Trends in Cognitive Sciences

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Letter

Three Criteria for Evaluating High-Level Processing in Continuous Flash Suppression

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A deeply challenging and popular question concerns what information is preserved during processing of invisible stimuli. Can an invisible stimulus reach processing stages commonly attributed to high-level semantic or cognitive processing? Continuous flash suppression (CFS) is a perceptual suppression technique that provides a means to test this question because it allows for keeping stimuli invisible for considerably more time than traditional suppression methods. Over the past 15 years, a substantive literature has accumulated and parts of this literature suggest that high-level processing of unseen stimuli as integrated, semantic entities can indeed occur. This notion of integrated high-level processing was recently challenged by highlighting that interocular suppression, the putative mechanism underlying CFS, likely relies on representations of fractionated stimuli early in visual cortex [1,2]. That is, interocular competition acts on the low-level features that are the consequence of stimulus fractionation in early visual processing.

Sklar *et al*. [3] do not challenge the premises on which our arguments rest, yet instead argue that a selective review of the literature can indeed lead to our 'pessimistic' fractionation account. They cite several findings consolidating their point that there is sufficient evidence for high-level processing despite stimulus fractionation. In principle, we do not disagree with the examples of high-level processing that are presented. Indeed, considered together they paint a positive and convincing picture. However, any particular selection of findings necessarily biases one's reading of the literature, in either direction.

We argue that not all published CFS studies should be weighted equally when debating whether high-level processing occurs under CFS. We outline three criteria we consider crucial to assess a study's evidential weight. None of the studies Sklar *et al*. [3] cite pass these three criteria. Therefore, we consider their examples to be unsatisfactory to claim high-level processing during CFS.

(i) Breaking CFS Findings Are Insufficient to Claim Unconscious Processing

Many studies Sklar *et al*. present as evidence for high-level processing are breaking CFS studies (where the time for an invisible stimulus to overcome CFS is used as a measure for unconscious processing). An aspect that is rarely highlighted in this discussion on high-level processing during CFS is that it is currently debated whether this paradigm can provide evidence for unconscious processing at all [4,5]. Nevertheless, even if it is considered to be a valid tool, very few studies show high-level unconscious processing if the proper controls are included [6]. Indeed, we consider the dissociation approach where an implicit processing measure is contrasted with an explicit awareness measure to be the stronger, more valid approach to claim genuine unconscious processing (see [7] for an example).

(ii) Findings That Have Not Yet Been Subject to Replication Should Be Judged with Caution

The CFS literature is riddled with so-called 'one-off' findings. As publication bias is still thriving, it is difficult to judge the evidential value of these findings, even if a published study consists of a set of multiple experiments, where each experiment is the logical next step based on the results of the previous experiment. Thus, to judge the evidence for high-level unconscious processing, findings that have been the subject of a replication study should be given much more weight compared to other findings. As a clear example of high-level processing during CFS, Sklar *et al*. highlight a study where expressions of unseen faces influence the perception of visible, neutral faces [8]. However, the same lab has now called into question the unconscious nature of this effect [9]. More generally, most studies claiming high-level unconscious visual processing that have been the target for replication fail to replicate [10].

(iii) More Parsimonious Explanations of the Findings Should Be Exhausted before Claiming High-Level Processing

A canonical case of invoking a more parsimonious explanation for a CFS finding is showing that low-level stimulus confounds or statistical artifacts due to post hoc data sorting explain the results. Sklar *et al*. present studies on certain emotional expressions having preferential access to awareness as examples of high-level unconscious processing. However, it has been shown that low-level stimulus differences between these expressions explain these results [11]. Relatedly, Stein *et al*. [12] showed that facial dominance, and trustworthiness-related differences in suppression times, can be explained by physical differences between stimuli in the eye region, as differences in suppression durations between dominance or trustworthiness conditions were still observed with cropped versions of these faces for which observers could no longer rate the dominance or trustworthiness.

We believe passing these three criteria is critical for claiming genuine high-level unconscious processing. Despite their subjective nature, they provide a useful benchmark to evaluate the literature in its proper context. Their application will facilitate a constructive discussion regarding the state of the literature. We hope this will ultimately enable a consensus view on high-level processing under CFS, providing solid groundwork on which future studies can be built.

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