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Iconic memory is not a case of attention-free awareness

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ABSTRACT

Whether or not awareness entails attention is a much debated question. Since iconic memory has been generally assumed to be attention-free, it has been considered an important piece of evidence that it does not (Koch & Tsuchiya, 2007). Therefore the question of the role of attention in iconic memory matters. Recent evidence (Persuh, Genzer, & Melara, 2012), suggests that iconic memory does depend on attention. Because of the centrality of iconic memory to this debate, we looked again at the role of attention in iconic memory using a standard whole versus partial report task of letters in a 3×2 matrix. We manipulated attention to the array by coupling it with a second task that was either easy or hard and by manipulating the probability of which task was to be performed on any given trial. When attention was maximally diverted from the matrix, participants were able to report less than a single item, confirming the prior results and supporting the conclusion that iconic memory entails attention. It is not an instance of attention-free awareness.

1. Introduction

Iconic memory, a phenomenon extensively explored in Sperling's now classic monograph (1960), named by Neisser in 1967, and studied extensively since, is considered to be a stage in the processing of visual input that occurs immediately upon the offset of a visual stimulus. It is thought by many to be composed of two components. The first, visible persistence, is of very brief duration, is afterimage-like and gives rise to the impression that the physical stimulus is still present. Its duration is thought to be inversely related to the duration of the array (Coltheart, 1980). The second, informational persistence, has a somewhat longer life and provides the information contained in the no longer visible stimulus in much the same way as the actual image (Coltheart, 1980; Loftus & Irwin, 1998). The first is vulnerable to masking.[1] The second is not.

Interestingly a search of the Sperling monograph and much of the subsequent literature fails to uncover any discussion of the role of attention in iconic memory per se, although there is agreement that attention is necessary to transfer the information from transient iconic memory to working memory, a more durable form of memory. (Although iconic memory is not explicitly mentioned, a paper by Visser and Enns (2001) reports that attention can amplify visible persistence, which may mean it can influence the first stage of iconic storage.) In fact, it seems to have been assumed that attention plays no role in the creation of an iconic memory. Iconic memories were considered to occur as a result of retinal stimulation and accounted for why we frequently have the impression that we see more than we are able to describe or recall. So, for

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[1] There is some evidence that this may not be the case (Smithson and Mollon, 2006).

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example, if we are briefly shown a string of 10 digits or letters and asked to recall them, we can recall 3 or 4 of them, even though we are aware that there were more than 4 items present. In fact, Sperling's ingenious partial report procedure validates this subjective impression. For example, when 12 items are presented in 4×3 matrix, one row of which is cued for recall immediately after the array has disappeared, practiced observers can generally recall all the items in a single row, again about 4, and because they can recall the items in any post-cued row, Sperling concluded that all the items must be accessible, at least very briefly. As the items in one row are being recalled, the items in the other rows are vanishing which is why only 3–4 items can be reported.

The distinction between short-lived iconic memory and longer lived working memory is thought to parallel the distinction between phenomenal and access memory made by Block (2011) where, as pointed out by Lamme (2004), iconic memory is linked to phenomenal awareness, and, according to Lamme, is attention free, whereas access awareness is linked to working memory and requires attention. Here the view that iconic memory is attention-free is explicit. Iconic memory is taken to be a large capacity, fleeting and attention-free, while working memory or access awareness, has limited capacity and requires attention.[2]

Since we are aware of iconic memory, if it is attention-free, as Lamme claims, and attention only enters the picture in the transfer of information into working memory, then this would be, as Lamme and others have argued (see Koch & Tsuchiya, 2007), a case of conscious awareness in the absence of attention. It would stand as evidence against the view that there is no awareness without attention as we (Mack & Rock, 1998) and others (for example, Cohen, Cavanaugh, Chun, & Nakayama, 2012) have argued. So the question of whether iconic memory does or does not require attention is not trivial and bears directly on the nature of consciousness, and whether it necessarily entails attention or not.

The first evidence suggesting that iconic memory requires attention was recently reported by Persuh, Genzer, & Melara, 2012. In 2 experiments in which an iconic memory task was paired with a second more or less attentionally demanding task, they found a very significant decrease in the number of items reported from iconic memory when the paired task was attentionally demanding. Even though the reported evidence was significant, we deemed the question at issue sufficiently important to merit further investigation, particularly since the experiments by Persuh et al. did not include a comparison between partial and whole reports, which is considered a critical diagnostic of iconic storage and because their iconic stimuli were always peripheral, (5.1° from fixation), which might have significantly degraded the iconic representation. Only when the number of items recalled from the memory array using the partial report procedure exceeds the number of items recalled with whole report, is it clear that we are exploring the contents of iconic memory. For this reason the experiment reported here included such a comparison.

To replicate as closely as possible the standard Sperling conditions for assessing iconic memory, we decided to use Sperling's partial versus whole report procedure, and to use a typical Sperling array as the iconic memory stimulus, namely a 3×2 consonant letter matrix that was centered at fixation. (Persuh et al.'s iconic memory display that was located in the retinal periphery consisted of oriented rectangles arranged in a notional circle around a search array at fixation.) Like Sperling, our partial report task required participants to report only the 3 items in one of the post-cued rows, (cued immediately upon array offset), while in the whole report condition participants had to report as many of the 6 items as possible.

The main way in which our experiment resembled the experiments of Persuh et al. was in one of the ways in which we manipulated the attention to the iconic memory task. Like them, we paired the iconic memory task with a more or less difficult visual search task and assumed that if attention were necessary for iconic memory, then the difficulty of the search task would be inversely related to the number of items that participants could report from the letter matrix. However, unlike Persuh et al., we also manipulated attention to the iconic memory display by including conditions in which we varied the probability of which of the two tasks, (search or iconic memory), participants would be asked to perform on any given trial. Since participants never knew until after the array disappeared whether they would be cued to report the letters in the matrix or perform the visual search task, varying the probability of which task they were asked to perform could be counted on to strongly influence which aspect of the array they were prepared to attend to. Thus we predicted that if iconic memory requires attention, the lower the probability of having to perform the iconic task, the fewer the letters reported from the matrix (Tseng, Hsu, Tzeng, Hung, & Juan, 2011).[3] We therefore varied the ratios from 40/60, to 60/40 and 80/20. All these manipulations were identical in the partial and whole report conditions. When the iconic memory task was paired with the hard visual search task and the probability of having to report the letters in the matrix was only 20%, attention was maximally diverted from the iconic memory task. If attention is irrelevant for iconic memory, this should not affect the number of letters that can be reported, but if there is evidence that the number of letters reported is sharply and significantly reduced, this would clearly point to the importance of attention in iconic memory.

[2] There is also discussion of a memory phase that mediates the connection between iconic and working memory designated fragile visual short term memory (fVSTM). Evidence has been presented very recently suggesting at least some aspects of this memory are attention-free (Bronfman, Brezis, Jacobson, & Usher, 2014).

[3] In the second experiment of Persuh et al. (2012), they used a single 60/40 ratio, which meant the participants were cued to report the searched for items on 60% of the trials and the item from iconic memory on 40% of the trials but probabilities were not varied.