propositional knowledge, or episodic memory. The question of this paper is thus roughly whether top-down input is necessary for awareness. Note that this paper concerns a phenomenon more general than that of perceptual awareness—I argue elsewhere that top-down input *is* necessary for conscious perception (Jennings 2014). This paper concerns the relation between attention and consciousness, in general.

2. The Opposition So Far

As stated above, many philosophers and cognitive scientists take the considerable evidence linking attention to consciousness as showing that attention is necessary for consciousness. A growing group of theorists have nonetheless put forward evidence for forms of consciousness that exist outside of attention. Crick and Koch argue early on for two types of consciousness ('awareness'), only one of which relies on attention: 'what reaches visual awareness is usually the result of [an] attentional step' (Crick and Koch 1990: 269) but there exists 'another form of awareness that is very transient, being associated with iconic memory and having a very large capacity at any one time' (Crick and Koch 1990: 272). Lamme, similarly, claims that attention is only necessary to integrate consciousness ('awareness') with other functions, but not for consciousness ('awareness') itself:

Depending on the extent to which recurrent interactions between visual areas incorporate interactions with action or memory-related areas, awareness evolves from phenomenal to access awareness. Whether this occurs depends on attentional selection mechanisms, via influences on both the feedforward sweep and recurrent interactions. (Lamme 2003: 16)

Finally, philosophers Campbell and Block provide accounts of consciousness that support the existence of consciousness beyond attention. What is common to their accounts is captured by Mole: 'According to this alternative hypothesis attention isn't necessary for *consciousness*, but it is necessary if one's experience is to provide one with knowledge of the sort probed by the experimenter's questions' (Mole 2008: 95–96, emphasis in original). Although I do not find myself moved by the evidence provided by these theorists (some of which I discuss below), I agree with them that there is a form of consciousness that exists outside of attention, albeit a new form that is not considered in their accounts. In this section, I will review the evidence that has been provided against the necessity claim so far and then move on to a discussion of conscious entrainment in the next section.

2.1 Perceptual Gist

Our ability to perceive general, identifying features of a short-exposure stimulus, known as 'perceptual gist', has served as a central point of criticism in the cognitive science literature against theories claiming that attention is necessary for consciousness.¹ Scientists Koch and Tsuchiya claim that 'we are always aware of some aspects of the world that surrounds us, such as its gist' (Koch and Tsuchiya 2007: 18). These theorists focus on our experience of perceptual gist largely because of its speed: it is faster, they suppose, than could allow for the influence of attention.

¹ There is also some mention of perceptual gist in philosophy: philosopher Paul Coates uses evidence that 'subjects are able very rapidly to ascertain the gist or general sense of a complete scene' to argue that 'unattended parts of the visual field enter into consciousness' (Coates 2004: 16).

However, some research suggests that the speed of gist perception does not prevent the influence of attention. Thus, I look at evidence both for and against the claim that conscious perceptual gist can exist without attention. I find that although perceptual gist can occur without attention, there is little evidence to suggest that this is true of *conscious* perceptual gist.

Perceptual gist is distinguished by the short exposure time of its stimulus and by the resulting limitations on what can be perceived (Li et al. 2007). Potter first observed the phenomenon by showing participants images for 125 ms and then testing their knowledge of those images (Potter 1976), but gist perception has also been found for exposure times as short as 30 ms (Oliva 2005) and even 16 ms (Pavlopoulou and Yu 2010). Such short exposure times yield limitations on what can be perceived. Oliva and colleagues demonstrate one such limitation through the different spatial frequencies of visual stimuli, where low spatial frequencies capture changes in light intensity over long distances and high spatial frequencies capture changes in light intensity over short distances.² As Oliva and colleagues show, although we normally perceive both the low and high frequencies of an image, perceptual gist includes only one or the other (Oliva and Torralba 2006). Specifically, if a stimulus contains two scenes, one in low frequencies and one in high frequencies (a ‘hybrid image’), perceptual gist of the stimulus includes only one of the two scenes (Schyns and Oliva 1994). Thus, the short exposure times of gist stimuli limit the percept to one or the other range of spatial frequencies.

Koch and Tsuchiya claim that the exposure times of gist stimuli are too short to allow for significant influence from attention: ‘In a mere 30 ms presentation time, the gist of a scene can be apprehended. This is insufficient time for top-down attention to play much of a role’ (Koch and Tsuchiya 2007: 18; see also van Boxtel et al. 2010). ‘Top-down attention’ is defined by the authors through the concept of ‘task-dependency’: processes that benefit from top-down attention are sensitive to task demands, whereas processes that do not benefit from top-down attention are not (Koch and Tsuchiya 2007: 16). However, at least one study shows that one’s current task can play a significant role in perceptual gist. Namely, Schyns and Oliva reveal the task-dependency of perceptual gist when they show that participants perceive different spatial frequencies for different tasks. For example, when the participant is given a hybrid image consisting of a high-frequency face and a low-frequency face and is asked whether ‘the face’ is expressive or nonexpressive (remember that perceptual gist includes only one of the two faces because of the short duration of the stimulus), the participant will tend to rate expressiveness for the high-frequency face. On the other hand, if the participant is asked to *identify* facial expression, the participant tends to identify facial expression for the low-frequency face (Schyns and Oliva 1999: 253–54). Since the very same participants see the high-frequency version of a particular stimulus in one task and the low-frequency version of the same stimulus in a different task, there is good reason to

² A high frequency version of a digital image, for example, might represent only the changes in light intensity that occur over every two pixels, whereas a low frequency version of an image might represent only the changes that occur over every 20 pixels.

suppose that this task-dependency reflects the influence of attention, given Koch and Tsuchiya's understanding of the term.

On the other hand, dual-task studies from Koch's lab have demonstrated that perceptual gist can be processed in parallel with other, attentionally demanding tasks (Li et al. 2002; Li et al. 2003; Li et al. 2007; Reddy et al. 2004; Reddy et al. 2006). That is, a participant can identify perceptual gist (e.g., the gender of a face presented in the periphery) while also performing a difficult task (e.g., determining whether a set of letters presented at fixation are all *T*s, all *L*s, or a mixture of *T*s and *L*s) without performance loss in *either* task (for this example, see Reddy et al. 2004: 109–110). If we assume that the use of attention in one task would reduce the available resources for another task, perceiving gist does not appear to use attention, since perceiving gist does not noticeably diminish the performance of a second, more difficult task.

