

Shedding Light on Consciousness:

The nature of visual attention and its relation to consciousness

Attention has been a popular topic among different disciplines. It has serious implication on how the brain functions, which is of particular interest to psychologists, cognitive scientists, and neuroscientists. The results will further unravel what consciousness is, which is relevant to philosophers. This essay will first explore the nature of visual attention, particularly whether it is like a spotlight or not. This is an important question as visual attention is usually taken as evidence to argue for or against models of consciousness. Then, explanations of the relation between visual attention and consciousness will follow.

Visual attention is often tested through online method to observe processing mechanisms real-time. Although rather objective results can be obtained through eye-tracking technology and other advanced experimental methods, the interpretations of the results may vary. One well-known interpretation on the nature of visual attention was proposed by William James (1890), which is commonly known as the spotlight metaphor. Under this model, visual spatial attention is like the beam of a spotlight, which means that information under the spotlight is prioritized for processing and attended to, while anything else is left unattended to. The details of the model also divide the visual attention spotlight into several parts, namely the focus, the central part of the spotlight where information is extracted with the most details; the fringe, which surrounds the focus, where information is roughly attended to; and the margin, which is the cut-off line between the area that receives any light and the area that does not (Eriksen & Hoffman, 1972). This is a fundamental model of visual spatial attention, since it inspired other renditions of the model. Examples of such renditions include the zoom-lens model and the gradient model, which mainly differ from the spotlight model in terms of whether the area of attention is limited and fixed, and how we shift our attention from one place to another.

At first glance, it seems that the spotlight model is an intuitive and plausible explanation to our daily experiences of visual attention. For example, in reading, people tend to fixate on content words much more than function words (Carpenter & Just, 1983). This is not at all surprising. Longer words are usually content words, so they are expected to be given more

cognitive resources. Moreover, function words are relatively unimportant, so keeping them in the fringe of the spotlight would not pose any serious hindrance to comprehension. However, if the above interpretation is re-evaluated in more details, it is not difficult to observe that other models of visual attention can also explain the same phenomenon. Perhaps, they might provide a better account of attention.

Many criticisms that the spotlight metaphor receives revolve around the assumption that our eyes must constantly move in order to allow for mobility for the attentional spotlight. However, anecdotal evidence, such as observing someone by mindlessly looking one way while paying more attention to your peripheral view to avoid being noticed, has proven otherwise. Our eye gaze or visual field does not necessarily have to move in order to allow for any shift in attention. On the other hand, phenomenon such as the attentional blink also shows that even if we fixate our eye gaze and attentional focus on the same space, attention is still not fully present. Experimental results show that when one target is presented 500 ms after another, subjects usually find it challenging to report the second target, a result that is not obtained if they are specifically told to ignore the first target or if the two targets are more spaced out temporally (Shapiro, Raymond & Arnell, 1997). In general, this is due to our tendency to allocate more attention to the first target than the second, which is not predicted by the spotlight model. According to the model, anything that falls within the focus should be processed preferentially and receive the most attention. The attentional blink shows that the attentional spotlight may not be the most comprehensive account for visual attention. As more and more ideas emerge, such as the zoom-lens and gradient models, as well as the notion that attention can be split, it has become blatant that the spotlight account is an inadequate yet a fundamental explanation in our understanding of attention.

Due to space constraints, alternative models will be not discussed in this paper. Another equally crucial question to address is: How is visual attention related to consciousness? Visual attention has been a useful tool in studying consciousness, as experimenters can easily manipulate input and observe the responses of the participants, e.g., ability to recall, accuracy and reaction time in identification, etc. Similar to visual attention, there are various models of

consciousness. Regarding attention and consciousness, it is inevitable to introduce the Attended Intermediate-level Representation (AIR) theory proposed by Jesse Prinz in his book *The Conscious Brain*.

The AIR theory explains the emergence of consciousness with two main parts: The first part is that consciousness occurs on the intermediate level of representations, and the second part states that consciousness only arises when these representations are attended to, i.e., become available to working memory (Prinz, 2012).

The attentional blink is one piece of evidence in favor of Prinz's theory. This is because even though subjects are presented with the first and second targets for an equal amount of time, their accuracy in reporting the second one is still very low. This could mean that consciousness tends to arise when subjects see the first target but not the second, since the first target is attended to so intensively that attentional resources have been depleted by the time they are presented with the second target. The inability to report the second target is a likely indicator of the second target being unavailable to the subjects' working memory. In other words, Prinz's idea that attention is necessary for consciousness is probable.

Another nature of our attention mechanism is that we have selective attention, leading to inattentional blindness. In short, inattentional blindness is compatible with the spotlight metaphor of visual attention, meaning that we are basically blind to objects that are not attended to but are present in our visual field. Rock and Gunman (1981) found that when they presented subjects with two objects for an equal amount of time simultaneously and asked them to rate one of them on pleasingness, the subjects had very poor memory for the unattended object. Although both objects were in the subjects' visual fields, only the item under the focus of the attentional spotlight was consciously seen and accurately reported. The failure to report on the unattended object shows the strong correlation between attention and availability to working memory again. Once again, inattentional blindness supports Prinz's argument that attention is necessary for consciousness.

