FRA FORSKNINGSFRONTEN

HOW DOES INFORMATION FLOW BETWEEN PERCEPTION AND COGNITION?

By Sebastian Watzl

1. Introduction

It is natural to think of perception as our informational interface with the world. It is the messenger that tells us about our environment. If I would like to gain information about whether an object on my kitchen table is yellow or grey, I look at the object, I see its color, and on the basis of what I see, I form the belief that it is, say, yellow and not grey. And if I would like to know whether there is mustard in the fridge, I look inside the fridge, and on the basis of what I see, I gain information about whether mustard is there or not. Perception delivers information to cognition. The information about the color of the object or the contents of the fridge is first in perception, it may seem, and what is there is the basis for what we come to think, judge, or believe. The flow of information goes from perception to cognition. Does information also flow the other way around, from cognition to perception? Does what we already know or believe, what we remember, what we want, suspect or fear influence perception? I already knew that the object on my kitchen table was a banana, and I believe that bananas are generally yellow. Did those cognitive states influence the color I perceived the object as having? And I already suspected that I am out of mustard. Did this fact influence whether I saw the mustard in the fridge? Is the mind one big informationally integrated whole, or is perception an informationally closed off messenger that only delivers and never receives? Whether information flows from cognition to perception, and, if so, how, and with what significance, forms the center of a rich debate in contemporary philosophy of mind and in cognitive science. The debate concerns the cognitive penetrability of perception. Does cognition penetrate into perception, or is perception informationally encapsulated, or closed off, from cognition?

Radical consequences might follow if information regularly flows from cognition to perception. Consider the role of perception in the acquisition of knowledge about our surroundings and in providing reasons for our beliefs (the epistemic role of perception). If perception is regularly influenced by more or less rational background assumptions, more or less rational suspicions and fears, then maybe the idea that perception is a neutral messenger is really a "farce" (Siegel 2015): perception "purports to tell us what the world is like, so that … we can check our beliefs, fears, and suspicions against reality … but it does not." (ibid.:420). Maybe perception sometimes just returns our pre-conceptions back to us, only covered in new clothing. Maybe, indeed, perception itself could now be rational or irrational, biased or balanced, depending on whether the pre-conceptions and the processes by which those influence perception are themselves rational or not (ibid.). Think also about the role of observation as a theory-, and background-neutral arbiter in the empirical sciences (the scientific role of perception). Only if perception is informationally closed off from cognition, it seems, could there be any observational judgments certain to be unaffected by a theorist's background commitments (Fodor 1984). By contrast, if background commitments influence what scientists see when they make observations in the wild, under the microscope, or when they look at scientific instruments, then the very idea of neutral observational data might seem threatened. All observation would be theory laden (Churchland 1979, 1988). Perception would not be a neutral arbiter, but an opinionated player in the game. In this article, I will, after making some conceptual clarifications, introduce the background of the contemporary debate. Then I present some threads in the current discussion. I will end by focusing specifically on the topic of whether cognitive influences on attention threaten the informational encapsulation of perception.

2. What is cognition? What is information flow? What does it mean to speak of a flow of information from cognition to perception?

First, what is cognition? I will take as the paradigm propositional attitudes like beliefs, judgments or suspicions, but also include desires or intentions, and standing emotional states like fears or hopes (cf. Macpherson 2012; Siegel 2011, 2017). If desire impacts perception, this, for example, might amount to cases of seeing what you want to see (wishful seeing; cf Siegel 2017). Not everything that is stored in our memory will amount to cognition, though, since perception might have its own memory store (see below). Whether visual imagination (like imagining seeing a yellow banana) should be classified with perception or cognition in this discussion is an interesting question of current debate (see Block 2016, Phillips forthcoming).

