A vision trap: blind areas create confounding effects in studies of complex processes like reading

Local areas of damage to the brain can create very specific problems in visual perception, which appear to affect one type of function but leave many others intact. Understanding what kind of processes could be affected that lead to such selective effects on vision is a real challenge. A classic example is the problem of ‘pure alexia’, in which damage to the left occipital lobe impairs the ability to read, while writing and auditory language are better preserved, as is the ability to recognize other types of objects visually. Several studies have used clever experiments to suggest, on the one hand, that there may be a failure in integrating letters into words, or, on the other, that the problem actually is not that selective and does affect the ability to see simple shapes and numbers in subtle ways.

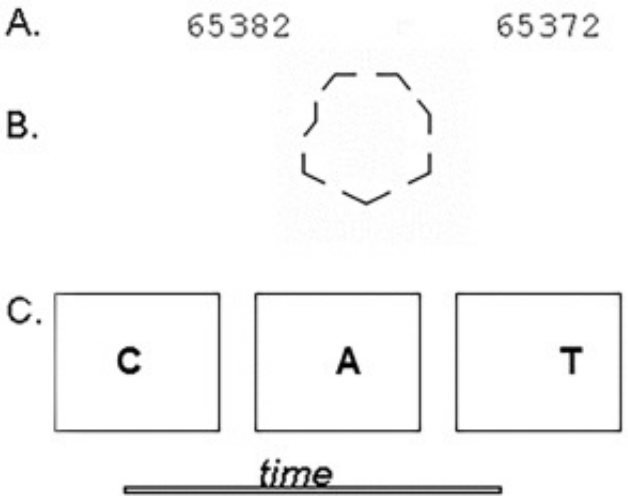

Fig. 1. A) Number scanning. Subjects have to determine if the two number strings are the same or different. B) Processing parts of visual shapes. Subjects must determine if one of the line segments is facing a different way than the others (concave versus convex). C) Letter integration. Over time the letters of the word cat are shown successively, either one at a time, as shown here, or in cumulative fashion, where the letters remain visible once shown.

However, most studies of alexia fail to consider the potential effects of another visual problem that many patients with pure alexia also have, which is a right hemianopia, the loss of the right half of vision of both eyes. Previous work has even shown that right hemianopia can also slow reading, although this is not as severe as that seen in most cases of pure alexia. This work raised the question, could some of the experimental findings previously reported in studies of alexia actually be due to the hemianopia instead? If so, this would invalidate some of the conclusions drawn about pure alexia from those studies.

To examine this question, this study did not use patients, but healthy subjects with a simulated hemianopia. By recording the eye movements of patients, the experimenters fed their current eye position to the computer generating the visual display, so that it could erase all stimuli to the right of where they were looking. Because these are healthy subjects without a brain lesion, there is no possibility that they have a coincidental pure alexia. The subjects then were given the same tasks used in two previously reported studies of patients with pure alexia, which were done with normal vision and then with a simulated right hemianopia.

The results showed first that a simulated right hemianopia did slow the reading of single words and the ability to decide whether letters formed a word or not. More importantly, several phenomena previously reported in studies of pure alexia were replicated. These included less accurate scanning of number strings (Fig. 1A), slower processing of the parts of abstract shapes (Fig. 1B), the effects of syllabic structure on the reporting of letter triplets, and difficulties in the integration of successively presented letters into words (Fig. 1C).

The important message of this report is that in the study in patients of complex visual processes like reading, it is important to consider the effects of simpler visual problems that may also be present. It may not be adequate to use only healthy subjects with normal vision as controls in these studies: either patients with hemianopia alone or healthy subjects with simulations that mimic such visual field defects would be important to ensure that any results are truly related to the deficit that causes pure alexia. This point is also relevant to many studies of other visual processes in which patients also have visual field defects.

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