The above studies show that perceptual gist is sometimes, but not always, subject to the influence of attention. The key question in assessing whether perceptual gist can serve as a counterexample to the necessity claim is whether perceptual gist is conscious when it is outside the influence of attention (as in the dual-task studies). Unfortunately, the dual-task studies do not yet provide evidence for this. Although participants in the dual-task studies were able to identify certain features of the gist stimulus, this is insufficient evidence to establish conscious perceptual gist of that stimulus, since the ability to answer questions about a stimulus has been shown to exist for subconscious presentations (e.g., Debner and Jacoby 1994). Furthermore, even if we grant that participants were likely conscious of the stimuli, this would be insufficient evidence to establish conscious perceptual gist since a participant's ability to answer questions about a stimulus together with *some form* of consciousness of the stimulus is insufficient to establish that it is a conscious percept (rather than a subconscious percept) that drives the ability to answer questions about the stimulus. If, for example, the participant experiences only an amorphous gray where the gist percept should be, this experience is insufficient to account for the participant's behavioral performance in categorizing the percept as, say, male or female. To determine whether the gist percept is conscious in the dual-task studies we need some more direct measure of the participant's internal state, which could be approximated by simply asking participants about their experience of perceptual gist (an experiment that has not yet been performed, to my knowledge).

Against simply presuming in favor of perceptual gist being conscious in the dual-task studies, studies examining perceptual gist in the single-task setting find it to be unlike normal perceptual experience. For instance, Levin and colleagues find that jumbling the features of animals has very little impact on perceiving the gist of those animals even though normal conscious perception of animals is affected by jumbling their features (Levin et al. 2001). Evans and Treisman find that participants are very poor at localizing the gist percept of an animal in a natural scene when given three location options, even though conscious percepts are normally localized (Evans and Treisman 2005). Finally, perceptual gist can include features that are not found within normal conscious perception, such as

the average size of multiple stimuli (Alvarez and Oliva 2009). That perceptual gist is unlike normal conscious perception does not show that it is not conscious, but it does suggest that we should not conclude that perceptual gist is conscious simply because of a participant's ability to answer questions about the stimulus perceived. Thus, until experiments address the question of whether perceptual gist is conscious in the dual-task setting, perceptual gist should not be used to argue against the necessity claim.

2.2 Imagistic Consciousness

Beyond perceptual gist, philosophers Campbell and Block have both put forward accounts of consciousness that need not rely on attention. As a second form of conscious content in addition to 'propositional content', Campbell proposes 'imagistic content', which involves only spatial (and not conceptual) relations between stimuli. As a second form of consciousness in addition to 'access consciousness', Block puts forward 'phenomenal consciousness', which involves only the experiential aspect of consciousness without any of its attendant functionality. These theorists' accounts diverge at several points, but importantly Campbell (in contrast to Block) does not argue directly for the existence of a second form of consciousness, and Block (in contrast to Campbell) does not explicitly tie attention to the first form of consciousness. Nonetheless, their work is regularly cited in arguments against the necessity claim by both philosophers and cognitive scientists (e.g., Mole 2008). I will thus review the evidence they provide against the necessity claim, starting with Campbell.

Campbell was not the first theorist to differentiate so-called 'imagistic' from 'propositional' content (see, e.g., Kosslyn 1980: 366). He does, however, provide a likely account of why propositional content might depend upon (conscious) attention. (Note that Campbell's 'conscious attention', or the experiential highlighting of a target, is different from the sense of 'attention' otherwise used in this article in that the latter need not be conscious. In the next few paragraphs I use 'attention' to mean top-down biasing that has the consequence of experiential highlighting, which I think is consistent with Campbell's use of the term.) In particular, for Campbell, propositional content begins with our ability to refer: before I can say what kind of a thing something is, I must be able to refer to that thing. Attention provides this ability to refer by allowing one to separate the targeted stimulus from other stimuli within experience. In Campbell's view, attention 'highlights' the targeted stimulus, thereby allowing the subject to identify and act on (what is now) the referent. Campbell's account, I will argue, leaves open the question as to whether or not we should take the stage prior to experiential highlighting and demonstrative reference to be conscious or subconscious. Thus, although Campbell may well be right to consider attention necessary for reference (and thus for propositional content), it is far from obvious that what facilitates attention and reference must be conscious 'imagistic' content.

In order to argue that conscious content plays a role in bringing about propositional content, Campbell puts forward cases where intuition tells us that

the standard indicators of someone's ability to refer—behavioral responsiveness and conceptual knowledge—are insufficient in the absence of conscious content. The first case is that of superblindsight. Where blindsight is a condition yielding partial visual functionality in the absence of visual experience, superblindsight is an imagined form of blindsight in which the participant retains total visual functionality despite lacking visual experience (Block 1995). Thus, the superblindsighter can *behave* as though he or she knows which stimulus is being referred to without consciously perceiving the stimulus. Campbell claims that intuition reveals to us that the superblindsighter lacks an understanding of the demonstrative in this case, or lacks the ability to refer to the stimulus (Campbell 2004: 267). The second case is that of a color-blind color expert (as found in Locke 2004a: 24; 2004b: 88; and Jackson 1982; 1986), where scholarly knowledge of a color without corresponding experience of the color does not intuitively suffice for an understanding of the demonstrative for that color, or for the capacity to refer to that color (Campbell 2002: 1). Thus, it is just when one does not consciously experience a stimulus that one is unable to refer to that stimulus, which might lead one to conclude that it is consciousness that allows for both attention and reference.

Whatever one thinks of these oft-debated examples, one can likely see that there is a more conservative lesson to be drawn from them than that there is conscious content that enables attention and reference. That is, one could agree that these examples show that conscious content plays a key role in reference, but one could disagree that this shows that there are two types of conscious content, one of which comes before attention in the causal order and is separable from propositional content. If, for example, attention enables *both* conscious content and demonstrative reference, then this could satisfy the intuitions at play in the cases above. The superblindsighter might, for instance, lack conscious content and the ability to refer to the object because he or she is not (consciously or unconsciously) attending to the object. Perhaps the superblindsighter attends to certain visual features that allow for accurate behavioral response without attending to the object itself (as in the visual-form agnosia case presented in Goodale and Milner 2004). Alternatively, the complex behavior of the superblindsighter might be achieved through entirely preattentive mechanisms, in which case both attention and conscious content are absent in this example. The color-blind color expert, similarly, might not consciously experience and understand the demonstrative for a particular color because he or she cannot attend to the color. The expert may only be able to attend to the *effects* of color, for example, without being able to attend to the color itself. Thus, intuition may tell us that an understanding of the demonstrative is absent in these cases because both attention and conscious content are absent. In this more conservative story there need be only one form of conscious content—conscious content that is enabled by attention and that provides for demonstrative reference.