Second, what is information flow? One notion is causal statistical: information flows from system A to system B, roughly if the state of A leads to changes in the likelihood that B is in a certain state (this is so-called Shannon information, with an added causal condition). Some ways cognition might influence perception in this causal statistical sense are arguably relatively un-interesting: I believe that there is mustard in the fridge, and I want some mustard, and so I open the fridge door and see the mustard. Here my beliefs and desires affect my perception by affecting my bodily position (where I look): they do not affect perception directly, but only by affecting the input perception receives through the eyes from the fridge, i.e. which information flows from the environment to perception. The more interesting question is whether information also flows from cognition to perception directly, without a change to the environmental input to perception. For our discussion, I will be concerned with the direct flow of information from cognition to perception. There is another important distinction in how information might flow from cognition to perception. Think of a case where I am so afraid of not making an important deadline that the stress causes eye floaters (little bright specks that float about in your vision). Here information flows from cognition to perception without changing its input (cf. Macpherson 2012): my stressful emotion changed the state of my perceptual system. But this effect is not based on the content of my fear (the looming deadline). Any strong fear may have had the same effect. The case here is different from the (alleged) case where my belief that bananas are generally yellow causes me to see the object on the table as yellow. If my belief had had a different content (if I thought that bananas are blue) then the effect on my perception would have been different. Many people in the debate about the cognitive penetrability of perception are specifically concerned only with the content based and direct flow of information from cognition to perception. Whether some cases of cognitive influence that are not content based are similar to those that are content based when it comes to consequences for the epistemic and scientific role of perception is currently debated (cf. Siegel 2017, Wu 2017). I will mostly be concerned with content based and direct cases. When we get to the discussion of attention at the end, we will, though, have a chance to return to this issue.

3. From the New Look to Informational Encapsulation

The idea of a theory neutral observational basis of all scientific knowledge was popular among the logical positivists of the 1930s. But a few decades later many philosophers of science had come to reject that picture. Thomas Kuhn (1962), in his influential Study of Scientific Revolutions, for example, thought that when working in different scientific paradigms, "two groups of scientists see different things when they look from the same point in the same direction." (150). This idea in the philosophy of science was accompanied – and partially influenced – by the so-called New Look movement in psychology that saw visual experience as "the end product of a categorization process" (Bruner 1957). This process was claimed to be influenced by the subject's needs, expectations, background assumptions, and available cognitive categories. Poor children were thought to perceive coins as bigger than rich children (Bruner and Goodman 1947), and colour perception was thought to be affected by assumptions about an object's typical colour, like the banana in my example (Bruner et al. 1951). The general idea of the New Look psychology was that "perceiving can be analysed as a three-step process" (Bruner et al. 1951:216): the subject starts with a set of initial hypotheses about the world stored in memory and influenced by her cognitive and emotional background. Then she receives stimulus information coming from her sensory organs, and finally, in the third step, the initial hypotheses are confirmed or rejected. Perception was thought to be hypothesis testing, and influenced by the strength of the hypotheses the subject already brought to the situation. In the hypothesis testing New Look psychology, perception was the result of a back and forth flow of information between cognition and sensory stimulation.

Yet, many experiments of the New Look psychology later failed to be replicable, and more and more methodological challenges slowly undermined the credibility of many of

the alleged results (Erdelyi 1974, Pylyshyn 1999, Firestone and Scholl 2016). In particular, what had been thought to be perceptual effects, were often as well as or better explained as effects on the subject's judgments. The poor children may have thought that the coins are bigger without seeing them as bigger. Yes, the subject is testing her background hypotheses when looking at the world around her. But that hypothesis testing might all happen in cognition and leave perception untouched.

