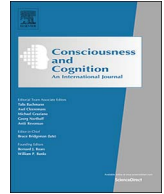




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## Consciousness and Cognition

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## Expectation creates something out of nothing: The role of attention in iconic memory reconsidered

Jaan Aru<sup>a,b,\*</sup>, Talis Bachmann<sup>a</sup>

<sup>a</sup> Institute of Penal Law, University of Tartu, Estonia

<sup>b</sup> Institute of Computer Science, University of Tartu, Estonia

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### ABSTRACT

Conscious experience is modulated by attention and expectation, yet is believed to be independent of attention. The experiments on iconic memory (IM) are usually taken as support for this claim. However, a recent experiment demonstrated that when attention is diverted away from the IM letter display subjects fail to see the absence of IM letters. Here we contribute to the ongoing debate by overcoming experimental shortcomings of this previous experiment, by measuring subjective visibility and by testing the effect of the post-cue. We were able to replicate these earlier findings and extend them by demonstrating that subjects who do not realize the absence of letters perceive illusory letters. This result means that there is still phenomenal consciousness, even when attention is diverted. Expectation creates illusory content that overwrites valid IM content. Taken together these findings suggest that the present experimental paradigm is not appropriate to make claims about IM content.

### 1. Introduction

Conscious perception is shaped by both sensory and top-down aspects of neural processing. Hence, there is not much doubt about whether attention influences conscious perception. However, there is quite some controversy about whether attention is *necessary* for conscious experience (Aru & Bachmann, 2013; Cohen, Cavanagh, Chun, & Nakayama, 2012; Koch & Tsuchiya, 2007). The classic iconic memory (IM) task of Sperling (1960) has been one of the cornerstones for the claim that phenomenal consciousness and attention are independent (e.g. Aru & Bachmann, 2013; Koch & Tsuchiya, 2007). Mack, Erol, Clarke, and Bert (2016) manipulated attention in the Sperling's IM task by having a dual task where subjects had to report either the features of the four circles in the four corners of the screen or, on a small proportion of trials, the letters on the IM display located at the central display area (see Fig. 1). The task, which the subjects had to attend to, was indicated by a post-cue (a high or low pitch tone). Similarly to the inattentive blindness experiments (Mack & Rock, 1998) on one trial something curious happened. Namely on the 101st trial there were no IM letters on the screen and the post-cue (the tone) indicated to the subjects that they should be doing the circle task. After such a post-cue the subjects were nevertheless prompted to enter the letters (which had not been there).

Mack et al. found that more than half of the subjects still entered letters on this trial where no letters were present. Mack et al. reported: "They entered letters into the response box, reported they did not see anything different on this trial, and were surprised to learn there were no letters present." (Mack et al., 2016, p.5). The authors "take this as powerful evidence against the existence of any phenomenal experience component of" IM. The logic is the following: the phenomenal experience component of IM should be empty (as there were no letters on the display), but the subjects still report letters, hence there was no phenomenal experience component of

\* Corresponding author at: Institute of Computer Science, University of Tartu, Ülikooli 17, 51005 Tartu, Estonia.  
E-mail address: [jaan.aru@gmail.com](mailto:jaan.aru@gmail.com) (J. Aru).