One significant worry about this conservative story is known as the problem of richness (as discussed, e.g., in Noë and O'Regan 2000; Coates 2004; and Schwitzgebel 2007): how can the necessity claim account for the richness of experience outside the focus of attention? In Campbell's terms, how can the

necessity claim account for the conscious content surrounding the highlighted target? This worry is sound so long as we see attention as operating exclusively on the ‘highlighted’ or most prioritized target, but it has less traction when we allow that attention normally operates both on the most prioritized target and on the inhibited (or less prioritized) surround. This is not merely a matter of ‘diffuse’ attention or of the ability to spread attention over a more diffuse target, but one of whether attention normally operates over both targets and distractors.

One reason to allow that attention normally operates over both targets and distractors is the phenomenological evidence: an important auditory event, for example, is regularly associated with a silencing or near-silencing of auditory distractors; in film this experience is represented by the sound of a record player stopping suddenly (the ‘record scratch effect’) and the background music simultaneously turning off when a character is about to say something important (Pesca 2005).³ Another reason is that attention is taken to operate over both targets and distractors in the neural modeling community, in part because this supposition fits much of the evidence we have on the neural and behavioral effects of attention. That is, attention is not supposed to operate by simply increasing the amplitude of the preferred signal; rather, it also increases the contrast between the preferred and nonpreferred signal (Reynolds and Heeger 2009). Of course, in allowing that attention normally operates over both targets and distractors, we must then have a way of separating those distractors that are inhibited by attention from those distractors that receive no attentional modulation. This distinction is achieved in the phenomenological accounts of attention provided by Husserl, Gurwitsch, and Titchener as well as in many neural models of attention, such as that of Reynolds and Heeger (2009), mentioned above.

If we allow that attention normally operates over both targets and distractors, the necessity claim requires only that there is no consciousness outside of the *field* of attention (where the field includes both the targets and the inhibited surround), and not that there is no consciousness outside of the *focus* of attention. This more nuanced version of the necessity claim takes the sting out of the problem of richness, since it is much more difficult to see whether there is conscious content beyond the field of attention. In other words, it is difficult to see whether we consciously experience anything like Titchener’s and Gurwitsch’s ‘margins’ or Husserl’s ‘horizons’, at least on some interpretations of them (interpretations that take these phenomena to exist beyond the limit of the attentional field, rather than as comprising that limit). Without further reason to hold the problem of richness as evidence against the necessity claim, we are left at an impasse with respect to the comparative explanatory merits of the necessity claim and Campbell’s imagistic content.

2.3 Phenomenal Consciousness

Block reinvigorates the problem of richness by ‘meshing’ evidence of phenomenological richness with behavioral and neural evidence. Before addressing

³ Thanks to Ian Blaustein for suggesting this example.

his ‘mesh argument’, I want to note a couple of differences between his and Campbell’s accounts. First, instead of distinguishing imagistic from propositional content, Block distinguishes phenomenal from access consciousness, where (unlike Campbell) he does not assume outright that these two types of content are naturally separable, but intends to establish their separability through his mesh argument. Block describes *phenomenal consciousness* as definitionally experiential: ‘phenomenally conscious content is what differs between experiences as of red and green’ (2005: 46). This quote refers to the inverted spectrum argument, where it is argued that behavioral and functional accounts of consciousness fail to distinguish between a normal subject experiencing red and an inverted-spectrum subject experiencing green (Block 1990). Thus, phenomenal consciousness consists of the experiential content that is left out of behavioral and functional accounts. Block describes *access consciousness*, on the other hand, as definitionally functional. The functionality of consciousness is contrasted with functionality outside of consciousness (e.g., sleepwalking), which evinces ‘indirect control . . . but not direct control of the sort that happens when a representation is poised for free use as a premise in reasoning and can be freely reported. (It is this free use that characterizes access-consciousness.)’ (Block 1995). Block argues that conscious functionality occurs when we are able to access our mental states in the sense that we are able to reflect and act on them.

A second difference between the two accounts lies in the fact that, in contrast to Campbell, Block does not explicitly discuss attention with respect to the distinction between these two forms of consciousness, so application to the current discussion will involve some interpolation. Specifically, I will assume that what Block understands to be phenomenal consciousness is separable from attention, while access consciousness (following the global workspace theorists) is not separable from attention. This interpretation appears to be supported by Block’s more recent discussion of the overflow argument (Block 2011).

As to the mesh argument, Block claims that the natural separability of phenomenal and access consciousness makes the best sense of a mesh of phenomenological, behavioral, and neural evidence. The relevant neural evidence is that visual processing is associated with lower-level brain areas than the processing attributed to control of access, which is associated with higher-level brain areas (Block 2008a: 498). This evidence allows for two possibilities: either visual processing associated with lower-level areas is subconscious and only becomes conscious with access, which is controlled by higher-level areas, or this lower-level processing is by itself conscious and just takes on new functionality with the access enabled by higher-level areas. While global workspace theorists normally side with the former, Block contends that the behavioral and phenomenological evidence sides with the latter. Namely, he contends that this evidence indicates that we have a greater capacity for phenomenal consciousness than for access, suggesting that phenomenal and access consciousness have distinct neural correlates. In an early paper on the topic, for example, Block cites the work of Raffman, a music theorist who is said to show that whereas we can experience and distinguish 1,400 frequencies in sound (through same/different judgments), we can report on and

identify only 80 pitches, purportedly showing that phenomenal consciousness has the capacity of around 1,400 pitches whereas access consciousness has the capacity of only around 80 (Block 1998: 34). Thus, by meshing the phenomenological, behavioral, and neural evidence, Block contends, we arrive at evidence for phenomenal consciousness beyond functional or access consciousness.

However, as with Campbell's evidence, there is a more conservative rendering of the evidence available to us. The evidence that participants can distinguish any two of 1,400 pitches is arguably based on limited access: the participants report that they experience a difference between any two of 1,400 pitches, although they cannot identify the precise difference (Raffman 1993). That is, it may be that the participants can freely report on and use as a premise in reasoning *that* there is a difference between any two of the 1,400 pitches without being able to report on and use as a premise in reasoning *the precise difference*. The participant might, for instance, attend to, access, and experience a relational property between the two pitches without attending to, accessing, or experiencing their individual pitches.⁴ So long as the participant's experience of the pitches corresponds with the level of access the participant has to those pitches, the capacity of phenomenal and access consciousness have not been shown to differ. Thus, this 'limited access' interpretation of Raffman's evidence meshes with the first account of the neural data, in which account it is access to subconscious visual content that brings such content into the realm of consciousness.

