

uncovering the two figures, then to one of a single figure moving (optimal motion), and then to one of blurred motion (pure motion) at the higher frequencies. If the rate is increased still further, of course, the display turns into an unmoving solid patch – as in many of the studies of persistence in the literature reviewed by Haber. In view of such examples, how can one consider vision to be merely spatial?

In summary, how much information for persistence is Haber willing to allow? And what does he mean when he says that hearing is temporal and vision is spatial?

Icons and iconoclasts

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The core hypothesis of Haber's argument is that visual persistence or iconic storage are "unrelated or even antithetical to normal perception." It is not difficult to falsify this hypothesis by challenging many of the assumptions Haber makes in his argumentation. I will challenge many specific assumptions and, in turn, illustrate how iconic storage has added to our understanding of visual perception.

In most normal viewing, an eye fixation maintains the image of a scene continuously and stably on the retina. Haber asks: Why do we need an internal mechanism to store the image when the stimulus can do it directly? Here, I believe, Haber has fallen into the trap of naive realism; that is, there is no need to postulate an internal process since an external process already exists. However, there is no reason to assume that the internal process directly mirrors the external process and, in fact, it may not, in the domain of iconic storage. The onset of visual stimulation is more important for the visual system and we might expect that a fixed visual input at the beginning of an eye fixation will have a larger consequence than the same input later in the fixation period. In fact, as illustrated on page 409 in Cornsweet (1970), we can make the visual input disappear by holding a steady fixation even though it continues to be imaged on the retina. For visual scientists, one concern must be to map out the temporal course of visual storage and processing within an eye fixation. Haber's naive realism would at best predict a linear process, which it definitely is not. The view also precludes the important issues of the nature and rate of processing, limited capacity, and selective attention within a given eye fixation. The tachistoscope, and now the CRT (cathode ray tube) have been important in studying these issues. I don't believe that many scientists can be convinced that these are unimportant or irrelevant questions just because our visual experience in a given day consists of over 100,000 eye fixations and not just one. They may get bored with the issues or discouraged with the slow progress and therefore seek other research endeavors. To justify their new endeavors, they might even argue that their new concerns are more ecologically valid than their old ones.

Haber's appeal to our natural viewing experience does not make 20 years of research on visual information processing irrelevant. What about his arguments based on experimental evidence?

Iconic storage does not seem to be identical with visual persistence; therefore, what is it, and how does it play a role in visual perception? Haber's problem is that he equates iconic storage with a static picture in the head. However, formal notions of iconic storage have always been much more sophisticated and have accounted for many of the features of temporal resolution in vision (Breitmeier & Ganz 1976; Lupker & Massaro 1979; Massaro 1975; Rumelhart 1970; Turvey 1973). From one perspective, it might be said that most of the research in visual information processing offered much theory and data to

replace the "instantaneous picture in the head" metaphor of perception. Haber has incorrectly accused visual scientists of the naive realism they so greatly abhor.

"Maskability of persisting excitation reduces the potential usefulness of an icon by limiting its duration, perhaps to nothing," writes Haber. Masking plays an important role in visual information processing. If stimulation persisted from a previous fixation and were not replaced by the stimulation of the present fixation, a perceiver would be faced with a montage of many images. The icon should not be equated with the persistence of information after the stimulus terminates but with the internal representation of a visual scene. Masking insures that a visual system is usually processing only one scene at a time. The initial stage of visual processing is the internalization and the resolution of the visual scene available to the visual system. For this resolution to be accomplished, the scene must remain relatively stable with respect to retinal coordinates. Iconic storage might be the mechanism that achieves this stability. A fixed image is necessary since pattern recognition requires a relatively consistent pattern of stimulation. Whether one believes in line detectors or sine wave detectors, some stable period of stimulation appears to be necessary for recognition to take place. Without this stable period, stimulation concerning the relations among the properties of the display would be constantly changing. Thus, given a continuously changing stimulation, there would be insufficient information and processing time for recognition to take place. Thus, iconic storage might allow the visual properties of a scene to be processed simultaneously and in a coherent way.

Haber argues that the generalization from auditory storage to visual storage is suspect. However, many parallels between the two modalities exist (Massaro 1975; 1979) and it would be a mistake not to acknowledge these parallels in research and theory.

In closing, we might ask whether Haber's criticisms are relevant to visual information-processing research and theory or simply to the idea of visual perception corresponding to a frozen picture in the head. I believe his arguments address the latter and not the former. Do we spend too much time with discrete scenes and too little with continuous viewing? Maybe, but it shouldn't surprise a scientific enterprise that values control, experimentation, parsimony, reductionism, and prediction as measures of understanding. Although this model has served the physical sciences well, viewpoints such as Haber's involve valuable considerations and should be respected. However, his negativism with respect to the progress made both in research and theory is completely unwarranted.

ACKNOWLEDGMENTS

Bruce Bridgeman and Melanie Mayer provided helpful comments on this commentary.

On the nature of brief visual storage: There never was an icon

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Haber's position is an awkward one: He believes that the icon exists but insists that it shouldn't! Without quibbling with a conventional interpretation of the evidence, he accepts the notion of the icon as a visibly persisting representation of the stimulus "existing in raw or unprocessed form," but he does question the usefulness of the concept. The icon cannot be a component of any valid model because, he argues, visibility would only interfere with normal perception. Consequently, Haber recants his version of an information-processing view and exhorts us to ignore the icon and to abandon our tachistoscopes!