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Cognitive penetration and the perception of colour

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Consider two observations. First, we see—visually experience—colours. Second, our thoughts influence how we perceive the world. At face value, it may seem that there is little to resist here; both observations seem to capture intuitive features of human mental life. But face value has little purchase in all but a few quarters of philosophical theorizing. The first observation, once disambiguated and made precise, engages more or less immediately, controversy concerning the reality of colours, the (non-)relational nature of perceptual experience, and perceptual phenomenology, among many other topics discussed in this very volume. And if 'perceive' in the second observation is disambiguated so as to concern conscious perceptual experience (in this case, visual appearances), then once again, controversy abounds. Indeed, one standard line in cognitive scientific and philosophical theorizing has it that one's beliefs, desires, intentions and so on are certainly influenced by visual experience, but they do not influence visual experience itself. At the very least, there is a live debate concerning this possible phenomenon or phenomena. That debate concerns whether visual experience, and perceptual experience more generally, is *cognitively penetrable*. This chapter focuses on this possible phenomenon, with an emphasis on visual experience of colour, thus offering an analysis that brings together the two observations above.

§I offers a brief introduction to the notion of cognitive penetrability. §II focuses on relevant empirical research and its interpretation. §III further identifies the special importance of alleged cases of the cognitive penetration of colour vision.

I. Cognitive penetration and its general importance

The term 'cognitively penetrable' originated with the work of Zenon Pylyshyn (1980; 1984; 1999). Pylyshyn works from within a computationalist framework of the mind, and so was motivated to distinguish parts of mental life that require, for their explanation, the attribution of rules and representation from those that do not. Pylyshyn argues that things like beliefs and inferences fall in the former category, and perceptual processes in the latter. Much debate has ensued, however, on how 'cognitive penetrability' should be defined so as to secure the distinction Pylyshyn and other computationalists have sought. Pylyshyn ultimately settled on the characterization found in the now often-cited passage, "[I]f a system is cognitively penetrable, then the function it computes is sensitive, in a semantically coherent way, to the organism's goals and beliefs, that is, it can be altered in a way that bears some logical relation to what the person knows" (Pylyshyn 1999: 343). Although this falls short of a definition (providing only a necessary condition for a state or process being cognitively penetrable), one can glean from it important lessons.

First, the importance of a 'semantic criterion' is that it ensures that cognitive penetration is no mere causal relation running from, say, a belief to perception. Instead, it is a causal relation where, on one interpretation, the content of the penetrating cognitive state stands in an inference-supporting relation with the content of the resultant perceptual state. Compare: if we simply said that cognitive penetration is any instance where one's cognitive states causally influence one's perceptual states, then any time my beliefs, say, direct where I look, or what I listen to or touch, then my visual or auditory or tactile experiences are thereby cognitively penetrated. This would render cognitive penetration a trivially common phenomenon.[1]

Others have attempted to capture the non-trivial nature of the possible phenomenon, but without any commitment to a semantic or inference-supporting relation. For example, Siegel (2012) characterizes the phenomenon in terms of contrasting perceivers:

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[1] Macpherson 2012 makes clear this virtue of Pylyshyn's semantic criterion.

> Cognitive Penetrability (second pass): If visual experience is cognitively penetrable, then it is nomologically possible for two subjects (or for one subject in different counterfactual circumstances, or at different times) to have visual experiences with different contents while seeing *and attending to* the same distal stimuli under the same external conditions, as a result of differences in other cognitive (including affective) states.
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> (Siegel 2012: 205-6).

This shares the motivation for the semantic criterion but without commitment to that very criterion: cognitive penetration of vision is a phenomenon where, as Macpherson 2012 puts it, holding fixed the viewing conditions, attentional focus, and sensory organs, two subjects have distinct perceptual experiences.[2] Another similarly motivated definition maintains that instances of cognitively penetrated experience are ones where the causal link between background cognitive state and resultant experience is "internal and mental" (Stokes 2013; see also 2012). All of these characterizations share the motivation that cognitive penetration is a non-trivial phenomenon, and not one that results (in any straightforward way) from change in environmental circumstances, or simple bodily actions, or shifts in attention (looking or listening in the ways that one wants, believes relevant, and so on). So while Pylyshyn is right to distinguish cognitive penetrability as a non-trivial cognitive-perceptual relation, the need for the semantic criterion remains a point of debate.

