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How to (and how not to) think about top-down influences on visual perception

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ABSTRACT

The question of whether cognition can influence perception has a long history in neuroscience and philosophy. Here, we outline a novel approach to this issue, arguing that it should be viewed within the framework of top-down information-processing. This approach leads to a reversal of the standard explanatory order of the cognitive penetration debate: we suggest studying top-down processing at various levels without preconceptions of perception or cognition. Once a clear picture has emerged about which processes have influences on those at lower levels, we can re-address the extent to which they should be considered perceptual or cognitive. Using top-down processing *within* the visual system as a model for higher-level influences, we argue that the current evidence indicates clear constraints on top-down influences at all stages of information processing; it does, however, not support the notion of a boundary between specific types of information-processing as proposed by the cognitive impenetrability hypothesis.

1. Introduction

One influential debate about perception concerns its purity: is perception an encapsulated process that is protected from influences by cognition or is perceptual bottom-up processing influenced by top-down cognitive information? This debate, which is frequently referred to as the 'cognitive penetration debate', is complicated by the fact that it is often not clear what kind of mental state is supposed to be doing the penetrating and what kind of mental state is supposed to be penetrated. In other words, it is not clear what is 'top' and what is 'bottom' in the debate about top-down influences on perception.

In the first part of this paper, we attempt to clarify some of these conceptual issues. We then proceed to suggest a practical alternative to the philosophical turf wars concerning the extent to which perception is encapsulated. We start with two uncontroversial observations: First, even the most avid proponents of the view that perception is cognitively impenetrable accept the existence of top-down processing *within* the visual system[1]; in other words, it is uncontroversial that higher-levels of visual processing feed back information to and shape lower-levels of visual processing (Pylyshyn, 1999). And second, the exact locus of the boundary between perception and cognition is notoriously difficult to determine (Bayne, 2009; Kriegel, 2007; Masrour, 2011; Nanay, 2011, 2012, 2013; Siegel, 2007; Siewert, 2002). On the basis of these two observations, we argue that important insights might be gained once we stop focusing exclusively on top-down modulation of perception by cognition;

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[1] We will focus on the visual sense modality in this paper, but there is no prima facie reason why our conclusions could not be generalized to other sense modalities.

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rather, we suggest that it is heuristically valuable to view this special case within the broader context of top-down influences in a hierarchically organised information processing system.

The general agreement concerning top-down processing within the visual system can be used as a starting point from which our understanding can be expanded to potential higher-level top-down influences without having to commit *a priori* to what exactly counts as perception or cognition. Once such an approach has been adopted, we can start asking nuanced questions about the specific mechanism of top-down modulation in information processing in general. Among other questions, we can ask what kinds of constraints exist on top-down influences between certain levels of processing and whether some of these constraints might amount to a full-blown boundary as proposed by the encapsulation hypothesis. According to our evaluation of the theoretical and empirical evidence, there is no reason to assume that top-down processing is restricted to specific parts of the information processing hierarchy. By contrast, we defend a view that puts clear constraints on all sorts of top-down processing – as well as on bottom-up processing – but that allows bidirectional flow of information between levels that some would consider to cross the perception-cognition divide.

2. Two debates about top-down influences on perception

The main conceptual confusion concerning debates about top-down influences on perception is that it is not clear what is meant by 'perception' in this context. Many philosophers (Macpherson, 2012; Siegel, 2011; Stokes, 2012), but also some psychologists (e.g., Firestone & Scholl, in press), take 'perception' to be perceptual experience: something we are consciously aware of. According to this conceptualisation, the question is whether top-down influences can alter the way we experience a scene – the phenomenal character of our experience: what it is like to perceive this scene.

Another way of understanding what is meant by 'perception' when we talk about top-down influences is perceptual processing – something neuroscientists, psychophysicists, and some psychologists care about. Here, the question is whether a certain type of information processing is influenced in a top-down manner. Most generally, all computations that are specialised for and concerned with transforming the spatio-temporal pattern of light hitting the retina into meaningful representations can be considered part of visual processing. Following the work of David Marr (1982), visual processing is often specified in further detail in terms of computations that lead to specific geometrical descriptions of a visual scene (e.g. Pylyshyn, 1999). Our understanding of the neurobiological architecture of the early parts of the visual system is advanced enough to provide a general picture of how such a functional description of vision is realised by populations of neurons that extract information about specific perceptual properties such as orientation, contours, and motion in striate and extrastriate cortices. Evidence of top-down modulation in these brain areas would therefore count as evidence for top-down modulation of perceptual processing.

These two questions are clearly very different – one of them is about phenomenology and the other is about a specific type of information processing. We are extremely pessimistic about whether the first of these debates could ever be resolved in a satisfactory manner. The main reason for this pessimism is methodological in nature. Most studies that attempt to address the extent to which perceptual phenomenology is influenced by top-down processing rely, at least to some degree, on introspection, which is known to be notoriously unreliable (see Dunham, Baron, & Banaji, 2008; Greenwald & Banaji, 1995; Haggard, Clark, & Kalogeras, 2002; Kahneman & Tversky, 1973; Nisbett & Wilson, 1977; Schwitzgebel, 2008; Spener & Bayne, 2010; Tversky & Kahneman, 1981; Wegner, 2002; Wegner, Sparrow, & Winerman, 2004; Williams & Bargh, 2008; Zhong & Liljenquis, 2006 – this is merely the tip of the iceberg of the vast literature on the unreliability of introspection). But we do not mean to suggest that it is *only* by introspection that one can find out about perceptual phenomenology. The so-called 'methodology of contrast cases' (Kriegel, 2007; Siegel, 2006), for example, combines introspective evidence with an inference to the best explanation – it is not introspection alone that does the job (although introspection is a necessary ingredient of all attempts to characterise perceptual phenomenology). What we take to be an even more important concern about the focus on perceptual phenomenology is that it is difficult to settle disagreements about its nature.

The main difficulty in this debate is to determine what is part of our perceptual as opposed to non-perceptual phenomenology. Those who argue for the existence of top-down influences on perceptual phenomenology need to show that there can be two mental states, call them M1 and M2, that only differ in that there is a top-down influence in M2, which is missing in M1 and that the two differ in their perceptual phenomenology. So the top-down influence results in a difference in perceptual phenomenology. Those who are against the idea of top-down influences on perceptual phenomenology can acknowledge that M1 and M2 differ only in that top-down influences are present in M2 but absent in M1 and they can also acknowledge that M1 and M2 differ in their non-perceptual phenomenology – they only deny that they differ in their perceptual phenomenology. So the only way of adjudicating between the proponents and the opponents of top-down influences on perceptual experience is by having a very clear distinction between perceptual and non-perceptual phenomenology.

But we are blatantly missing any such clear distinction or even a methodology that might be able to help develop it. Take the following example: You are at a dinner party and are eating what you take to be chicken. Then your host tells you that it is in fact rat meat. Your experience, presumably, changes. The meat tastes differently. This seems to be an indication that your perceptual phenomenology changes – what changes is the way the meat tastes to you. But suppose that you insist that what changed was not the perceptual but the non-perceptual phenomenology in this example. It is difficult to see what could possibly settle this disagreement. We may be able to tell whether our overall phenomenology changed. But to

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