This more conservative 'limited access' interpretation applies just as well to Block's better-known Sperling example (as used in Block 2008a and 2008b). As Block discusses, the Sperling experiments show that when a participant is flashed a random set of up to twelve letters for a fraction of a second, the participant reports experiencing all twelve letters but can only access and freely report around four individual letters (Sperling 1960: 7).⁵ Block concludes, as with the Raffman example, that the capacity of phenomenal consciousness overflows that of access consciousness, where phenomenal consciousness has a capacity upward of twelve letters and access consciousness has a capacity of around four (Block 2008b: 487). In contrast, a more conservative interpretation is that the Sperling participants at first have limited access to twelve letters and later have more complete access to four letters, two levels of access that may well map onto their phenomenological experience since they first report experiencing just twelve letters but later report experiencing four *distinct* letters. To explain the fact that participants report experiencing twelve complete letters, rather than the partial visual information that limited access would allow, Sid Kouider and colleagues suggest that the partial

⁴ The possibility of a relational representation that cannot be broken down into its parts could also be used to respond to Block's charge that the Carrasco experiments cannot be explained by 'representationism' (Block 2010).

⁵ Block also examines the partial report paradigm of the Sperling experiment (Sperling 1960: 8) to argue that the retention of visual information after the disappearance of the stimulus points to the existence of phenomenal consciousness outside of access, but the informational retention that enables partial report need not be conscious, as others have pointed out (e.g., Kouider et al. 2011). Further, the auditory cue used in the partial report paradigm may well interact with the visual percept, as is pointed out in Phillips (2011). Note that Phillips' criticisms do not impact the whole report paradigm, which is the paradigm that I review here.

stimulus information is ‘filled in’ by participants based on past experience (Kouider et al. 2011).⁶ In my view, this is enough to provide a ‘limited access’ account of the Sperling experiments that can compete with Block’s account.

Although Block has put forward other evidence for phenomenal consciousness outside of access, I have not found it to tip the scales in favor of the overflow account (see Phillips [2011] for a more exhaustive review of Block’s recent work on phenomenal consciousness). Without clear evidence of overflow, we have little reason to believe that phenomenal consciousness takes place without access, even if sensory information is processed separately from the control of access in the brain. The lack of evidence for overflow with respect to access consciousness is also a lack of evidence for consciousness outside of attention, as the terms are understood here. Thus, the necessity claim appears able to withstand the evidence put forward by Block.

2.4 Summary

We could summarize the above sections with a representative question and answer for each of the three accounts, together with my reasons for thinking that the necessity claim is left unscathed in each case. In that vein, Koch and Tsuchiya asked the question, ‘Is attention necessary to experience short-duration stimuli?’ and found that attention is not always necessary to answer questions about such stimuli. I argued that the ability to answer questions about such stimuli is insufficient evidence to count against the necessity claim. Campbell asked the question, ‘What content drives our capacity to refer to a stimulus?’ and found an answer in preattentive conscious content. I suggested that an answer to that question could instead involve attentional conscious content or preattentive subconscious content, leaving the relationship between attention and consciousness up for grabs. Block asked the question, ‘What explains the richness of experience?’ and found an answer in the overflow of phenomenal consciousness. I suggested, to the contrary, that the multigrained character of phenomenal consciousness may be matched by multiple grains of access and perceptual filling-in, leaving no room for overflow. In this case, the richness of experience would not point to the natural separability of phenomenal and access consciousness and would thus not establish the existence of consciousness outside of attention. In short, I find in reviewing this material that the question of whether there is consciousness outside of attention has not been settled by the evidence provided in these accounts and in the debates surrounding them.

I think the underlying problem in the attempts to discover consciousness outside of attention so far, including the three accounts above, is in targeting just those forms of consciousness that are already known to be strongly correlated with

⁶To understand the concept of perceptual filling-in, one might stare at a point in space (best accomplished by staring at a small, fixed object) and note what happens to certain small stimuli around that point as one’s gaze is kept fixed: very small stimuli disappear, but the space they once occupied appears filled-in with the color and texture of their surround. If the eyes move even a little, these stimuli come back, replacing this filled-in area with the rightful stimulus.

attention. For instance, many of the experiments described above target the experiences of participants engaged in a novel task. The use of a novel task is a standard method of controlling for expertise, and it also eliminates the need to train participants in a new task. However, as I will discuss in the next section, novel tasks are widely assumed to require attention whereas habitual tasks require little to none. Thus, it makes sense to study participants who are performing habituated tasks if we want to get at forms of consciousness that can exist outside of attention. It is this insight that led me to take a closer look at consciousness during the performance of habitual tasks, and this led to the discovery of ‘conscious entrainment’. In the next section I will describe what I take to be the central characteristics of conscious entrainment and give reasons to think that it exists without the benefit of attention.

3. Conscious Entrainment

As I use it here, ‘conscious entrainment’ is the experience of being entrained to a task as though one has no other interests or tasks. It is an experience of absorption and focus, but without the effort of focus normally associated with attention. Further, conscious entrainment occurs through habituation to a task, which is known to decrease the demand on attention, at least as I am using that term here. I will start by examining the last of these claims before addressing conscious entrainment in more detail.

What happens when a task becomes habitual? One way of understanding habituation is as generating a stimulus-based response in the place of goal-directed action; habituation can lead one to ‘automatically’ flip a light switch in a dark room while knowing that light switch is broken, for example (Yin and Knowlton 2006: 464).⁷ What is almost universally thought to be missing when one automatically flips the switch is attention. As one theorist puts it, ‘A major factor of human cognition is that certain behaviors can be performed with little, if any, attention, whereas other behaviors are very sensitive to attentional allocation. The “low attention” behaviors are referred to as automatic processes or behaviors’ (Schneider et al. 1994: 177).