By the 1980s, the New Look had waned and a new orthodoxy arose. In his influential book, *The Modularity of Mind*, Jerry Fodor (1983) articulates a view of the mind on which there is no significant flow of information from cognition to perception. A similar picture was defended by the psychologist Zenon Pyslyshyn (1999) who argued for the cognitive impenetrability of perception. Perception, on Fodor's and Pylyshyn's view, is a modular input system, and distinguished from the mind's central systems. The function of the input systems is to process information coming from the stimulation of the sensory organs, and make that information accessible to the central cognitive systems. Perception becomes a pure informational messenger again. The modularity of perception, according to Fodor, is characterized by a number of features. Most important for our purposes, and according to Fodor the "the essence of … modularity", is that modular systems are informationally encapsulated: the operations within, say, the visual system have access only to input from the visual organs and to information contained in what Fodor calls its "proprietary database" (63); the visual systems cannot use information contained in a different module, like the auditory system, or in the central cognitive systems. Because of this informational encapsulation the modularity of perception implies, Fodor argued against theorists like Kuhn (and Churchland 1979), "that perceivers who differ profoundly in the background theories … might nevertheless see the world in exactly the same way" (Fodor 1984:38).

Why did Fodor and Pylyshyn believe that perception is a cognitively impenetrable module? Their argument was partly positive and partly negative. One strong positive argument consisted in the persistence of visual illusions even when we know better. Consider the famous Müller-Lyer illusion: even after you have measured the length of the two lines and know perfectly well that they are the same length, they still look to be of different lengths. This suggests that the visual system does not have access to the information that you now have in your central cognitive systems, and that you have no conscious control over how it operates. For the negative argument, Pylyshyn follows earlier theorists in uncovering a host of methodological flaws with the New Look movement, and other alleged results that were thought to undermine the impenetrability of perception.

Fodor's and Pylyshyn's claims regarding the cognitive impenetrability and informational encapsulation of perception form the background of the contemporary debate.

4. Philosophical arguments for the cognitive penetrability of perceptual experience

Fodor and Pylyshyn were mostly interested in whether perceptual information processing is impenetrable by cognition. They focused on the functioning of the perceptual systems, which – arguably – is largely unconscious and inaccessible from the subject's own perspective. Yet, while some of the contemporary discussion has followed that emphasis, a large part of the current debate in philosophy has shifted towards a slightly different question: whether conscious perceptual experience is cognitively penetrated.[2] Perceptual experience here is a conscious perceptual state, and the question is whether the phenomenal content of that state – the way things look, sound, or smell to the subject in her visual, auditory, or olfactory experience – is influenced by her beliefs, expectations, fears or suspicions. One might hold that some perceptual information processing is indeed encapsulated from cognition (and might deserve to be called a "perceptual module"), but that the subject's perceptual experience is not confined to the output of that processing and itself enriched by influence from her cognitive states.

The shift toward the penetrability of perceptual experience has been accompanied by a shift in the argumentative strategies. One major strategy has been the investigation of phenomenal contrast cases (cf. Siegel 2011). Suppose that a subject learns how to recognize elm trees. Before, she could not tell apart an elm tree from many other kinds of trees; but now she can recognize them. She has gained a certain recognitional capacity. Susanna Siegel, who argues for the cognitive penetrability of perception, holds that what it is like for the subject when she now looks at an elm tree is different from what it was like for her before she was able to recognize it as an elm tree. That phenomenal contrast (a contrast in what the experience is like for the subject), she then argues, can only be explained by the fact that her perceptual experience now has a different phenomenal content. The tree now phenomenally looks to be an elm tree. Cognition (in this case, her recognitional capacity) has penetrated into her perceptual experience.

The phenomenal contrast argument just discussed concerns what is often called "categorical" perceptual experience: the experience of something as belonging to a certain kind or category (like being an elm tree). Such types of influence of cognition would be compatible with the cognitive impenetrability of the perceptual experience of simple features like colour or shape as well as with the existence of a distinct perceptual module (that deals with "low level" perception; Raftopoulos 2001). One important discussion on this combination of views concerns the significance of cognitive penetrability into categorical perception. One might hold that a cognitive influence on categorical perception alone already has some of the interesting consequences regarding the epistemic and the scientific role of perception: many observational judgments based on experience, after all, seem to be judgments about whether something is a certain kind of object. Think about the following case for illustration (cf. Siegel 2017): some preformationist biologists of the 17th and 18th century, like Nicolaas Hartsoeker, seem to have literally seen the inside of a male sperm under the newly invented microscope as a little crawled up embryo, which – of course – further convinced them in their false belief that humans are essential already preformed in the male sperm; the female egg only helps that embryo to properly develop.[3]