Another clarification is gleaned from comparing Pylyshyn's characterization from those offered just above. Pylyshyn's emphasis is, usually explicitly, on whether goals, beliefs, and other cognitive processes can influence perceptual *processing*. This comports with the research agenda of other computationalists like Jerry Fodor, who maintain that some parts of mental architecture are *modular*, operating independently of beliefs, goals, and so on (Fodor 1983). Modularists of this strength maintain that modular systems—Fodor takes visual "input systems" to be of this sort—are therefore *informationally encapsulated* with respect to cognitive processes. By contrast, one might note that all the theorists in the previous paragraph emphasize cognitive effects on perceptual *experience*. There are good reason for this. First, a philosophy of perception concerns, first and foremost,

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[2] Distinct in some type: in content, in qualitative character, or both. And to be clear, Macpherson 2012 does seem to endorse Pylyshyn's semantic criterion, in spite of being presented here alongside theorists who do not.

person-level conscious perceptual experiences, not the mere computational mechanisms that cause or subvene those experiences. Second, and related, a central area of concern for philosophers of perception is epistemological, most basically, whether and how perception provides knowledge about one's environment. And, by the standards of just about any epistemological theory, the perceptual *things* that do (or do not) provide knowledge or epistemic warrant or reason for belief, are person-level experiences: what the subject sees, hears, and otherwise experiences in a first-person accessible way.[3]

It is worth noting that although the modularists focus on processing, they too are interested in person-level experiences, and for the reasons just given. Part of Fodor's motivation for positing informationally encapsulated (and thus cognitively *im*penetrable) visual input systems is that those systems should (and apparently do) provide fast and objective information about the creature's environment, such that the creature "can detect what is right here, right now—what is available, for example, for eating or being eaten by" (Fodor 1985: 4). Now of course for some very simple creatures, this kind of detection could be entirely automatic and dumb, with nothing answering to "personal" or "conscious". But Fodor is perfectly clear that at least for creatures like us, perception must function less like a true reflex and more like a filter. This is due to the remarkable variability in proximal stimuli—in vision, the array of light wave reception on the retina—by contrast to the largely stable distal stimuli—the object/s or event/s reflecting those light waves. And what an organism needs so that it doesn't get eaten, as Fodor is fond of putting it, is to know what of the variability in proximal stimulus accurately corresponds to variation (or stability) in the distal environment. After all, tigers can eat you, rod and cone stimulation cannot. Thus "the function of perception…is to propose to thought a representation of the world from which such irrelevant

[3] There are of course tricky cases, like those involving agnosic patients who can successfully manipulate objects in the visual environment, but who appear unable to report visually detectable features of those same objects (their shapes, colours, or kind). Such patients act upon these objects reliably and so, some epistemic externalists might say, know that the object is in such-and-such position, or in motion, and so on. Other theorists, for example mentalistic internalists, might deny the knowledge attribution since the agnosic cannot report on those features (even if some of those features are clearly represented somewhere in the sub-personal cognitive system). But this case is non-standard.

variability has been effectively filtered" (4). Accordingly, perception here is understood at the level of experience: the kinds of states that are "proposed" to higher level-thought for consideration and further decision making. Accordingly, 'perception' will be assumed to denote perceptual experience in the remainder of this chapter.

It should by now be clear that much of the cognitive penetration debate concerns just what such a phenomenon is or would be. Accordingly, there are reasons to be cautious about committing to any extant definition here. Instead, the following rough characterization will do. Cognitive penetration of perception involves, at least, a cognitive effect on conscious perceptual experience, where this effect is non-trivially direct, and the effect on perception involves a phenomenal difference (put in Siegel's counterfactual terms, a difference that would not be there absent the relevant background cognitive state). This (relevant) effect is not one on post-perceptual judgment or memory, and is not the result of active bodily movements or acts of attention.[4]

Finally, it should be emphasized that the question about cognitive penetration of perception is an empirical one. Theorists are asking whether, in human beings, cognition penetrates perceptual experience and, if so, with what frequency. The consequences that would follow are then theoretical-scientific and epistemological. There is little interesting metaphysics to be done here. There are possible worlds where creatures much like us engage in rampant wishful seeing, or regularly perceive in ways infected by their theories. Put another way, there seems to be nothing in the concept of sense perception that precludes its compatibility with cognitive penetration. Accordingly, the discussion that follows concerns relevant empirical research on colour perception (§II), followed by an emphasis on the epistemic importance of this research (§III).

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[4] Stokes (2016) argues that securing a definition for a (single) phenomenon called 'cognitive penetration' is less important, theoretically, than its supposed consequences. An alternative methodological approach is then to characterize the phenomenon in terms of the consequences that were and are of interest to parties on both sides of the debate. The three standard consequences concern: modularity theories of mind, the theory-ladenness of scientific observation, and the knowledge-providing role of perception. These are discussed in §III.