A more controversial area of study of visual attention can also be taken as support for the AIR theory, namely unilateral neglect. Marshall and Robertson (2013) defined unilateral neglect

as a “‘cognitive’ inability to respond to objects and people located on the side contralateral to a cerebral lesion”, and that it has often been taken as a syndrome caused by a disturbance of attention. Although scientists have different ideas of what attention is, which is central to this discussion, we will adopt Prinz’s notion that it has to do with availability to working memory here. To explain neglect with the attentional account, the syndrome is likely due to an inability to attend to the neglect side, the over-sensitivity to the non-neglected side, or impairment in shifting and disengaging attention (Marshall & Robertson, 2013). These are theories derived from experimental results showing that the extent of neglect can either be improved by redirecting patients’ attention to the neglect side by cueing or exacerbated by presenting stimuli on both sides at the same time. This account is in line with the aforementioned results, showing that attention is crucial and necessary to consciousness.

The attentional account is a strong explanation of unilateral neglect, but it is not the only one. Proponents of other theories, such as the sensorimotor and representational accounts, have also attempted to explain neglect in ways that do not involve attention. On the surface, these seem like challenges to the AIR theory, but they can actually be interpreted in ways that in part support the AIR theory instead.

The attentional account presumes that the right hemisphere is responsible for attention to both sides, while earlier versions of sensorimotor account attribute neglect to the sensorimotor deficit caused by the same asymmetry in control. However, this is not plausible as neglect patients have shown unconscious visual perception, and their visual fields are usually unaffected. A later version, namely the defective exploration hypothesis, attributes neglect to a deficit in automatic eye fixation mechanisms, hindering the exploration of the neglected side (Marshall & Robertson, 2013). Although this is another acceptable explanation of neglect, this paper argues that it is not completely incompatible with the attentional account, as automatic eye fixation often correlates with attention.

The representational account argues that it is the temporary visual representation that is impaired in neglect patients. Bisiach and Luzzati (1978) asked patients to imagine and describe the Piazza del Duomo in Milan, and they still showed signs of neglect, even though their

knowledge of the buildings were intact. They were able to report on the side that they previously neglected when asked to imagine from the other side of the building. This proves that Prinz is right in hypothesizing that it is the intermediate level of representations that interact with attention. When imagining the Piazza del Duomo, neglect patients were unable to establish intermediate level representations for their neglect side, even though they could successfully recall from their knowledge in their long-term memory (evidenced by being able to report on both sides when they changed perspectives). Combined with the attentional account, there is no intermediate level representation on the neglect side to attend to. Hence, consciousness cannot arise.

Although quite a number of scientists accept that there is a close relationship between attention and consciousness, the role of attention has long been debated. Some argue that attention is not sufficient for consciousness, and some even argue that it is not necessary.

Jiang, Fang, Huang and He (2006) used a interocular suppression paradigm, with nude and scrambled displays in the first eye and high-contrast displays in the second, to examine the possibility of attention without consciousness. They indeed found gender- and sexual orientation-specific facilitation effect in target detection when the target occurred where the supposedly unseen nude picture had been. This proves that attention is not sufficient for consciousness. De Brigard and Prinz's (2010) reply is that it is possible that the representation of the nude picture captured spatial attention, but failed to be modulated by attention in the sense of object representation. However, this seems like a weak reply. It is because establishing representations in our mind seems to be a rapid and automatic process. Thus, it is questionable whether it is possible to separate spatial attention from attended object representation, especially when the said object occurs in the same space where attention is captured. Their reply is particularly confusing as it is rather self-contradictory when they use the argument that spatial attention is employed in ganzfeld perception against the idea that attention is not necessary in consciousness. Why does spatial attention suffice in one case but not another for the criteria of attention? Why does spatial attention seem inferior to attended object representation in some cases? These are questions that have yet been addressed.

Koch and Tsuchiya (2007) have attempted to prove that attention is not necessary for consciousness, and they found that people are generally aware of the gist of their surroundings in the near absence of attention. Brigard and Prinz's (2010) reply is that the near absence of attention is not nearly the same as the absolute absence. Without any attention, we would not be able to carry out minute tasks such as face recognition, which is supported by the phenomenon of inattention blindness. Koch and Tsuchiya's (2007) findings are compatible with the spotlight metaphor. We are generally aware of our surroundings without paying much attention to it, as that sort of information is often kept in the fringe of our attentional spotlight. Hence, we have strong reason to at least accept that attention is necessary for consciousness.

In conclusion, visual attention is similar to but not exactly the same as a spotlight. Although attention and consciousness are closely related, evidenced by various experimental results from visual attention studies, we can only accept that attention is necessary for consciousness. Whether attention is sufficient for consciousness still leaves much room for debate.

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Topic: Is visual attention like a spotlight? How is it related to consciousness?

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