Not everyone is convinced that cognition penetrates into perception in the case of categorical perceptual experience. Some suggest that there is no phenomenal contrast between before and after gaining the (apparent) recognitional capacity or belief, but only a difference in the judgments a subject makes about what they see. People think differently about elm trees, but their experience of them does not feel different (cf. Macpherson 2012). Others suggest that while the phenomenology of the subject's overall experience does change, we do not have sufficient reason to think that this change is a change to perceptual experience (Koksvik 2015). There may, for example, be cognitive phenomenology: thinking differently about elm trees may itself make a difference to how the experience feels to the subject, without an effect on perception (Cf. Bayne and Montague 2011). Both of these would not implicate the cognitive penetrability of perception. Again others think that the phenomenal change is best explained by processes of perceptual learning: becoming an expert at elm or embryo detection requires regular exposure to certain types of stimuli. This plausibly slowly leads to changes in the perceptual systems by an automatic and purely perceptual learning process, that by themselves leads to "relatively long-lasting changes to an organism's perceptual system" (Goldstone 1998: 587). But that process would not involve any influence from cognition to perception, since it is happening only within perception (Connolly 2014; Arstilla 2016). Finally, one might argue – possibly in combination with the last strategy – that cognition does influence perception in a case like Siegel's, but the way it does so is not appropriately direct (cf. Macpherson 2012, Firestone and Scholl 2016): it changes only what subjects attend to, which parts of the elm tree she, for example, focuses on. Pylyshyn (1999) explicitly did not count changes to attention as a case of cognitive penetration. The idea here was that a cognitive influence on perception through changes in what the subject pays attention to is like an influence on perception through changes in where she points her eyes to or how she positions her body. It changes the input, but not the internal operation of perception (more on whether that is right in Section 7 below).

Siegel's arguments, and some of the problems others have raised for it, are specific to categorical perception. What then about the cognitive penetrability of the experience of simple properties, like colors and shapes? Fiona Macpherson (2012) has argued that color experience is cognitively penetrable. Her argument is based on experimental work by Delk and Fillenbaum (1965), and similar new work by Hansen (et al. 2006). In the Delk and Fillenbaum experiments subjects look at cutout figures of objects. Some of these figures had a characteristic color (yellow for bananas, red for hearts or lips), and some did not (a bell, a square, or a horse head). The subjects now had to adjust the background of the colored figure until that background matched the color of the cutout. The finding was that subjects made the background redder if the figure was characteristically red (and yellower if it was characteristically yellow) than when that figure did not have a characteristic color. This, Macpherson with Delk and Fillenbaum argues, implies the cognitive penetrability of color experience (from beliefs about object's characteristic colors). The cognitive penetrability of color by background beliefs or associations is also shown, Macpherson argues, by recent results by Levin and Banaji (2006). Here the experimenters showed the subjects greyscale images of the faces of stereotypically white and stereotypically black people that were matched in terms of their overall luminance (the images of the "black" faces have exactly the same overall level of brightness as the images of the "white" faces). Subjects now had to change the level of brightness of a patch of grey until it subjectively matched the level of brightness of the image of the face. Levin and Banaji showed that subjects chose darker patches for stereotypically black faces and lighter patches for stereotypically white faces, even though the faces actually had the same overall brightness. Again,

Macpherson argues, we see the cognitive penetrability of color perception. Black people look darker than white people even if they are not.

5. New research programs in cognitive science

The new philosophical work on the cognitive penetrability of perception is accompanied by new work in the cognitive sciences that revives some of the ideas of the earlier New Look psychology. I will mention two broad and popular research programs and some of their results.

