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Commentary

# What's "inattentional" about inattentional blindness? ☆

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ABSTRACT

In a recent commentary, Memmert critiqued claims that attentional misdirection is directly analogous to inattentional blindness (IB) and cautioned against assuming too close a similarity between the two phenomena. One important difference highlighted in his analysis is that most lab-based inductions of IB rely on the taxing of attention through a demanding primary task, whereas attentional misdirection typically involves simply the orchestration of spatial attention. The present commentary argues that, rather than reflecting a complete dissociation between IB and attentional misdirection, this difference highlights potential grounds for delineating mechanistically distinct forms of IB: *spatial inattentional blindness*, which stems from the covert misallocation of spatial attention, and *central inattentional blindness*, which stems from disruption or preoccupation of perceptual mechanisms that interface with higher-level processes such as working memory. Recognition of such distinctions can help situate theoretical understanding of IB more firmly within the context of the broader attention literature.



Recently, Kuhn and colleagues developed a line of investigation into the relationship between misdirection of spatial attention and participants' failures to notice salient objects (e.g., Kuhn & Findlay, 2010; Kuhn & Tatler, 2005; Kuhn, Tatler, Findlay, & Cole, 2008). In doing so, they suggested that the consequences of such attentional misdirection (and similar misdirection used by stage magicians; see Macknik et al. (2008)) is directly analogous to "inattentional blindness" (IB). In a valuable commentary, Memmert (2010) critiques this claim and cautions against assuming too close a similarity between these phenomena. Among his reasons, he highlights the following: typically, IB is induced by engaging participants in an attentionally demanding primary task, whereas the attentional misdirection procedure simply manipulates where participants aim their "spotlight" of spatial attention. Memmert's point is well taken; taking it a step further, it might be that buried within this distinction lie grounds for delineating mechanistically different forms of IB.

*Inattentional blindness* refers to the common failure to notice plainly visible items when attention is otherwise preoccupied, *even though people look directly at them* (e.g., Mack & Rock, 1998; Most, Scholl, Clifford, & Simons, 2005; Most et al., 2001; Neisser & Dube, 1978, cited in Neisser, 1979; Simons & Chabris, 1999). In many cases, IB stems from people "covertly" (i.e., independent of eye movements) directing spatial attention away from the item in question. For example, in one series of experiments, participants judged the relative lengths of the arms of a briefly presented cross and an unexpected additional item could appear in one of the cross's quadrants (Mack & Rock, 1998). With this small spatial separation between the cross's arms and the unexpected object, about 25% of people failed to detect the unexpected item. In a different variation, participants tracked a subset of items moving randomly within a computerized display and counted the number of times that these items touched a horizontal line bisecting the display (Most, Simons, Scholl, & Chabris, 2000). On a critical trial, an unexpected cross traveled horizontally through the display at a variable distance from the line, which was presumably the focus of

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spatial attention. The further the cross appeared from the line, the less likely people were to notice it. That is, IB was more likely to occur when spatial attention was directed away from the unexpected item (see also Mack & Rock, 1998; Newby & Rock, 1998). Note that this particular demonstration of IB is indeed analogous to attentional misdirection.

However, IB can also stem from aspects of selection that are independent of *where* people attend. For example, in the aforementioned study, fewer than half of the participants noticed the unexpected cross even when it traveled *on* the line at the focus of spatial attention (Most et al., 2000). Similarly, in other studies, people failed to notice the critical stimulus even though it intermingled with and often overlapped the items that people were tracking (Becklen & Cervone, 1983; Most et al., 2001, 2005; Neisser & Becklen, 1975; Neisser & Dube, 1978, cited in Neisser, 1979; Simons & Chabris, 1999). Eye-tracking studies (which employ an *overt*, if not covert, index of attention) confirm that patterns of fixation do not differentiate between people who notice and people who fail to notice unexpected objects (Koivisto, Hyönä, & Revonsuo, 2004; Memmert, 2006), and evidence from beyond the inattentional blindness literature converges to suggest that although spatial attention enhances the quality of information available to later stages of perception (e.g., Carrasco, Ling, & Read, 2004; Carrasco, Williams, & Yeshurun, 2002), it is not sufficient by itself to support visual awareness (Kentridge, Heywood, & Weiskrantz, 1999, 2004; Lambert, Naikar, McLachlan, & Aitken, 1999; McCormick, 1997; Woodman & Luck, 2003). Direct evidence that IB can arise from bottlenecks independent of the locus of spatial attention comes from studies in which IB was induced simply by placing participants under heavy working memory and/or executive load (Fougnie & Marois, 2007; Todd, Fougnie, & Marois, 2005). Thus, even when an object is the focus of spatial attention, failures to see it can occur due to preoccupation of more central, late-stage bottlenecks critical to perception.

