
Reviews

The two sides of perception by R B Ivry, L C Robertson: MIT Press, Cambridge, MA, 1998. 315 pages, \$74.50 (UK £46.50) ISBN 0 262 09034 1

According to the leading psychologists quoted on its book cover, *The Two Sides of Perception* “offers a fresh approach to the issue of hemispheric asymmetries in visual and auditory perception” (Diver), “provides an excellent overview of laterality and will be essential reading for anyone interested in perception, attention, language and the brain” (Treisman), “contains a masterful integration of empirical studies and computational modeling, which permits the authors to develop a theory that goes beyond earlier descriptive accounts of hemispheric asymmetry to provide a variety of testable hypotheses” (Hellige), and “has powerful implications for the future of cognitive neuroscience” (Posner).

It is a formidable challenge for any book on hemispheric asymmetry to live up to such a billing. Sorting fact from fiction is difficult when one encounters controversial theories, contradictory experimental results, and skepticism toward the concept of hemispheric asymmetry (Efron 1990). The authors seem aware of these difficulties as they present what they hope will be a unifying theory. They hope to link the cerebral hemispheres to sensory, cognitive, neural, and computational sciences. Of special interest to sensory and perceptual scientists is the claim that spatiotemporal processes in vision and audition are central to understanding hemispheric asymmetries.

The book begins with a general introduction to hemispheric asymmetry (chapter 1). Beginners may find this introduction helpful, as it samples many of the key concepts surrounding laterality studies [but be sure to read Efron (1990)].

Most readers can skip to chapter 2, which contains the heart of the authors' proposal, the 'double filtering by frequency' (DFF) theory. The theory is summarised as follows:

(i) The cerebral hemispheres show a consistent asymmetry in the processing of frequency information. For vision, these frequencies include spatial and temporal frequencies. For audition, they include auditory frequencies. In both cases, the right hemisphere is more adept at identifying low-frequency patterns and the left hemisphere is more adept at identifying high-frequency patterns.

(ii) The first stage of information processing represents sensory information in multiple scales (eg the outputs of multiple spatial-frequency or temporal-frequency channels, or auditory critical bands). The second stage involves an attentional filter that selectively amplifies frequency components that are relevant to completing an experimental task. Hemispheric asymmetries do not typically emerge until a third stage. Specifically, it is proposed that information undergoes differential filtering in the two cerebral hemispheres when higher-order analyses are required, as in identification or discrimination tasks. At this third stage, processing in the right hemisphere is characterised as a low-pass filtering operation. In contrast, left-hemisphere processing is characterised as a high-pass filtering operation.

(iii) Hemispheric asymmetries found in a wide variety of experiments may be attributed to, or exist as emergent properties of, this fundamental (third stage) asymmetry:

“The central hypothesis of the DFF theory is that the output of those filtering operations underlies many of the laterality effects reported in visual and auditory perception.”
(page 65)

(iv) At this third stage, asymmetries exist in terms of relative frequency (eg cycles per object), not absolute frequency (eg cycles per degree of visual angle on the retina).

The remainder of the book elaborates upon DFF theory. The authors discuss the laterality literature with respect to visual perception (chapter 3), visual attention (chapter 4), auditory perception (chapter 5), and speed perception and language (chapter 6). In each chapter, the authors suggest that their review leads to at least tentative support for the theory. The authors offer a computer implementation of the theory (chapter 7), complete with a connectionist architecture and simulations. (The authors warn that the modeling was crude in places. Most striking, perhaps,

is the strange spacing of the six filters on the spatial-frequency axis. Filters were chosen to peak at 0.2, 0.3, and 0.5 cycle deg⁻¹; and at 2, 3, and 5 cycles deg⁻¹; page 234.) Next (chapter 8), the theory is discussed with respect to specific clinical cognitive dysfunctions (alcoholism, schizophrenia, dementia), in an attempt to identify and understand processing components associated with these diseases. The book concludes (chapter 9) by returning to three central issues, addressed in three sections: "Hemispheric specialisation as an emergent property of the asymmetric representation of frequency information"; "Computational specificity of the DFF theory"; and "Hemispheric interactions: cooperation or competition?".

The book has much to recommend it. It is well written and samples a wide range of topics. Newcomers to laterality may indeed find sections that clarify difficult concepts, and veterans may find the unifying approach seductive. These points stated, several additional issues warrant mention.