Before arriving at this opposition between attention and automaticity, habit first engenders decreased attention. Dual-task studies have long demonstrated that habituation decreases interference between concurrent tasks, eventually allowing one to perform two or more tasks at the same time with no noticeable performance loss for either task (see, e.g., Hirst et al. 1980 for an early example). Since one of the two tasks is controlled to maintain a high level of difficulty and since attention is thought to be a limited resource, this end result is almost universally assumed to be evidence that the second task is eventually performed with little to no attention (see, for instance, the many dual-task studies used to establish that there is gist perception in the absence or near absence of attention, cited above). In these dual-task

⁷This does not entail that the stimulus-based response is a mere reflex; it may well be only because of the intention to add light to the room that one reacted to the light switch in the first place, intention being the crucial difference between reflex and action in that case.

studies, the decrease in behavioral interference has been found to correspond with reduced activation in prefrontal areas (Poldrack et al. 2005; Goldberg et al. 2006). Since top-down attention is normally understood to rely on feedback from prefrontal areas, this reduced activation in the prefrontal areas is consistent with a reduction in attention, even if the reduced activation is due to changes in ‘the speed of information processing’ (Dux et al. 2009: 127).⁸ The opposition occurs when automaticity is complete: ‘automatic processes involve qualitatively distinct processing in the form of superior algorithms when compared with controlled processing’ and ‘there is extensive evidence in the functional imaging literature that the neural substrate for automatic processing is distinct from that involved in controlled processing’ (Saling and Phillips 2007: 15–16). In other words, the opposition comes about when interference is not merely reduced but eliminated, which occurs because of a qualitative change in processing and its neural correlates. Returning to the dichotomy introduced at the beginning of this section, controlled or ‘goal-directed’ action has been found to correspond with an ‘associative network’ that includes the prefrontal areas, whereas automatic or ‘stimulus-based’ response has been found to instead correspond with a ‘sensorimotor network’ that has distinct cortical and subcortical elements (Yin and Knowlton 2006: 469).

The above is empirical evidence to think that habituation and decreased attention go hand in hand, eventually resulting in an opposition between attentive action and automatic response. But what happens within consciousness as habituation increases and attention decreases? While habituation enables one to perform multiple tasks at once, in which case the habituated task might be performed without consciousness, habituation need not result in reduced consciousness. In fact, I have found that habituation to a task sometimes corresponds to a different form of consciousness rather than to reduced consciousness; when we remain focused on a task that no longer requires our attention we instead seem to enter a new form of consciousness that I call ‘conscious entrainment’. Conscious entrainment is the experience of being entrained to a task without the aid of attention. This form of consciousness has been previously discussed in the work of Csikszentmihalyi under the name ‘flow consciousness’ (e.g., Csikszentmihalyi and Csikszentmihalyi 1992). I avoid using the terms ‘flow consciousness’ and ‘flow’ because they are thought to correspond with positive affect and an intensely focused attention. On the contrary, conscious entrainment need not be connected with positive affect nor be brought about by attention, as I understand it here, even though it does require focus on a single task.

I say above that conscious entrainment is the experience of being entrained to a task despite performing that task without the aid of attention, but I have also claimed that conscious entrainment requires focus. Why think that this focus occurs without the aid of attention? This assertion is based partly on the evidence

⁸That is, Dux and colleagues found that fMRI evidence concerning reductions in interference between concurrent tasks corresponded best with the hypothesis that processing in the prefrontal cortices becomes faster with practice. Note that the results of Dux and colleagues do not apply to automaticity in general, since they did not achieve complete automaticity, as is revealed by the fact that they did not eliminate interference between their tasks: ‘the residual multitasking costs were still significant’ (Dux et al. 2009: 128).

given above on the relationship between habituation and attention and partly on phenomenological reflection. As to the first, conscious entrainment occurs for habituated tasks, and the end point of habituation—automaticity—operates in opposition to the control of attention. Thus, the entrainment to a task comes ‘for free’, without the aid of attention.⁹ This is further supported by evidence from phenomenological reflection, reviewed below.

Phenomenological reflection on conscious entrainment yields three central characteristics that distinguish it from the type of consciousness that has so far been linked to attention. Recognition of these three central characteristics will generally depend on the reader having had such an experience, but it may be possible to recognize these characteristics in the descriptions that others give of the experience of entrainment to a task. Candidate experiences will be those that occur during the performance of a habitual, skilled activity, such as while playing a musical instrument or sport. However, many such experiences may only count as partial entrainments. To qualify as conscious entrainment in the sense I am using the phenomena—that is, for the phenomena to count as evidence against the necessity claim—the experience would have to be a complete entrainment. That is, one must be completely entrained to one’s task or activity and not thinking about oneself, one’s surroundings, or one’s future. If you think you have had such an experience, hold it in mind as I next describe what I take to be the key characteristics of conscious entrainment. These characteristics lead me to believe that conscious entrainment operates outside the influence of (again, top-down) attention, despite being conscious.

First, the defining characteristic of conscious entrainment, as mentioned above, is that the relationship between the subject and task is one of total focus: all of the subject’s available mental resources are concentrated on the task. This characteristic distinguishes conscious entrainment from partial entrainments, wherein the subject may be performing multiple tasks at once. Such focus is a defining feature of conscious entrainment and is discoverable through phenomenological reflection, but one external reason to think that all of one’s mental resources are focused during conscious entrainment is that one is performing at peak. That is, one would expect peak performance to require all of one’s available mental resources, which are split during partial entrainments. Yet, that conscious entrainment leads to peak performance is a commonly cited benefit of these experiences. We say, for example, of record-breaking athletes that they must have been ‘in the zone’. Since conscious entrainment occurs when one is engaged in a habitual, skilled activity, the quality of one’s performance should be relatively easy to assess (skill now being a stable factor). Thus, we might say of conscious entrainment that it requires *attunement*, or the concentration of mental resources on a single task, which should be distinguished from *attention*, or the top-down biasing of mental resources in favor of a certain task. The fact that someone is attuned to an object, process, or

⁹ As noted by Eric Schwitzgebel in correspondence, this means that while undergoing conscious entrainment one might not be using attention at all, on any task, which can be contrasted with the dual-task scenario. This may well also be true of other conscious experiences, as I note later in the paper, such as in hypnosis and dreaming.

activity need not tell us whether that person is attending to that object, process, or activity since the attunement can come about due to habit or other bottom-up factors. In other words, an attuned subject may be skillfully responding to particular visual stimuli without invoking the top-down biasing of attention.

The second characteristic of conscious entrainment is that this focusing of one's mental resources onto the requirements of the task is effortless and seems beyond one's direct control. This is not to say that the performance of the task is unsophisticated, just that any sophistication derives from something other than personal oversight and control. This characteristic is most apparent when one attempts to exert personal oversight and control: performance drops and activity is hindered. Race car driver Ayrton Senna reports such an experience during one of his races, which he found disturbing enough to stop racing for the day: 'Then suddenly something just kicked me. I kind of woke up and realised that I was in a different atmosphere than you normally are. . . . It frightened me because I was well beyond my conscious understanding' (Orosz 2010). Baseball player Chuck Knoblauch describes the interference of personal oversight on his ability to throw: 'I couldn't overcome it. I got to thinking too much, and I couldn't shut it off' (Rayno 2014). Such reflections indicate that personal oversight and control oppose the full focus of conscious entrainment.¹⁰ Attentive experience, on the other hand, is felt to be within one's direct control, such that controlling the focus of one's attention does not seem disruptive to the experience, but seems an integral part of the experience. Novice drivers, for instance, direct attention to different aspects of the car and road without disrupting the flow of experience—their effortful attention seems a characteristic feature of such an experience. That is, although the experience of the novice driver may be more disruptive and chaotic than the experience of the expert driver, the type of experience had by the novice driver is not itself disrupted by the driver's attempts to control his or her attention, but is defined by this type of control.

