

A theoretical framework of visual line bisection errors

Stroke is one of the leading causes of disability and death in Sweden. The effects of a stroke depend on the location of the obstruction and extent of brain tissue affected. Everyone is individual and every stroke unique, but there are a number of common ways in which stroke can affect someone. For instance, in a condition called hemispatial neglect, information about objects on the side of space opposite to the damaged hemisphere tends to be neglected. Hemispatial neglect most commonly results from brain injury to the right cerebral hemisphere, causing visual neglect of the left side of space, although it can also result from damage to the left cerebral hemisphere causing visual neglect of the right side of space.

One task used regularly in diagnosis of visual neglect is horizontal line bisection. When asked to bisect a horizontal line into two equal parts patients with visual neglect, resulting from damage to their right cerebral hemisphere, tend to place their midline mark to the right side of true centre. These rightward bisection errors increase with increased line length and for lines at more leftward positions. However, for short lines, or for lines presented in the right space, line bisection errors can 'cross-over' to become leftward.

There is some consensus that visual neglect concerns the mechanisms of attention. It is not the case that patients cannot physically see the left or right side of objects. A characteristic feature of visual neglect is that if the patient's attention is drawn back to the neglected information they can usually report what is there. However, beyond broad characterisation as an asymmetric attentional deficit, visual neglect is a perplexing and poorly understood condition.

One way to think about visual neglect is in terms of the disruption of normal cerebral processes. Careful examination of the line bisection errors of healthy adults shows that they tend to bisect lines to the left of centre. Moreover, such line bisection errors can cross-over to become rightward under certain conditions. So the attentional problems suffered by stroke victims are perhaps not so unusual after all.

Given recent advances in our understanding of how people discriminate between sensory events, we can start to build functional mathematical models of how people bisect horizontal lines and more generally how people make perceptual judgements about visual objects. The further development of mathematical models of visual line bisection will grant a formal framework by which to conceptualize and pinpoint the malfunction of processes underlying visual neglect.

Mathematical and statistical modelling is an important tool by which to complement anatomical understanding of how the visual brain works. It will help us to develop a better understanding of how we judge visual objects, and will provide us with new diagnostic benchmarks against which to assess, individually, the function of attentional mechanisms following stroke. Once we have a better idea of the attentional problems suffered by stroke patients more realistic and individually tailored rehabilitation programs can be developed to help victims of stroke recover and continue with their lives.

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