In short, the overarching term "inattentional blindness" likely obscures mechanistic distinctions between at least two different sub-types, one driven by covert allocation of spatial attention and a second driven by preoccupation or disruption of non-spatial selection mechanisms that make the difference between what Block has called "phenomenal consciousness" and "cognitive access" to perceptual representations (Block, 2007). Although phenomenologically similar, these two types of IB link mechanistically to somewhat different literatures. IB driven by spatial attention, which could be termed *spatial inattentional blindness*, connects naturally with the spatial cueing literature (e.g., Posner, 1980). A second type of IB, which could be termed *central inattentional blindness*, links more closely with phenomena such as the attentional blink, repetition blindness, and object substitution masking, which reveal failures of visual awareness stemming from late-stage bottlenecks, such as those that interface with visual working memory and contribute to the individuation of object representations (e.g., Chun & Potter, 1995; Di Lollo, Enns, & Rensink, 2000; Enns & Di Lollo, 1997; Kanwisher, 1987; Moore & Lleras, 2005; Raymond, Shapiro, & Arnell, 1992).[1] Some manipulations that have been found to modulate rates of IB, such as participants' expectations about the number of items that will appear in a display (White & Davies, 2008) or prioritization of items on the basis of semantic meaning (Koivisto & Revonsuo, 2007), might operate though their impact on mechanisms related to central-IB.[2]

Notably, the distinction between spatial- and central-IB has potential implications for the notion of "inattentional amnesia", the suggestion that IB reflects not a failure of perception, but rather the rapid forgetting of information at a post-perceptual stage of processing (Wolfe, 1999). Whereas central-IB might very well reflect the type of memorial processes implicated in this construct, spatial-IB might reflect a more profound failure of initial perceptual encoding. This distinction also has potential relevance to a second disconnection highlighted by Memmert: IB typically occurs only for unexpected stimuli, whereas attentional misdirection can induce failures to notice even expected stimuli. One possibility is that unexpectedness is more critical for the induction of central-IB than of spatial-IB. Note, however, that this distinction might be more practical than theoretical in nature. If it were possible to ensure that central resources were 100% preoccupied, then one might find high rates of IB even for stimuli that are expected.

To conclude, the term "inattentional blindness" has to date been used largely to refer to a phenomenologically related family of instances where people fail to see objects and events due to a preoccupation of attention. At a mechanistic level, however, although the term captures the essence of the experience, it may obscure subtleties in the meaning of "inattentional". Memmert is right to urge caution when drawing too direct an analogy between IB and the misdirection of spatial attention. However, it might be that such caution is warranted not because the two are entirely dissociable, but because the orchestration of spatial attention represents only one tile in the mosaic of inattentional blindness phenomena.

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[1] Central-IB might conceivably be sub-divided further into additional sub-types stemming from different perceptual bottlenecks. For example, although the attentional blink and object substitution masking are both thought to arise from mechanisms beyond the allocation of spatial attention, evidence suggests that undetected items in the former elicit neural signatures of semantic activation and category-specific identification (Luck, Vogel, & Shapiro, 1996; Marois, Yi, & Chun, 2004), whereas those in the latter do not (Reiss & Hoffman, 2006, 2007).

[2] IB also depends robustly on other non-spatial factors, such as how people "tune" attention to prioritize certain visual features (i.e., on their feature-based *attentional set*), with stimuli that match one's attentional set more likely to reach awareness than those that do not (Most & Astur, 2007; Most et al., 2001, 2005; Simons & Chabris, 1999). Although such attentional sets might impact mechanisms related to central-IB, it is alternatively possible that they reveal yet a third class of IB phenomena: *feature-based IB*, which could reflect the filtering of stimuli at a stage too early to qualify as central-IB, but which nevertheless depends on factors that are partially or wholly independent of spatial attention (e.g., see Desimone & Duncan, 1995).

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