Perception, prediction, and penetration
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Abstract
The traditional view in philosophy and psychology maintains that perception and cognition are distinct, and that perception can influence cognition but not vice versa. This view is challenged in a new paper by Andy Clark, in which he suggests that perception and cognition are ‘intertwined’, ‘continuous’, and ‘unified’, and that perception is ‘theory-laden’. These claims about the nature of perception and cognition, according to Clark, are the result of the hierarchical and predictive nature of the human brain. In this paper, I show that this model of the brain is entirely consistent with the traditional view of perception and cognition. In particular, the debate over the cognitive penetrability of perception is left untouched.

Perception and cognition
Perception and cognition, according to the traditional view, play distinct roles in our mental lives. Perception gathers information about the immediate environment; cognition combines this with stored information (e.g. beliefs, memories) to draw inferences, and with motivational states (e.g. desires) to guide action. The relation between the two is traditionally understood to be one-way: what we perceive influences what we believe, but our perception of the world is not (directly) influenced by our beliefs. Another way to put this latter claim is to say that perception is cognitively impenetrable – the contents of our perceptual experience are not penetrated by our cognitive (doxastic, epistemic) states.

The standard case for the cognitive impenetrability of perception involves optical illusions like the Muller-Lyer illusion, in which you are shown two lines that appear (due to contextual effects) to be differing lengths. Even once you have measured the two lines and convinced yourself that the two lines are the same length, you still perceive them to be different lengths: your beliefs do not influence your perceptual experience.

If the traditional view is false, then perception is cognitively penetrable. This would have substantive philosophical implications regarding the epistemic role played by perceptual experience. For example, rational scientific progress seems to require that we can use observation to adjudicate between between competing scientific theories, which in turn requires that observation itself be theory-neutral. But if perception is cognitively penetrable, then one’s theoretical commitments can influence what one perceives, and observation is ‘theory-laden’.
(Notice that as standardly understood, cognitive penetration is the penetration of perceptual experience by conceptual thought. Top-down effects on ‘early vision’ processes from within the visual system would not count as cognitive penetration for standard purposes: see Macpherson 2012 for discussion.)

Hierarchical predictive models

The relation between perception and cognition, therefore, impacts on key philosophical issues. The traditional view of perception and cognition has recently been challenged by Andy Clark (in press), who claims that a new model of perception represents “a genuine departure” from our previous thinking about perception and cognition. Clark suggests that this is a new model not only of perception, but “perhaps ultimately of the relation between perception and cognition itself”, in which perception and cognition are “profoundly unified and, in important respects, continuous” and in which “[b]elieving and perceiving emerge as deeply intertwined”.

The model to which Clark refers is the hierarchical prediction model of brain function (hereafter HPM). The key idea behind HPM is that the brain is ultimately a predictive engine, composed of a hierarchy of systems operating according to Bayesian rules. Higher-level systems try to predict the inputs to lower-level systems, and any prediction errors are used by the higher-level system to refine its predictions. The brain attempts to ‘explain away’ the input errors by generating predictions that match the input. The higher-level guesses act as Bayesian priors for the lower-level processing. As a model of perception, this means that the brain predicts what the next sensory stimuli will be. Sensory input is not used as raw data from which to build up a model of the environment: rather it is used to correct our existing model of the environment.

Clark claims that HPM leads to a view of perception as (i) inferential, (ii) knowledge-driven, and (iii) the result of top-down processes. I'll take each of these claims in turn in at attempt to establish the extent to which they are true, and the extent to which they make us rethink the relation between perception and cognition.

In what sense is perception inferential in HPM?

Clark claims that HPM follows the work of Helmholtz and others “in depicting perception as a process of probabilistic, knowledge-driven inference”. The ‘inferences’ in question are Bayesian, and so, claims Clark, ”[t]he process of perception is thus inseparable from rational (broadly Bayesian) processes of belief fixation”. Claims about the ‘inferential’ nature of perception, however, are nothing new. While some of these claims refer to genuinely inferential processes, most are using the term metaphorically. As Hatfield points out, many people use ‘inferential’ as synonymous with ‘information-processing': ”They are not inferential theories of perception, but theories of information transmission in perception" (Hatfield 2002).
So in what sense are Bayesian perceptual systems inferential? First, notice that Bayesian models do not attribute perceptual inferences to the person: "There is no good sense in which the thinker herself, as opposed to her perceptual system, executes perceptual inferences" (Rescorla forthcoming). On the Bayesian view, the transitions between perceptual states are "statistical inferences" in the sense that "[t]ransitions among perceptual states approximately conform to norms of Bayesian decision theory" (Rescorla forthcoming).