The third main characteristic of conscious entrainment is the lack of a divide between subject and object. Although in a novel task one feels as though one is observing and controlling the objects of the task as from a distance, habit diminishes and finally removes this distance. One might appreciate the point through the example of a new technology: although at first using the technology requires effortful attention, over time its use may become so habitual that the subject feels united with the technology while using it. This unity is most apparent when the technology fails, at which point it suddenly takes on its old aspect of separateness, requiring one's attention once more. But it is also apparent when one loses oneself while using it. In contrast to conscious entrainment is the attentive consciousness that accompanies the performance of novel tasks: in attentive consciousness one experiences a separation between self and object that is necessitated by the application of one's attention to that object.

¹⁰ Here is an alternative explanation, offered by Eric Schwitzgebel and Joan Weiner on separate occasions: habituation may cause attention to simply draw back from the more local, detailed aspects of the experience to more global aspects of the experience. In that case, one might have an experience of disruption in attempting to direct attention to finer-grained details of the activity. Such disruptions could only serve as evidence of partial entrainment.

The above three characteristics distinguish conscious entrainment from the forms of consciousness associated with attention, such as the consciousness one experiences while performing a novel task. It is because conscious entrainment is a different form of consciousness that I think it presents a promising avenue of criticism against the necessity claim. That is, the fact that conscious entrainment does not have the phenomenological, behavioral, and neural characteristics of attentive consciousness gives one reason to believe that it does not benefit from attention, and the fact that it is a different form of consciousness from attentive consciousness gives one reason to believe that this is a difference in kind rather than one of degree. On the other hand, if attention is necessary for reference and/or access, as is claimed in the work of Campbell (see section 2.2) and, perhaps, Block (see section 2.3), respectively, the absence of attention from conscious entrainment will mean that the subject is unable to refer to and/or access his or her experience. Likewise, if conscious entrainment does not make use of the global workspace, then one will not be able to use working memory in order to study it. In that case, one might wonder what kind of evidence could be used to study conscious entrainment. How could one know what it is like or even whether it is conscious? I suppose here that evidence concerning conscious entrainment must be gathered indirectly. That is, a subject may not be able to refer to conscious entrainment while in a state of complete entrainment, but the subject may be able to reach back to that entrainment experience by way of leftover traces from the experience. This can be compared to waking up from a dream, which is often remembered through traces left over from the dream once one wakes up. It is because evidence concerning conscious entrainment must be gathered indirectly that I think it has been so far neglected in debates on this topic. However, I think that I have made a strong case here for thinking that conscious entrainment is worth further study, if for no other reason than because it is a form of consciousness that is strikingly different from what is normally discussed in philosophy and cognitive science.

Conscious entrainment also has some advantages over the competing accounts discussed in section 2. First, these other accounts base their evidence on the conscious detection of stimuli, which is notoriously difficult to affirm, whereas evidence of conscious entrainment does not hinge on any such detection. Second, these other accounts have used evidence from novel tasks, which normally require attention, whereas conscious entrainment stems from habitual tasks, which normally require little to no attention. Thus, conscious entrainment may be a relative of these other forms of consciousness (i.e., perceptual gist, imagistic consciousness, and phenomenal consciousness), but the current state of the arguments for these other forms of consciousness is at best inconclusive, whereas the evidence for conscious entrainment is suggestive and allows a clear direction for further research.

4. Future Directions

Although the results discussed in this paper are merely suggestive of a form of consciousness that exists outside of attention, I find the evidence points to a

promising avenue for future research on the topic. That is, conscious entrainment presents a challenge to the view that attention is a necessary component of consciousness that is different in important ways from the challenges raised by gist perception, imagistic consciousness, and phenomenal consciousness. This is not to say that conscious entrainment is the only form of consciousness that is likely to operate outside of attention. At least three other forms of consciousness are possible avenues for future research on the topic. I already mentioned dreaming as one form of consciousness with characteristics similar to those of conscious entrainment. Like conscious entrainment, dreaming is associated with ‘reduced voluntary control of action and thought’ (Nir and Tononi 2010: 89) as well as ‘altered mnemonic processes’ (Nir and Tononi 2010: 92); both are explained by the absence of certain chemicals required for prefrontal feedback (e.g., dopamine, Hobson 2009) and the ‘deactivation of dorsolateral prefrontal cortex’ in sleep (Nir and Tononi 2010: 92). Consciousness in patients with ADHD, or attention deficit hyperactivity disorder, is also likely to have characteristics similar to those of conscious entrainment. ADHD is characterized by a diminished ability to exert voluntary control over the prioritization of mental and neural processing (Bellgrove et al. 2009) along with a reduced ability to remember (Pineda et al. 1999; Johnson et al. 2001). Both of these deficits are attributed to neural abnormalities in areas associated with cognitive control and attention, in connectivity involving these areas, and in the regulation of chemicals (e.g., dopamine) essential for feedback from these areas (Cubillo et al. 2011; Arnsten 2006). Finally, hypnosis can be used to induce the disorder of attentional neglect, which prevents the subject from voluntarily disengaging attention from a salient stimulus even while the subject is presumed to be conscious, revealing that conscious hypnosis may have qualities similar to those of conscious entrainment (Priftis et al. 2011). All three of these forms of consciousness reveal a diminished capacity to attend to and remember conscious stimuli. Therefore, any one of these forms of consciousness may serve as reason to doubt the necessity claim, pending future research on the topic.