The authors assert throughout the book that their hypothesis is novel and new, and that "our theorising is at odds with other accounts of hemispheric specialisation" (page 71). I cannot agree.

Ivry and Robertson chose to write little about the late Justine Sergent, their brief references to her residing in the book's middle pages: "Sergent (1982) first proposed that there was a fundamental asymmetry between the two hemispheres in the representation of high and low spatial frequencies in vision ..." (page 40); "It has been more than a decade since Sergent first proposed that the two cerebral hemispheres differ in how they process spatial frequency information." (page 170)

In total, Ivry and Robertson made perhaps ten or twelve brief references to a few of Sergent's experiments but did not clarify her influential theoretical contributions. Why?

Most of the new book's central ideas duplicate ideas found in Sergent's (1982) influential paper, "The cerebral balance of power: Confrontation or cooperation?". Sergent was indeed among the first to suggest that visual spatial and temporal frequencies might be related to hemispheric asymmetries, though the book generally neglects parallel insights of her contemporaries (Pitblado 1979; see Christman 1997, for a review). Sergent hypothesised the same link between visual spatial frequencies and the hemispheres that is now proposed by Ivry and Robertson. Like Ivry and Robertson, Sergent did each of the following: (i) She extended her hypotheses to the auditory (and other) domains. (ii) She suggested that hemispheric asymmetries emerge at a processing level beyond simple sensory representation and attentional filtering. (iii) She suggested that hemispheric asymmetries found in a wide variety of experiments may be attributed to, or exist as emergent properties of, frequency-related asymmetries:

"This is not to deny the existence of the more traditional dichotomies, but rather to argue that such dichotomies result from—and are explained by—a more fundamental dissociation." (page 267)

Sergent never discussed relative spatial frequencies, though this variant of Sergent's hypothesis was proposed long ago (Peterzell et al 1989).

Like Ivry and Robertson, Sergent considered extending her work into the now popular realm of computational modeling (Sergent 1990). However, Sergent explicitly rejected the approach (for reasons not discussed by Ivry and Robertson, chapter 7), warning against its serious pitfalls:

"In conclusion, the study of cerebral lateralization is certainly in need of fresh blood, and computational models may infuse into this study new ingredients susceptible of diversifying the experimental approaches and of enhancing the rigor of the investigation by providing a powerful technique for the decomposition of complex cognitive functions. However, blood transfusions are not without risks. For one, new blood may contain viruses whose damaging effects may not manifest themselves immediately, and the initial benefit associated with blood transfusion may later have devastating consequences if its components had not been carefully controlled. For another, there must be compatibility between the donor and the receiver, and, as currently conceived, computational models are based on principles that are not entirely compatible with the properties of the brain." (1990, page 126)

Sergent published approximately fifteen papers pertaining to her theory before her untimely death in 1994. In her papers, she clarified, defended, tested, and refined her hypotheses, while also acknowledging their failures and limitations when such an acknowledgment was warranted. Sergent (1987, page 415) replied to a variety of challenges including one contained in a paper coauthored by Robertson.

The significance of Sergent's (1982) ideas was recognised immediately by laterality experts (eg Hardyck, Hellige, Kitterle, Bryden), and her hypothesis inspired a wave of research. (Sergent and her work inspired me, too, as I worked as an undergraduate in Hardyck's laboratory at UC Berkeley. My very first psychology experiments were conducted in 1982 to examine Sergent's hypothesis.)

There is now a variety of books and articles that review the 15+ years of research on the frequency hypothesis of the hemispheres (eg Christman 1997). Additionally, some research has failed to support the hypothesis for reasons left out of the book (eg response-bias issues); the hypothesis has its detractors (Peterzell 1997). So, Ivry and Robertson seem to be mistaken when they write, "At present, evaluation of the DFF theory is still in its infancy, and the theory is best seen as one post hoc interpretation of disparate empirical findings" (page 71). That fussy infant is an incorrigible adolescent now.

Indeed, Ivry and Robertson appear to have followed Sergent's recipe, albeit in a reorganised and amplified fashion that includes some valuable additions. Much of the new book is essentially an elaboration of Sergent's original hypothesis, and many of the fresh ingredients of this book were taken out of the refrigerator about 10 to 20 years ago.

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