And indeed, Bayesian frameworks are a way of taking talk of unconscious inferences are converting it into "mathematically rigorous, quantitatively precise psychological models" (Rescorla forthcoming). Clark himself seems to be committed to such a view of inference talk: the 'free energy minimization' framework is supposed to discharge talk of prediction, inference, etc. leaving it harmlessly metaphorical. So the fact that perceptual processing is Bayesian and 'inferential' in form doesn't tell us anything new about the relation between perception and cognition. In particular, perception is no more 'continuous with cognition' on this view than in any other computational theory of perception.

**To what extent is perception knowledge-driven in HPM?**

Clark thinks that HPM gives us a picture of perception as involving "knowledge-driven inference." In what sense are the Bayesian statistical inferences in HPM 'knowledge-driven'? Knowledge comes into the picture due to the predictive commitments of the model, and the phenomenon of 'explaining away': higher-level models attempt to cancel out prediction errors from sensory signals, to match the predicted data to the actual data. Clark emphasises that "[t]hese predictions reflect what the system already knows about the world", and that "[t]o perceive the world just is to use what you know to explain away the sensory signal" (emphasis mine).

First, notice that 'knows' here does not refer to agent-accessible propositional attitude states involving belief and justification. 'Knowledge' here refers to the assumptions of the visual system, where even the term 'assumption' is a metaphorical gloss. Clark's example of an assumption is the visual system's 'knowledge' that only one object can exist in the same place at the same time. This is not the agent's belief about how the world is, but rather a prior assignment of probabilities that acts as an input to Bayesian processing.

What should we make, then, of Clark's claim that perception is "theory-laden in a very profound way" on HPM? Clark suggests that perception is theory-laden in the sense that what we see is determined by our best hypothesis. But this need not be understood as 'our' (i.e. the agent's) best hypothesis, rather than the visual system's best hypothesis. Compare the 1980s debate between Churchland and Fodor, in which Churchland claimed that perception was theory-laden on the grounds that the perceptual system involves certain assumptions. Fodor countered that these
assumptions leave “perception neutral with respect to almost all theoretical disputes” and “couldn't ground any general argument for the unreliability of observation” (Fodor 1988:189). I suggest that the same can be said for Clark's theory ladeness. What we perceive is partly determined by assumptions in the visual system (either hard wired or acquired) such as that light generally comes from above – but this has been a standard feature of theories of perception for a long time due to the poverty of the stimulus. A genuine case of theory ladeness would be the Muller-Lyer lines appearing the same length after we have learned their measurements, but there is no indication that HPM gives us that. I suggest that Clark's ‘assumptions' are like Churchland's assumptions in that they “have nothing to do with beliefs, theories, or other doxastic commitments that we may have [...] [They] leave the epistemic normativity of perception untouched" (Stokes forthcoming).

**In what sense is perception top-down in HPM?**

Even if we dismiss the sense in which perception is inferential or knowledge-driven in HPM as being any different from other models of perception, there is a sense in which the HPM clearly departs from other models in its emphasis on top-down processing. The predictive hierarchies mean that higher hypotheses determine what we see, with lower processing playing less of a role than usually supposed. But the distinction between 'top down' and 'bottom up' effects is problematic, if 'top down' is taken to include implicit assumptions or expectations:

"There is a problem, however, with the psychological distinction. Top-down effects are defined as influences of an individual’s expectations and stored knowledge (Eysenck, 1998, p. 152). On the face of it, that includes the expectations that are implicit in the operation of a psychological process – in its dispositions to transition from one representation to another." (Shea forthcoming)

The philosophically interesting cases of top-down effects are restricted to information that is explicitly represented in the system. If we redefine the notion of 'top down' to retain the philosophically interesting distinction, as Shea does, then the mere fact of hierarchical processing in a downwards direction is insufficient to raise problems about cognitive penetration. The top-down influence has to come from explicit representations – but Bayesian perceptual models don’t require explicit representation:

"There is no evidence that the perceptual system explicitly represents Bayes's Rule or expected utility maximization. The perceptual system simply proceeds in rough accord with Bayesian norms." (Rescorla forthcoming)

**Conclusion**

Clark (forthcoming) claims that hierarchical predictive models of brain function have implications for the relation between perception and cognition. Specifically, he claims that perception is inferential, knowledge-driven, and top-down. I have
examined the extent to which perception fulfils these criteria, according to HPM, and concluded that the traditional view of perception and cognition remains unaffected. A further interesting question relates to the implications of HDM for a causal theory of perception and for questions about realism, which I will discuss in a future paper.

**Bibliography**


