Trends in Cognitive Sciences

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Letter

The Fundamental Problem with No-Cognition Paradigms

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A central controversy in consciousness science concerns whether the neural correlates of consciousness (NCCs) exclusively reside posterior to the central sulcus or also include frontal regions [1–4]. In a recent *Trends in Cognitive Sciences* article, Block [5] contends that popular 'no-report' paradigms [6,7] cannot settle this dispute, since absence of report is consistent with extensive private cognition. To make progress, we instead require a 'no-cognition' (or more precisely, 'no-post-perceptual cognition') paradigm. According to Block, doubts about such approaches [8–10] are misplaced, since Brascamp *et al.* [11] have already developed precisely such a paradigm. Block is rightly dissatisfied with no-report methods. However, a fundamental difficulty faces no-cognition paradigms, as examination of Brascamp *et al.*'s study reveals.

Brascamp *et al.* exploit binocular rivalry: the presentation of different stimuli to each eye, leading to alternating percepts. Specifically, they presented each eye with a distinct pattern of quasi-randomly moving dots with 40% motion coherence. These dots changed direction every 300 ms, creating an impression of high-tempo jitter in their global motion. Average dot motion was orthogonal across patterns, creating two types of transition: objective transitions, where the dots physically changed direction every 300 ms, and rivalry transitions, where a switch in eye dominance changed the perceived motion direction every few seconds. When dots differed in color across eyes, rivalrous transitions were easily detectable. However, when dots were the same color, although rivalry transitions still occurred, observers detected them eight times less frequently, a level insignificantly different from chance. This is plausibly because such changes, while visible, could not be distinguished from objective changes in dot dynamics (i.e., the constant jitter in global motion). (In Box 1, we discuss the possibility that such transitions were in fact invisible.)

According to Block, what is theoretically important is that 'this method avoids the systematic change of cognitive states… that can accompany rivalrous changes'. Thus, the methodology is 'not just a no-report methodology: it is a no-differential-post-perceptual cognition methodology'. Yet, Brascamp *et al.*'s paradigm does not avoid systematic changes of cognitive states. All it avoids are thoughts specifically tied to rivalrous transitions as opposed to objective changes in dot dynamics. Nothing in Brascamp *et al.*'s methodology prevents observers engaging in extensive cognitive processing when transitions occur, so long as similar processing attends objective changes. Indeed, Brascamp *et al.* precisely designed their displays so that the appearance of objective change closely matched that of rivalry-driven change, so we should expect close similarities. Cognitive processing cannot be expected to distinguish the subjectively indistinguishable.

This fundamentally compromises Block's interpretation of Brascamp *et al.*'s fMRI data. Brascamp *et al.* calculated blood-oxygen level-dependent (BOLD) contrasts between intervals inferred to contain a rivalry transition and intervals inferred to be transition free in three overlapping frontoparietal and temporoparietal attentional networks. No evidence was found that this activation differed from model predictions, which treated BOLD activation as a function of transition reportability. Thus, a large contrast was found in the different color condition and a much smaller contrast in the same color condition. However, this does not indicate an absence of activity in target regions accompanying transitions. It only shows that this activity does not significantly differ between intervals with and without transitions. Moreover, since both intervals contain multiple objective changes engineered to look just like rivalrous transitions, it is unsurprising if subjects respond to both intervals in very similar ways. Compared with the different color condition, where there is a dramatic difference in the type of change between intervals, there is effectively no detectable difference in the same color condition.

What is evidenced by the absence of contrast is that frontal areas do not causally initiate transitions. This was the purpose of Brascamp *et al.*'s study. However, we should not conflate the property of causing transitions with the property of being an NCC of rivalrous changes or contents. Sensory circuits may determine when changes between contents occur, even though prefrontal circuits are constitutively involved in our awareness of them. This hypothesis is consistent with the finding that invisible stimuli elicit switches detectable in sensory cortex but not in frontal regions [12].

Box 1. Completely Unconscious Rivalry Transitions

It is possible (albeit unlikely in our view) that rivalrous changes are genuinely invisible in the same color condition, not merely indiscriminable from objective changes. However, this does not avoid our concerns. If rivalrous changes are invisible, we will not predict any contrast in frontal activity due to differences in consciously perceived change: there are no such differences. However, since rivalry still occurs, one interval could contain at most one extra change in perceptual contents. Yet, since there are multiple matching objective content changes in both intervals, we again will not predict a measurable difference in BOLD activity. Even more sensitive analyses of the data (e.g., multivoxel pattern analysis) or more sensitive methods (e.g., electrocorticography), which Brascamp *et al.* did not use [11], may well still fail to detect such subtle differences.

This methodological point generalizes to all studies that subtract activity during rivalry from activity during a 'replay' condition, designed to mimic observers' percepts during rivalry using a single external stimulus (e.g., [6]). Such subtraction methods help determine the etiology of transitions. However, they are not suitable for establishing NCCs [10]. Although Block partially acknowledges this point about 'replay' subtraction, he does not appreciate that the issue represents an in-principle problem for rivalry-based 'no-cognition' paradigms. As Block remarks, we cannot stop subjects thinking. At most, we can match their thinking across conditions (or intervals). However, to match thinking requires conditions that are indiscriminable in some relevant respect. Yet, indiscriminable stimuli look the same. Consequently, all sides will predict matching frontal activity between conditions with and without transitions. Thus, such paradigms cannot discriminate rival hypotheses concerning NCCs.

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