

Commentary era Ralph Norman Haber (1983). The impending demise of the icon: A critique of the concept of iconic storage in visual information processing. *Behavioral and Brain Sciences*, 6:1-54.

Abstract of the original article:

Without disputing the experimental evidence that subjects have available most of the content of brief displays for a fraction of a second, or that visual stimuli persist after their physical termination for a similar time, I argue that this evidence is irrelevant to perception. Specifically the notion of an icon as a brief storage of information persisting after stimulus termination cannot possibly be useful in any typical visual information-processing task except reading in a lightning storm. Since the visual world that provides the stimuli for perception is continuous and not chopped up by tachistoscopes, and since our eyes and heads are rarely motionless, no realistic circumstances exist in which having a frozen iconic storage of information could be helpful. Rather, the presence of such an icon interferes with perception. This paper examines instances of normal perception, and then reviews experimental evidence on temporal integration, saccadic suppression, masking, and the photoreceptor basis of visual persistence, to further demonstrate that a storage of excitation cannot be a useful device for storing information. Finally, I note that little would have to be changed in our theories of visual perception or information processing if we simply forgot all about the icon and iconic memory as an early stage of processing.

Iconic memory or icon?

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Identifying the consequence of a brief stimulus presentation with its aftereffects on the retinoreceptors in his target article, Haber (1983) envisages a static (or "frozen") two-dimensional retinal image of a stimulus (i.e., an icon). Haber further argues that this icon cannot represent ecologically relevant information, which is predominantly three-dimensional and temporally distributed, and that much of what we know about the icon is irrelevant to normal perception because the data are obtained in artificial settings.

The objectives of the present commentary are to show that (1) one important theoretical property of iconic memory is inconsistent with a retinotopic icon, (2) data difficult for the notion of an icon do not necessarily challenge the notion of an iconic store, (3) the iconic store, as a theoretical mechanism, is an ecologically valid one, and (4) the rationale of experimentation is such that the experimental task need not mimic the phenomenon being studied.

Iconic memory store and Icon. The representation at the level of iconic memory cannot be an icon for the following reasons: First, consider a brief nine-item display. Are there nine icons, one for each item? This possibility implies a unitization mechanism, something beyond the capability of the retinoreceptors. Alternatively, there may be only one icon within which the nine items are not differentiated. In this case, an icon is rich in detail, but it does not have any storage capacity. However, Haber also identifies "iconic memory" in terms of the observation that subjects' partial-report performance is superior to their whole-report performance. This requires the assumption of a relatively large storage capacity. Hence, the hypothetical mechanism studied with the partial-report task cannot be the static icon (see also Massaro's 1983 commentary). Second, the icon metaphor would commit one to the "integration" interpretation of backward masking. This has been shown to be incorrect under some circumstances (Haber 1969; Turvey 1973).

Third, although the representation in the iconic store is "raw," "unprocessed," and precategorical (Clark 1969; Sperling 1960; Turvey & Kravetz 1970; von Wright 1968), this characterization is made with respect to a particular frame of reference – namely, verbal coding. When information is not represented at the verbal level, it is said to be "raw" or "unprocessed." This does not mean a complete absence of any processing (Allik & Bachmann 1983; Boynton 1983; Coltheart 1980; Hauske, Wolf & Deubel 1983; Julesz 1983; Klatzky 1983). A notable example of this type of thinking is the view that iconic representation consists of visual features (Haber 1971; Haber & Hershenson 1980). That is, iconic representation is the result of some processing beyond the retinal level, not literally a retinotopic icon.

Theoretical notion, experimental task, and data. In their commentaries on Haber's target article, some investigators (e.g., Breitmeyer 1983) have noted that visual persistence may be found at many different levels of description. Coltheart (1980) has noted that there are qualitatively different kinds of persistence – namely, visual, neural, and informational. What can be added here is that the various kinds of persistence are studied with radically different experimental paradigms. For example, visual persistence was studied by Haber and Standing (1969) with a task which relied on the subject's phenomenological report. Neural persistence was studied by Eriksen and Collins (1967) with a two-part presentation (or "integration") paradigm involving a forced-choice response. Informational persistence was studied with the partial-report task by Sperling (1960).

As can be learned from Coltheart's (1980) review, conclusions obtained with a particular paradigm (e.g., Eriksen & Collins's 1967 integration paradigm) are not applicable to the kind of persistence established with another paradigm (e.g., informational persistence as studied with the partial-report task). This is because the visual system is under different kinds of constraints in different paradigms. The bulk of the experimental data considered by Haber deal primarily with visual and neural persistence. Although these data may be damaging to the concept of a retinotopic icon, they are compatible with iconic memory.

Ecological validity of Iconic memory. In emphasizing visual and neural persistence in his target article, Haber has ignored the capacity of the iconic store, thereby overlooking its ecological validity. The ecological significance of the large capacity of iconic memory was recognized by some of the commentators on Haber's target article (e.g., Loftus 1983). More specifically, the presence of a large-capacity buffer renders selective attention possible (Coren 1933). The joint presence of informational persistence and of a large storage capacity makes it possible to integrate information obtained from functionally discrete inputs into the visual system (Adelson 1983; Coltheart, 1983; Hauske et al. 1983; Uttal, 1983).