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References

- Alvarez, G., and A. Oliva. (2009) ‘Spatial Ensemble Statistics are Efficient Codes that can be Represented with Reduced Attention’. *Proceedings of the National Academy of Sciences*, 106 (18), 7345.
- Arnsten, A. (2006) ‘Fundamentals of Attention-deficit/Hyperactivity Disorder: Circuits and Pathways’. *The Journal of Clinical Psychiatry*, 67, 7.
- Baars, B. J. (1997) ‘Some Essential Differences between Consciousness and Attention, Perception, and Working Memory’. *Consciousness and Cognition*, 6 (2–3), 363–71.
- Bellgrove, M., K. Johnson, E. Barry, A. Mulligan, Z. Hawi, M. Gill, et al. (2009) ‘Dopaminergic Haplotype as a Predictor of Spatial Inattention in Children with Attention-deficit/Hyperactivity Disorder’. *Archives of General Psychiatry*, 66 (10), 1135.

- Block, N. (1990) 'Inverted Earth'. *Philosophical Perspectives*, 4, 53–79.
- Block, N. (1995) 'On a Confusion about a Function of Consciousness'. *Behavioral and Brain Sciences*, 18, 227–47.
- Block, N. (1998) 'How to Find the Neural Correlate of Consciousness'. *Royal Institute of Philosophy Supplement*, 43, 23–34.
- Block, N. (2005) 'Two Neural Correlates of Consciousness'. *Trends in Cognitive Sciences*, 9 (2), 46–52.
- Block, N. (2008a) 'Consciousness, Accessibility, and the Mesh between Psychology and Neuroscience'. *Behavioral and Brain Sciences*, 30 (5–6), 481–99.
- Block, N. (2008b) 'Consciousness and Cognitive Access'. *Proceedings of the Aristotelian Society*, 108, 289–317.
- Block, N. (2010) 'Attention and Mental Pain'. *Philosophical Issues*, 20 (1), 23–63.
- Block, N. (2011) 'Perceptual Consciousness Overflows Cognitive Access'. *Trends in Cognitive Sciences*, 15 (12), 567–75.
- Campbell, J. (2002) *Reference and Consciousness*. New York: Oxford University Press.
- Campbell, J. (2004) 'Reference as Attention'. *Philosophical Studies*, 120, 265–76.
- Coates, P. (2004). 'Wilfrid Sellars: Perceptual Consciousness and Theories of Attention'. *Essays in Philosophy*, 5 (1), 8.
- Crick, F., and C. Koch. (1990) 'Towards a Neurobiological Theory of Consciousness'. *Seminars in the Neurosciences*, 2, 263–75.
- Csikszentmihalyi, M., and I. S. Csikszentmihalyi. (1992) *Optimal Experience: Psychological Studies of Flow in Consciousness*. Cambridge, UK: Cambridge University Press.
- Cubillo, A., R. Halari, A. Smith, E. Taylor, and K. Rubia. (2011) 'A Review of Frontostriatal and Fronto-cortical Brain Abnormalities in Children and Adults with Attention Deficit Hyperactivity Disorder (ADHD) and new Evidence for Dysfunction in Adults with ADHD during Motivation and Attention'. *Cortex*, 48 (2), 194–215.
- Debner, J. A., and L. L. Jacoby. (1994) 'Unconscious Perception: Attention, Awareness, and Control'. *Journal of Experimental Psychology*, 20, 304.
- Dehaene, S., and L. Naccache. (2001) 'Towards a Cognitive Neuroscience of Consciousness: Basic Evidence and a Workspace Framework'. *Cognition*, 79, 1–37.
- Dux, P. E., M. N. Tombu, S. Harrison, B. P. Rogers, F. Tong, and R. Marois. (2009) Training Improves Multitasking Performance by Increasing the Speed of Information Processing in Human Prefrontal Cortex. *Neuron*, 63 (1), 127–38.
- Evans, K., and A. Treisman. (2005) 'Perception of Objects in Natural Scenes: Is it Really Attention Free?'. *Journal of Experimental Psychology*, 31 (6), 1476.
- Goldberg, I., M. Harel, and R. Malach. (2006) 'When the Brain Loses its Self: Prefrontal Inactivation during Sensorimotor Processing'. *Neuron*, 50 (2), 329–39.
- Goodale, M., and D. Milner. (2004) *Sight Unseen*. New York: Oxford University Press.
- Grassia, M. (2004) 'Consciousness and Perceptual Attention: A Methodological Argument'. *Essays in Philosophy*, 5 (1), 18.
- Hine, R. (2010) 'Attention as Experience through "Thick" and "Thin"'. *Journal of Consciousness Studies*, 17 (9–10), 202–20.
- Hirst, W., E. S. Spelke, C. C. Reaves, G. Caharack, and U. Neisser. (1980) 'Dividing Attention without Alternation or Automaticity'. *Journal of Experimental Psychology: General*, 109 (1), 98.
- Hobson, J. (2009) 'REM Sleep and Dreaming: Towards a Theory of Protoconsciousness'. *Nature Reviews Neuroscience*, 10 (11), 803–13.
- Jackson, F. (1982) 'Epiphenomenal qualia'. *Philosophical Quarterly*, 32, 127–36.
- Jackson, F. (1986) 'What Mary Didn't Know'. *Journal of Philosophy*, 83, 291–95.
- Jennings, C. D. (2012) 'The Subject of Attention'. *Synthese*, 189 (3), 535–54.
- Jennings, C. D. (2014) 'Attention and Perceptual Organization'. *Philosophical Studies*, doi: 10.1007/s11098-014-0348-2.

