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What draws the line between perception and cognition?

Behavioral & Brain Sciences commentary on Chaz Firestone & Brian Scholl
Cognition does not affect perception: Evaluating the evidence for 'top-down' effects

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Abstract: The investigation of top-down effects on perception requires a rigorous definition of what qualifies as perceptual to begin with. Whereas Firestone and Scholl's phenomenological demarcation of perception from cognition appeals to intuition, we argue that the dividing line is best attained at the functional level. We exemplify how this approach facilitates scrutinizing putative interactions between judging and perceiving.

In their target article, Firestone and Scholl maintain the position that—for all we know—perception should be considered modular and impenetrable by cognitive top-down influences. They propose a recipe for the audit-proof identification of true top-down effects on perceptual function by avoiding six common pitfalls that have consistently undermined the significance of existing evidence. Given what is at stake—our understanding of the mind's fundamental architecture—we fully agree that this field requires the most rigorous empirical reasoning. However, to achieve this ambitious goal, we need to put our own house in order first and face the problem's other side: We need a clear definition of what qualifies as a perceptual phenomenon to begin with.

Firestone and Scholl appeal to the reader's intuition of what perception is and how it is different from cognition: "Just imagine looking at an apple in a supermarket, and appreciating its redness (as opposed, say, to its price). *That* is perception." (p. 4). This phenomenological definition neatly illustrates to *us as observers* the quality of perception. Yet its amenability to *us as scientists* remains vague. Indeed, a purely phenomenological definition may expose perceptual measures to the pitfalls legitimately targeted by the authors. Asking an observer to appreciate the redness of an apple, for instance, opens the judgement to coloring from memory or knowledge. Similarly, the conscious percepts that visual processing produces can not be easily distinguished from the conscious cognitive state of the perceiver. Rather, the mere act of reading out the result of a perceptual process may stain its immaculateness, just as palpating a soft sponge will never reveal its true shape. The authors concur with this view, emphasizing the importance of performance-based measures tied directly to the perceptual phenomenon. To truly determine whether cognition penetrates perceptual processing, we need to know where perception ends and where cognition starts. How do we isolate perception empirically in the first place? How can we distinguish visual processing and experience from cognition to make its pure form—if it exists—amenable to empirical scrutiny?

The divide between perception and cognition is hard to maintain at the physiological level. Firestone and Scholl emphasize the importance of descending pathways on sensory areas of the brain, and indeed, a considerable number of physiological studies show effects of top-down knowledge at the earliest cortical stages of sensory processing (e.g., Boutonnet & Lupyan, 2015; Dambacher, Rolfs, Göllner, Kliegl, & Jacobs, 2009; Kim & Lai, 2012; Rabovsky, Sommer, & Abdel Rahman, 2011; reviewed in Gilbert & Li, 2013). In fact, anatomy tells us that the only substrates of visual processing that are not targeted by top-down feedback are in the retina, leaving little room to distinguish vision and cognition at this level of description.

We propose instead that perception is separated from cognition by its function. Perception has the purpose of providing packaged descriptions of the environment, which are then used by other functions of the mind, such as reasoning, conscious decision making, or acting. To create these descriptions, perceptual processes extract stimulus features, group them in space and time, partition the scene into separate entities that obey figure-ground relationships, and label these objects or events. At this functional level, we argue, the distinction between perception and cognition works.

Agreeing on a level of description at which a dissociation between perception and cognition is justifiable is an important step. It allows us to identify the traces of processing in these functionally defined modules, which can then be used to track their cognitive malleability. But what would such traces be? To decide that, we contend, we need to turn to the properties of the perceptual system and identify those that uniquely serve its function, while being unsuspicious to result from cognitive reasoning.

This idea is best illustrated using a tangible research example, which entered the long-standing debate of whether the detection of causality in dynamic events results from perceptual processes (like perceiving distance, motion, or color), or from cognitive reasoning that is based on the perceptual output. In a series of visual adaptation experiments, we showed that viewing many collision events in a rapid sequence (discs launching each other into motion) causes observers to judge subsequent events more often as non-causal (Rolfs, Dambacher, & Cavangh, 2013). Critically, these negative aftereffects of exposure to causal events were retinotopic, that is, coded in the reference frame shared by the retina and early visual cortex, and were not explained by adaptation to other low-level features (e.g., motion, transient onsets, luminance, or contrast). A negative aftereffect (similar to those known in color vision or motion perception), its emergence from pure stimulus exposure, and—perhaps most importantly—its retinotopy are traces of visual functions. Arguably, their combination is an unlikely product of cognition. Therefore, these results strongly support the view that the detection of causal interactions is an achievement of the perceptual system, where visual routines in retinotopic brain areas detect and adapt to seemingly complex physical relations—cause and effect.

This example illustrates that the perceptual nature of a phenomenon becomes compelling when functional traces of the underlying sensory system can be revealed. While we showcased the perceptual detection of causality, this is a general point that equally applies to the study of established visual features like motion or color. Evidence that perception is pliable by cognition becomes persuasive only if identifiable traces of perceptual processing follow observers' (allegedly biased) perceptual reports at every turn. We readily acknowledge that the feasibility of this approach depends on the particular research question and phenomenon, but we believe it complements the target article's call for eliminating confounding pitfalls. Yet, to facilitate decisive empirical contributions along this line, a rigorous definition of perception is in demand—one that is concrete enough to lend itself to the study of potential top-down effects of cognition. We suggested the functional level as expedient ground to evaluate the degree of isolation of perception from cognition. We challenge the authors to substantiate their definition of perception in this—or, if they disagree, in a different—realm.

1. References

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