One research program stresses the situated and embodied character of our mental lives and is broadly associated with labels like 'Situated' or 'Embodied' Cognition. It stresses that both perception and cognition are aspects of the lives of agents who are placed in physical and social environments, which they navigate with their entire bodies. Given that perception serves those embodied lives, we would expect it to be shaped by an agent's abilities, needs, skills, emotions, and bodily state. And, indeed, a host of results, strikingly similar to some of the New Look ideas, seems to support that conclusion.

Wearing a heavy backpack or being tired makes hills look steeper, it is claimed (Bahlla and Proffitt 1999); by contrast, they look less steep, when you have just consumed a high calorie drink (Schnall, Zadra and Profitt 2010).[4] Similarly, if you have to jump with heavy weights, distances look longer (Lessard, Linkenauer and Profitt 2009). Our perceptual experience, according to those researchers, is "scaled" by "units" of our bodily abilities (Witt, Profitt and Epstein 2010). Other results claim that dieting subjects see pieces of food as larger (van Koningsbruggen, Stroebe and Aarts 2011), a bottle of water looks closer when you have just had some salty pretzels, and a bill of money looks nearer when it is potentially yours (Balcetis and Dunning 2010). Other studies claim to show that "moral behavior influences not only individuals' feelings of personal well-being, but also how they perceive the environment around them" (Banerjee, Chatterjee & Sinha 2012): when subjects recall an unethical action, they are claimed to see the room around them as darker when compared to those subjects who recall a morally right action. Maybe our emotions literally color the way we see the world around us. If all of those results (and there are many more) are correct, then we seem to have, after all, a sweeping vindication of the New Look psychology.

The other research program that seems to support cognitive influences on perception started its life in the neurosciences. It is the predictive coding framework. Higher level areas in the brain (far removed from the sensory organs), so the idea, send predictions down to lower level areas (those closer to the sensory organs). They predict what the activity in those areas will be. The actual activity in the lower areas is then compared to those predictions and an error signal about the deviation from the prediction propagates upward to the higher areas, where that information is used to update the information store and make new predictions over time (Rao and Ballard 1999). According to this model of brain functioning, the flow of information in the brain is never purely bottom-up from the sensory to the more cognitive, but always in both directions: predictions are sent down, and error-signals up. Perception and cognition are supposed merely to be aspects of that continuous loop-like process. The result is what is sometimes viewed a unified framework of brain function and of the mind (see Friston 2010; Hohwy 2013; Clark 2013, 2016). Reminding, again, of the New Look, the predictive coding framework models brain functioning after scientific hypothesis testing. Our brain is a prediction engine (Clark 2016).

Many proponents of the predictive coding framework believe that it abolishes many of the classic boundaries between the parts of the mind and brain. "Perception, cognition, and action" are thought to be "in important respects … continuous (Clark 2013:7). The framework "dissolves, at the level of the implementing neural machinery, the superficially clean distinction between perception and knowledge/belief" (ibid:10). Predictive coding, some think, implies that in an important sense all perception is "theory laden" (Clark 2013, Lupyan 2015) and that perception, insofar as we can retain that category at all, is cognitively penetrated by categorical knowledge and the language spoken by the agent (Lupyan et al. 2010, Lupyan 2015).

6. The return of informational encapsulation?

So, does information, after all, flow fairly freely from cognition to perception, thus undermining any claim to the informational encapsulation of perceptual processing or perceptual experience? In this section, I will present some work that aims to rescue informational encapsulation.

In an influential paper, Firestone and Scholl (2016) claim to undermine many of the alleged cognitive penetrability effects. They uncover a number of fallacies that plague the relevant research.

