Neuropsychological Analogies Of Inattentional Blindness

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ABSTRACT: I discuss the relations between the phenomenon of inattentional blindness and neuropsychological syndromes such as visual neglect, extinction and simultanagnosia. While there are similarities in the types of unconscious processing apparent in inattentional blindness and in these syndromes, there are also differences - for instance, grouping affects the reportability of stimuli in some neuropsychological syndromes but not necessarily in inattentional blindness. The reasons for such discrepancies, and the link between unconscious processing and underlying neural structures are discussed.

Mack and Rock's (1998) *Inattentional Blindness* is an intriguing and thoroughly engaging book that ought to be recommended to any PhD student interested (even peripherally) in visual attention. The authors set out a detective story in which they try to get to the heart of their finding that many subjects fail to report a clearly perceptible visual stimulus when they are attending to another item. The story has various twists and turns, not least the result that, even though many subjects report very little, what they do report can be affected by the meaningfulness of the stimulus - one's own name can be reported but

another name, differing only by a single letter, is typically not. This result leads Mack and Rock away from what is in some respects a kind of 'extreme' early selection view (that nothing is perceived unless attended) to a late selection view, in which stimuli are processed to deep levels even when unattended. The change in the authors' views provides a good example of how one needs to be led by the data in science. There remain many untied ends, and methodological questions to be worked-through (such as, exactly what is meant by 'unable to report'?), but as an example of how exciting and captivating research can be, this book goes far.

In their final chapter, Mack and Rock discuss possible analogies between their finding of inattentional blindness and neuropsychological disorders in which there seems to be a disturbance of conscious report of visual stimuli. In particular, they speculate that there are aspects of the syndrome of unilateral neglect that appear to be similar to normal subjects in a state of inattentional blindness. In neglect, patients typically fail to respond to/report stimuli presented on the side of space contralateral to their lesion. They appear to be functionally blind to such stimuli - leaving the food on one side of their plate, even if hungry! This is not necessarily a sensory loss, since the same stimuli can be reported if attention is cued to the affected side and electrophysiological measures indicate that neglected stimuli can be registered in early sensory areas (see Driver, 1998, for one review). As in inattentional blindness, stimuli are perceptible but unreported when unattended. In the phenomenon of extinction, patients can even report the presence of a single stimulus presented on the affected side, but then fail to detect it when a second stimulus is presented simultaneously on the 'good' (ipsilateral) side. Here the stimulus on the affected side seems to lose under conditions of attentional competition from stimuli in the ipsilesional field. The consequence of this competition is that the extinguished items may not even be detected.

Now, as in studies of inattentional blindness, there is evidence of processing taking place in the neglected field. For example, there can be semantic priming from a stimulus presented in the neglected field, which affects responses to stimuli subsequently presented on the unimpaired side (McGlinchey-Beroth et al., 1992). This seems similar to evidence of priming on fragment completion tasks for stimuli presented under conditions of inattentional blindness, even when prime and target stimuli are presented in different modalities (see Chapter 8, Mack & Rock). Apparently in both neglect and inattentional blindness, there is high-level processing of stimuli even when they are unattended.

However, in addition to such similarities, there also appear to be differences between the neglect syndrome and inattentional blindness in normal subjects. These differences suggest several important issues concerning the representation of stimuli presented under conditions of inattention, and the role that such representations may play in behaviour. Take the phenomenon of extinction. There have been several results now showing that the magnitude of extinction shown by a patient is affected by grouping between the ipsi- and contralesional stimuli (e.g., Gilchrist, Humphreys & Riddoch, 1996; Mattingley, Davis & Driver, 1997; Ward, Goodrich & Driver, 1996). If the contralesional stimulus groups with the ispilesional item, then there is less extinction that if the stimuli do not group and so are represented as two independent objects. At first sight, this seems

contrary to the evidence reported by Mack & Rock, that the strength of grouping does not affect whether stimuli are reported under conditions of inattention. Perhaps in neglect and extinction, but not when there is inattention, elements do group and the strength of grouping influences report.