- Johnson, D., J. Epstein, L. Waid, P. Latham, K. Voronin, and R. Anton. (2001) 'Neuropsychological Performance Deficits in Adults with Attention deficit/Hyperactivity Disorder'. *Archives of Clinical Neuropsychology*, 16 (6), 587–604.
- Koch, C., and N. Tsuchiya. (2007) 'Attention and Consciousness: Two Distinct Brain Processes'. *Trends in Cognitive Sciences*, 11 (1), 16–22.
- Kosslyn, S. (1980) *Image and Mind*. Cambridge: Harvard University Press.
- Kouider, S., de V. Gardelle, J. Sackur, and E. Dupoux. (2011) 'How Rich is Consciousness? The Partial Awareness Hypothesis'. *Trends in Cognitive Sciences*, 14, 301–307.
- Lamme, V. A. F. (2003) 'Why Visual Attention and Awareness are Different'. *Trends in Cognitive Sciences*, 7 (1), 12–18.
- Laureys, S. (2005) 'The Neural Correlate of (Un)Awareness: Lessons from the Vegetative State'. *Trends in Cognitive Sciences*, 9 (12), 556–9.
- Levin, D., Y. Takarae, A. Miner, and F. Keil. (2001) 'Efficient Visual Search by Category: Specifying the Features that Mark the Difference between Artifacts and Animals in Preattentive Vision'. *Perception & Psychophysics*, 63 (4), 676.
- Li, F. F., R. VanRullen, C. Koch, and P. Perona. (2002) 'Rapid Natural Scene Categorization in the Near Absence of Attention'. *Proceedings of the National Academy of Sciences*, 99 (14), 9596.
- Li, F. F., R. VanRullen, C. Koch, and P. Perona. (2003) 'Natural Scene Categorization in the Near Absence of Attention: Further Explorations'. *Journal of Vision*, 3 (9), 331.
- Li, F. F., A. Iyer, C. Koch, and P. Perona. (2007) 'What Do We Perceive in a Glance of a Real-world Scene?'. *Journal of Vision*, 7 (1), 1–29.
- Locke, J. (2004a) *An Essay Concerning Human Understanding*. Vol. 1. Whitefish: Kessinger Publishing.
- Locke, J. (2004b) *An Essay Concerning Human Understanding*. Vol. 2. Whitefish: Kessinger Publishing.
- Mack, A., and I. Rock. (1998) 'Inattentional Blindness: Perception without Attention'. In R. D. Wright (ed.), *Visual Attention*. New York: Oxford University Press.
- Mole, C. (2008) 'Attention and Consciousness'. *Journal of Consciousness Studies*, 15 (4), 86–104.
- Nir, Y., and G. Tononi. (2010) 'Dreaming and the Brain: From Phenomenology to Neurophysiology'. *Trends in Cognitive Sciences*, 14 (2), 88–100.
- Noë, A., and J. K. O'Regan. (2000) 'Perception, Attention, and the Grand Illusion'. *Psyche*, 6 (15), 6–15.
- Oliva, A. (2005) 'Gist of the Scene'. In L. Itti, G. Rees, and J.K. Tsotsos (eds.), *Neurobiology of Attention* (San Diego: Elsevier Academic Press), 251–56.
- Oliva, A., and A. Torralba. (2006) 'Building the Gist of a Scene: The Role of Global Image Features in Recognition'. *Progress in Brain Research*, 155, 23–36.
- Orosz, P. (2010) 'Ayrton Senna on the Very Edge'. Available at: <http://jalopnik.com/5452870/ayrton-senna-on-the-very-edge>.
- Pavlopoulou, C., and S. Yu. (2010) 'Classification and Feature Selection with Human Performance Data'. In *IEEE International Conference on Image Processing*, 1557–60.
- Pesca, Mike. (2005) 'Record Scratch'. *On the Media*. Available at: <http://www.onthemedial.org/2005/jan/21/record-scratch/transcript/>.
- Phillips, I. (2011) 'Perception and Iconic Memory: What Sperling Doesn't Show'. *Mind & Language*, 26 (4), 381–411.
- Pineda, D., A. Ardila, and M. Rosselli. (1999) 'Neuropsychological and Behavioral Assessment of ADHD in Seven-to twelve-year-old Children'. *Journal of Learning Disabilities*, 32 (2), 159.
- Poldrack, R., F. Sabb, K. Foerde, S. Tom, R. Asarnow, S. Bookheimer, et al. (2005) 'The Neural Correlates of Motor Skill Automaticity'. *The Journal of Neuroscience*, 25 (22), 5356–64.
- Potter, M. (1976) 'Short-term Conceptual Memory for Pictures'. *Journal of Experimental Psychology*, 2 (5), 509.
- Priftis, K., S. Schiff, V. Tikhonoff, N. Giordano, P. Amodio, C. Umiltà, et al. (2011) 'Hypnosis Meets Neuropsychology: Simulating Visuospatial Neglect in Healthy Participants'. *Neuropsychologia*, 49 (12), 3346–50.

- Prinz, J. J. (2011) 'Is Attention Necessary and Sufficient for Consciousness?'. In C. Mole, D. Smithies, and W. Wu (eds.), *Attention: Philosophical and Psychological Essays* (Oxford: Oxford University Press), 174–203.
- Prinz, J. J. (2012) *The Conscious Brain: How Attention Engenders Experience*. New York: Oxford University Press.
- Raffman, D. (1993) *Language, Music, and Mind*. Cambridge, MA: MIT Press.
- Rayno, Amelia. (2014) 'Chuck Knoblauch: Unpacking Memories'. *Star Tribune*, July 24.
- Reddy, L., L. Reddy, and C. Koch. (2006) 'Face Identification in the Near-absence of Focal Attention'. *Vision Research*, 46 (15), 2336–43.
- Reddy, L., P. Wilken, and C. Koch. (2004) 'Face-gender Discrimination is Possible in the Near-absence of Attention'. *Journal of Vision*, 4 (2), 4.
- Reynolds, J. H., and D. J. Heeger. (2009) 'The Normalization Model of Attention'. *Neuron*, 61 (2), 168–85.
- Salang, L. L., and J. G. Phillips. (2007) 'Automatic Behaviour: Efficient not Mindless'. *Brain Research Bulletin*, 73 (1), 1–20.
- Schneider, W., M. Pimm-Smith, and M. Worden. (1994) 'Neurobiology of Attention and Automaticity'. *Current Opinion in Neurobiology*, 4 (2), 177–82.
- Schwitzgebel, E. (2007) 'Do You have Constant Tactile Experience of Your Feet in Your Shoes? Or is Experience Limited to What's in Attention?'. *Journal of Consciousness Studies*, 14 (3), 5–35.
- Schyns, P., and A. Oliva. (1994) 'From Blobs to Boundary Edges: Evidence for Time- and Spatial-scale-dependent Scene Recognition'. *Psychological Science*, 5 (4), 195.
- Schyns, P., and A. Oliva. (1999) 'Dr. Angry and Mr. Smile: When Categorization Flexibly Modifies the Perception of Faces in Rapid Visual Presentations'. *Cognition*, 69 (3), 243–65.
- Siegel, S. (2010) 'The Contents of Perception'. Available at: <http://plato.stanford.edu/entries/perception-contents/>.
- Sperling, G. (1960) 'The Information Available in Brief Visual Presentations'. *Psychological Monographs*, 74 (11), 1.
- Suchy-Dacey, C. M. (2012) 'Inductive Parsimony and the Methodological Argument'. *Consciousness and Cognition*, 21 (2), 605–9.
- van Boxtel, J. J. A., N. Tsuchiya, and C. Koch. (2010) 'Consciousness and Attention: On Sufficiency and Necessity'. *Frontiers in Psychology*, 1, 1–13.
- Yin, H. H., and B. J. Knowlton. (2006) 'The Role of the Basal Ganglia in Habit Formation'. *Nature Reviews Neuroscience*, 7 (6), 464–76.