Consider the claim that reflecting on unethical actions makes the surrounding world look darker. In the original research, subjects rated the brightness of the surrounding room on a numerical scale. What if they are asked to pick a greyscale patch that matches the brightness of the room? This should cancel the effect, Firestone and Scholl argue: after all, if the whole world looks darker, this would affect the patch just like the room, and the two effects would cancel each other out. Yet, Firestone and Scholl find that the effect is not canceled in this new experiment. Subject's thus do not see the world in a different way: maybe they just choose a brightness level that they think is appropriate given that they have been asked to reflect on a bad action. This is a form of response bias where the subject unconsciously gives the response they suspect that the experimenter is expecting. Similarly, consider the claim that wearing heavy backpacks makes hills look steeper. Firestone and Scholl report evidence (Durgin et al. 2009) that the effect completely disappears if the subjects have been instructed with a story that did not let them to suspect that the experiment was about an effect of the backpack on how steep the hill looks (the effects of sugar intake also disappear in this variant of the experiment). Again, this suggests that the original results may have been due to response bias.

Firestone and Scholl also report evidence that undermines some of the alleged cases of top-down penetration of color perception that formed the basis of Macpherson's argument. Consider the effect of the judged race of a face on its apparent brightness. Firestone and Scholl conducted an experiment where they blurred the relevant images so that subjects could not anymore detect its race. Surprisingly, subjects still rated the image derived from a black person as darker than the one derived from the image of a white person. How could that be? Firestone and Scholl suggest that there are differences between the images in their distribution of light and dark so that subjects rate the overall brightness of the images as different, even though it is the same. In any case, their results show that the effect can be explained without appeal to the penetration of perception by knowledge of the face's race, since in the new results the subjects did not know the face's race.[5]

Firestone and Scholl, together with others, thus claim to find many and often systematic problems with the, no doubt rich, research that claims to find cognitive influences on perception. Overall, we are now seeing a period of intense and rigorous experimental testing of many of the alleged cases of cognitive penetration into perception. Many proponents of the cognitive penetrability of perception are convinced that some of the effects are real (see the discussion in Firestone and Scholl 2016). It remains to be seen whether some of the results hold water, or whether they can all be explained away by some of the "pitfalls", as they call it, that Firestone and Scholl have uncovered.

What about the predictive coding framework? While some of the rhetoric of its proponents suggests that they think of the brain as one big informationally integrated whole, it is clear that the "mere acceptance of the predictive coding approach to perception does not determine whether one should think that cognitive penetration exists" (Macpherson 2017: 15). The high-level states that enter into the prediction process need not be cognitive states, and even if they are cognitive they may only affect high level, categorical perception. It may be compatible with the framework to think that there is an important modular part of perception (Hohwy 2013, Drayson 2017, Macpherson 2017). Whether predictive coding leaves room for an interesting category of perception and whether it is compatible with the informational encapsulation of at least an important part of perceptual information processing is currently intensely debated (For yes see Hohwy 2013, Drayson 2017; Macpherson 2017, for no see Vance and Stokes 2017 and Lupyan 2015; the interpretation of Clark 2016 is a bit unclear on this issue). At least, it is not obvious that the predictive coding framework actually threatens the informational encapsulation of perception.

One issue that the discussion of the predictive coding framework, the phenomenal contrast method, and of Firestone's and Scholl's re-evaluation of many apparent cognitive penetrability effects, has brought to the foreground is that we need to think more about what the distinction between perception and cognition actually is. Which part of our overall experience is properly thought of as perceptual experience, and which parts of information processing are parts of perceptual processing? If there is a part of the mind that is informationally encapsulated, why think that this part is all there is to the perceptual system? This is another question that is at the forefront of current research (see Block 2014, Burge 2014, Beck 2017, Sydhagen 2017, Phillips forthcoming).[6]

7. What counts? The case of attention

I will close by briefly considering one special case of information flow from cognition to perception: the way cognition influences perception through changes in attention. The distribution of perceptual attention is clearly influenced by cognition: what we attend to depends on our intentions, or fears and other emotions, on the cognitive categories at our disposal, and on what we think the world is like. Do such cognitive influences on perceptual attention threaten the cognitive impenetrability of perception?