On the other hand, it might be pointed out that, even in studies of inattention, there is evidence for implicit grouping - witness Moore and Egeth's (1997) evidence showing that, even under conditions of inattention, grouping between elements influences perceptual report of attended stimuli. The lack of an effect of grouping on the report of unattended stimuli does not indicate a lack of grouping in the first place. The difference between the results of Moore and Egeth, on the one hand, and the data on recovery from extinction, on the other, is that grouping influences report in extinction. In addition, it is grouping between the unattended/extinguished stimuli and the attended/extinguishing stimulus that has been shown to be important. The relations between the attended stimulus and stimuli presented under conditions of inattention has not been examined but they are crucial for understanding how unattended stimuli are represented. Indeed, such studies may help to throw light on the mysterious step between (i) stimuli being processed but not reported, and (ii) stimuli becoming reportable. We need to know whether the same factors that govern the implicit processing of stimuli are those that also determine reportability, or whether quite different 'rules' apply. The 'common sense' view is probably that the same rules should apply; stimuli that are better processed implicitly (e.g., due to grouping), should be more available for report. The preliminary evidence on inattentional blindness is intriguing at least in part because it suggests that this may not be the case - an example being the report of one's own name under conditions where other similar stimuli appear not to be detected. Perhaps the rule - detect one's own name - has an overwhelming effect on a reportability threshold, but less at the level of implicit processing. These issues are important for understanding the transition from implicit to explicit representation of stimuli. Studies that address the inter-relations between attended stimuli and stimuli presented under conditions of inattention may begin to address such issues.

One other difference between neuropsychological symptoms such as neglect and extinction, and inattentional blindness concerns the role of expectation. In inattentional blindness, subjects do not expect the unreported stimulus. In contrast, in neglect and extinction, patients may expect a stimulus to be presented on the affected side but still fail to report it when another, ipsilesional stimulus competes for attention. It may be that expectation affects reportability but not the implicit processing of stimuli.

There are also some neuropsychological syndromes in which the perceptual goodness of stimuli does directly influence report (independent of grouping with attended stimuli). Balint's syndrome occurs after bilateral parietal damage, with one of its main symptoms being 'simultanagnosia' - patients appear only to 'see' one object at a time. Humphreys et al. (1994) showed that, when two stimuli are presented simultaneously, such patients will tend to report a perceptually good stimulus whilst failing to detect the perceptually less good item (e.g., the patient may detect a stimulus that has good Gestalt properties such as closure, relative to a stimulus matched in other respects but lacking closure). This

dominance by perceptually good stimuli can occur even when the 'good' item appears away from fixation and the 'less good' item falls at fixation. As in the evidence reported by Mack and Rock on inattention, presentation at fixation does not guarantee good report, when fixation is pitted against an attentional bias. But, why does perceptual goodness influence report in such patients when it does not under conditions of inattention? One possibility here is that, in the studies of simultanagnosia, the 'good' and 'poor' stimuli compete for attention. In studies of inattentional blindness, stimuli are presented in competition with an already attended stimulus. It may be that concurrent attention to a stimulus overwhelms unattended stimuli not matter how 'perceptually good' they are. This could be attacked by varying the difficulty of the attentional task in studies of inattentional blindness - much as has been done in experiments on 'the attentional blink' (e.g., Jolicoeur, 1999).

Neuropsychological studies also suggest other intriguing dissociations between perceptual report and effects of stimuli on behaviour. For example, patients may show less neglect when reaching to grasp objects then when making perceptual judgements about the centre of such stimuli (e.g., Edwards & Humphreys, 1999). This suggests that representations may be made available to action systems even when patients fail to consciously report stimuli. Similar examples to this can be found in studies of agnosia, where patients can be at chance at making perceptual judgements to properties of stimuli that nevertheless affect their action (see Milner & Goodale, 1995). One way of interpreting such results is that stimuli are processed in parallel by different visual pathways. Perceptual report is typically based on outputs from one pathway, but limitations on this pathway (caused by brain damage, but perhaps also by inattention?) do not necessarily reflect limitations on processing within other pathways (e.g., where visual information is used for action). Clearly it would be interesting to assess whether stimuli presented under conditions of inattention can affect action when they cannot be reported - e.g., would reaching to an attended stimulus be influenced by its proximity to nearby items to which the subject is inattentionally blind?

Just like the study of inattentional blindness itself it seems that, at this stage in our scientific progress, the analogy between inattentional blindness and neuropsychological syndromes throws up as many questions as answers (perhaps even more questions!). Nevertheless, the questions seem fundamentally important for our understanding the relations between attention, stimulus coding and behaviour; an understanding that may best be advanced by converging approaches that combine neuropsychological measures with those derived from experimental psychology.

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