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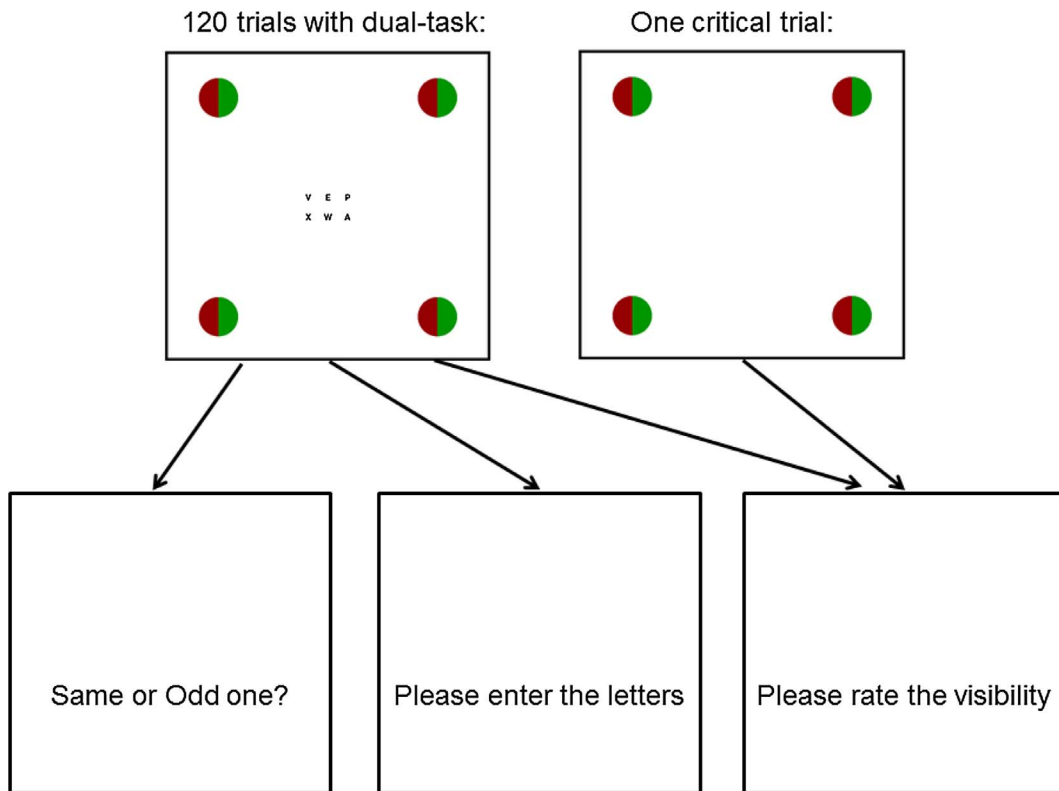


Fig. 1. The experimental paradigm (adopted from Mack et al. (2016)). The display on the top left with circles in the corners and letters in the middle is associated with three different tasks (bottom row). In the single task condition (see Section 2) all these tasks are trained independently, but in the main experimental phase (dual-task condition) the subject has to be prepared for all these tasks. However, in the dual-task condition a post cue (a tone) indicated that the subjects must perform the circle task on 90% of trials, thus ensuring that attention is diverted away from the letters. In one critical trial there were no letters (depicted on top right), but the subjects were prompted to rate the visibility of these absent letters.

IM. We think this logic is flawed.

Our main argument is that subjects who reported having seen the non-existing letters on the 101st trial did not report absence of letters because, subjectively, they indeed experienced *illusory expected* stimuli (Bachmann & Aru, 2016). Their phenomenal experience component of IM could have been veridical and empty, but as they had expected letters filling the phenomenal experience, they reported letters. Therefore, reporting non-existing letters would not be an indication of absent IM content, but rather an artefact of expectancy.

In other words, there are two competing representations for phenomenal consciousness: the (bottom-up driven) IM content and the (top-down driven) expected content. For these subjects who reported the non-existing letters the IM content might have been empty, but as expectations created the subjective letters, the participants reported having seen letters. Hence, according to this view, the paradigm of Mack et al. (2016) is not a pure paradigm about IM because IM content of an empty display might be overwritten by top-down expectations. (Note that we here take the view that IM is a short term buffer of sensory (i.e. bottom-up) information and we suspect that Mack and colleagues take the same perspective. However, we acknowledge that a broader perspective is also possible and return to this issue in the Section 4).

To move on in this debate, it seems appropriate to focus empirically on the aspect of discussion directly causing controversies – the phenomenality of the letters on the IM screen. If the subjective experience of the reported but actually non-existing letters is evaluated higher than “no experience of the stimulus” in the *diverted-attention* condition, then this is evidence for the phenomenal representation of the expected stimuli independent of attention.

To study the illusory quality of the expected letters, we directly measured the subjective clarity of letters and asked for this visibility rating also in the trial with no IM letters. In particular, we used the well-validated PAS scale (Overgaard, Rote, Mouridsen, & Ramsøy, 2006) for asking the subjects about how well they perceived the letters. Our hypothesis was that the subjects who notice the absence of letters would rate the visibility with “no experience of the stimulus” (see Section 2) whereas those subjects who report having seen the non-existing letters would rate the visibility of the letters with a higher rating.

In addition, we took care of two issues that emerged from using the misleading post-cue. In particular, after the experiment of Mack et al. (2016) was conducted “the experimenter asked the observer whether they *noticed anything different* on this trial” (Mack et al., 2016, p. 2, emphasis ours). The main interest of Mack et al. (2016) was of course whether the subjects had noticed that there were *no letters*, but in fact this was not the only aspect that was different during this 101st trial. Namely, as explained above, for drawing attention to the circle task, on the 101st trial the post cue (the tone) signaled the circle task, but then the letter task appeared

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