As I have mentioned above, many have followed Pylyshyn in explicitly not counting effects of cognition on perception as serious threats to the cognitive impenetrability of perception. The idea was that a change in attention

is like a change in the input to perception, or – we may add – a change in how perceptual information is taken up by cognition. In either way, this would seem to leave perceptual processing itself (and perceptual experience) intact and uninfluenced by cognition.

One issue currently discussed is whether such effects of attention may have some of the same consequences for the epistemic and scientific role of perception. This could be the case even if they would not, in a sense, influence proper perceptual processing or proper perceptual experience (Siegel 2015, 2017; Stokes 2017). Suppose that two scientists are looking at a screen with red and green lights. One has a preconceived background belief that red lights are more important and thus attends more to the red ones, and fails to notice many of the green ones. On that basis, she comes to believe that most lights are red. The other believes that green lights are more important, and with a corresponding process arrives at the belief that most lights are green. Maybe the difference in their background beliefs leaves their perceptual experience and processing untouched, but arguably its influence on the distribution of attention still undermines the theory neutrality of observation; and maybe this type of influence still implies that perception puts on a farce: it returns our preconceptions through the distribution of perceptual attention (see Siegel 2015, 2017).

Another issue about attention is that the contemporary science of attention shows that attention does not just affect the input to and the output of perception. It also affects perceptual processing itself. The distribution of attention, for example, depends on how sensory input is divided within perception into objects. For instance, you do not just see colors floating around, but objects with often clear boundaries (cf. Mole 2015). Perceptual processing, then, has to have happened before the distribution of attention is determined: attention, unlike changing your bodily position, does not just change the input to perception; it acts after some perceptual processing has already taken place (Mole 2015). Further, much is now known about how attention also affects perceptual processing, down to the level of how it affects the responses of single sensory neurons (see Carrasco 2011 and Wu 2017 for a philosophical discussion). In addition, some evidence strongly suggests that attention changes how things look to the subject in her perceptual experience: when attended, you see things as bigger and with more contrast (Carrasco 2011; but see Beck and Schneider 2017). Attention thus does seem to have a direct impact on both the phenomenal content of perception and on very basic perceptual processing.

It is thus clear that information flows from all aspects of cognition, our beliefs, intentions, fears and hopes, through attention into perception in rich and interesting ways. In that sense, perception is clearly not a neutral informational messenger. Attention shapes perception dramatically (see Watzl 2017). Much of that influence, though, arguably is not content based: our scientist may have attended more to the red lights, because she thought red lights are important; but the same distribution of attention could have been brought about in a different way: "the influence of attention (or eye movements) in cases where attention changes perceptual processing is completely independent of why you attended that way" (Firestone and Scholl 2015:35; cited and discussed also in Gross 2017). Our scientist could have focused on the red lights instead of the green ones also because she had come to associate them with an annoying, re-occurring, but unimportant distraction. The way information flows from cognition to perception through changes in attention thus may be direct, but it is normally not content based in a coherent and systematic way (Gross 2017). Whether cognitive influences on perception through the distribution of attention then are important, depends on what matters in the study of the flow of information from cognition into perception (for different sides see Gross 2017, Siegel 2017, Wu 2017).

NOTER

[1] would like to thank Anders Nes and Kristoffer Sundberg of the Thought and Sense project, Petter Sydhagen, and Susanna Siegel for many discussions of the issues in this paper.

[2] See Stokes 2013 for a review of the recent philosophical debate.

[3] https://plato.stanford.edu/archives/fall2008/entries/epigenesis/. See also Siegel (2017) for discussion.

[4] Zero calorie, artificially sweetened, drinks, by contrast, have no such effect.

[5] Block 2016 argues that the other evidence Macpherson uses may be due to influences by perceptual imagination. Whether that counts as a cognitive influence is, as I mentioned, unclear.

[6] It is currently investigated at the "Thought and Sense Project" at the University of Oslo.

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