To Haber, the most serious problem with the iconic store is that its theoretical properties were established on the basis of an artificial task (see also Haber, 1983r). It can be argued, however, that there has been a confusion between the source of a theoretical insight and the converging operations used to study a hypothetical mechanism.

Admittedly, much of what we know about information persistence comes from studies using single-flash tachistoscope presentation of stimuli, an artificial type of stimulation. However these studies are not the reasons for postulating a large-capacity temporary storage in the first place. Sperling (1960) noted that his subjects felt subjectively that they had seen more than the number of items they could recall when given the typical attention-span task. This observation is an analog of our common anecdotal experience that we have seen more than we can describe. So long as the theoretical properties of the iconic store are consistent with the real-life phenomenon for which the iconic store is proposed, the theory of the iconic store is ecologically valid.

Haber, however, found fault with the artificiality of the experimental tasks used to test the theoretical statements about iconic memory. His metatheoretical assumption in the target article is that in order to study a phenomenon the task used must mimic the phenomenon. The more similar the task is to the phenomenon, the more valid are the data.

Loftus (1983) has noted that Haber's metatheoretical assumption is not the one adopted by most scientists. Loftus's example is that a near-vacuum is an artificial condition. Yet, much of what we know about gravity is learned from studying falling objects in a near-vacuum. This example can be amplified by showing that the logic of scientific investigation requires that the experimental task used to study a phenomenon be an atheoretical one (Feigl, 1970). As can be seen, an atheoretical task should not mimic the phenomenon of interest.

To begin with, identifying some event as an instance of a phenomenon requires an interpretation, a theory-dependent activity. The dilemma confronting a scientist is that, given any event, it can be interpreted in many different ways. In other words, the same event may be an instance of diverse phenomena, depending on one's theoretical assumptions.

At the same time, a hypothesis proposed to account for a phenomenon is of course consistent with the phenomenon. By the same token, a rival hypothesis is also consistent

with the phenomenon of interest. In testing a hypothesis about a phenomenon, the more similar the experimental task is to the phenomenon itself, the less discriminating it is regarding the relative success of the rival hypotheses. This general argument can be illustrated with the following trivial example (see Table 1).

Table 1. Schematic representation of the trivial example

Phenomenon:	Wet highway	Wet highway
Explanation:	It rained.	Someone washed the highway.
Implications:	(a) Wet highway.	(a) Wet highway.
	(b) Wet side lanes throughout the city.	(b) Wet side lanes throughout the city.
	(c) Wet lower parts of lamp poles along highway.	(c) Wet lower parts of lamp poles along highway.
	(d) Wet leaves on treetops.	(d) Dry leaves on treetops.

Suppose that travelers A and B find the highway wet on their way back to their hometown after a trip. Traveler A hypothesizes that it has rained, but B suggests that someone has washed the highway. How can this dispute be settled? First, traveler A has to work out what else must be true, other than the obvious implication indicated in (a), if it has rained. Two such additional implications have been tabulated in the left column of Table 1. Traveler B's hypothesis likewise implies events other than a wet highway (see the right column).

Following Haber's metatheoretical assumption regarding ecological validity, successive sections of the highway should be looked at in order to corroborate traveler A's hypothesis. A less satisfactory piece of evidence to look for is whether side lanes in the city are wet. These choices are made because the former is identical, and the latter is similar, to the wet-highway datum. However, neither piece of evidence is effective in discriminating between the hypotheses because either of them can readily be accounted for by traveler B's hypothesis. Obviously, what is needed is a condition which will occur if A's hypothesis is true, but not if B's hypothesis is true. As can be seen from Table 1, the best data to look at are the leaves on top of a tall tree. Without doubt, leaves on tree tops are very different from a highway. Yet, the discriminating test appeals to the leaves, not a different section of the highway or the side lanes. In other words, the evidence used to support the theory should not mimic the phenomenon to be explained by the theory under investigation (a point also made by Uttal, 1983).

A subject's response to a single-flash tachistoscopic presentation of stimuli is admittedly very different from normal casual glances. It is also true that the iconic store is postulated for visual information processing outside the laboratory. However, the implication of our trivial example is that the artificial nature of tachistoscopic presentation does not diminish the ecological validity of iconic memory, the intuition for which comes from an

everyday experience (Sperling 1960). More specifically, the artificial nature of an experimental task used to test a theoretical notion does not have any bearing on its ecological validity. (Julesz's 1983 commentary also presents a positive argument as to how the use of an artificial task may enhance our understanding of how vision works.)

Summary and conclusion. Haber is not successful in purging the hypothetical iconic store for some theoretical and meta-theoretical reasons. However, Haber's target article is useful because we are reminded of the meagre theoretical advance in our understanding of the hypothetical mechanism. We have not advanced beyond the statement that the content of the iconic store is sensory or precategorical in nature. It is complacency on our part to assume that the iconic store is passive or automatic.

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