II. Alleged cases of cognitive penetration of colour perception

Like many other organisms, human visual systems acquire information about the light reflectance wavelengths given by their environments. Processing of this information gives rise to (or just is) conscious colour experience (this is true whether one is a colour realist or sceptic). And further, we abstract information on the basis of that and related experience. We learn that certain kinds of natural and artefactual things are typically coloured in one way or another. So, we acquire colour *concepts*, and explanation of this acquisition may take many forms. Perhaps we first learn to group a kind of thing—say tomatoes—and then abstract a feature that they all share—being red. Or perhaps we first learn to distinguish red things from non-red things by simple identification of sameness and difference relations, and then identify the distinctive kinds among them—*this* red thing is a tomato, *this* red thing is a stop sign, and so on. In any case, at some point we learn what redness is and this learning has a perceptual basis. We also form *beliefs*, a type of thought of which concepts are constituents (or so many theorists think anyway). So we have beliefs—evidenced by dispositions to act in certain ways and make particular verbal reports about what is true—that tomatoes and stop signs are red, bananas are yellow, and so on. Thus we have (constituents of) cognitive states concerning visibly perceptible features of the world. A number of experiments, both old and recent, exploit the relation between colour-related cognitive representations and colour experience.

II.1 Some cases

A case recently revived in philosophical discussion is Delk and Fillenbaum's 1965 study involving (in the experimental condition) items of characteristic colours and (in the control condition) items of a kind that have no characteristic colour. In both conditions, the task was an online matching task (this term is clarified below), where subjects were instructed to colour-match cutouts of various shapes, all of them cut from a uniformly orange piece of paper (e.g. a love-heart shape, which is characteristically red, or an oval which has no characteristic colour), to a background

that could be adjusted from various shades from yellow to orange to red. In the experimental conditions, subjects matched the cutout shape (when of a characteristically red item like a love-heart) to a significantly more red background than in the control condition (where the control condition cutouts, again, were of kinds not characteristically one colour or other). On the face of it, and so Macpherson 2012 argues, this is an instance where beliefs about red-coloured kinds (love-heart shapes, apples, human lip shapes) influence visual experience such that the relevant perceptual stimuli are experienced as more red than they in fact are. It is a plausible case where beliefs about kinds or kind-concepts influence, in a non-trivial and relatively direct way, phenomenal colour experience. If this is its proper explanation, it would be a case of cognitively penetrated colour perception. But as Macpherson notes, the results of this experiment underdetermine the choice of explanation: it *may* be cognitive penetration, or it may be a case where repeated exposure to a kind results in heightened visual sensitivity, that is, a case of perceptual learning.[5]

In a much more recent series of studies, experimenters again explored the way that cognitive representations of objects with "high colour diagnosticity" may influence current perceptual colour experience. In Hansen et al 2006, subjects were presented, on a computer monitor, with digital images of fruits/vegetables, in their typical colour. The task was to adjust the image, in real-time, to (subject-specific) achromatic grey.[6] For these images, by contrast with the control task involving uniformly coloured discs, subjects adjust the image past achromatic grey and into the opponent hue range while reporting that it is grey (e.g. adjusting a banana image into the opponent blue range). By hypothesis, the subjects must then make a typically yellow object more blue (objectively) in order to see it as achromatic grey. As the researchers quantify it, this "memory colour effect" ranges from 3 to 5 times the threshold for discrimination. In the first followup study, Olkonnen et al 2008 found

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[5] Macpherson goes on to argue that the Levin and Banaji (2006) studies, discussed below, provide better candidate evidence for genuine cognitive penetration.

[6] There are individual differences in how people see (or judge) perfectly achromatic grey. Accordingly, in a preliminary norming study, experimenters determine the "perfect grey" for each participating subject.

the effect more pronounced for images natural in appearance (with texture, appearance of depth, etc) and statistically weak for mere fruit/vegetable outlines (more on the importance of this difference below). In the most recent followup study, Witzel et al 2011 performed roughly the same set of procedures, but this time with images of human-made objects of high colour diagnosticity. The results were similar: they found memory colour effects for images of the Red Coca-Cola icon, the blue Smurf, green ping-pong table, and several others. In controls, no effects were found for images of colour-variant kinds (e.g. socks) or typically achromatic kinds (e.g. golf balls).[7] In each of these experiments, the subjects made online adjustments, attempting to make a match between the target object and background. So, although there are reasons for doubt, these effects are plausibly explained as instances of cognitive penetration: background cognitive states (say beliefs about the colours of natural and artefactual kinds) influence perceptual experience such that, in these cases, subjects are making errors.

One final study that has received philosophical discussion is Levin and Banaji 2006. In this study, researchers explored the way that race categories (or, if one likes, beliefs about features of race) might influence perception. Here again there are numerous iterations and complexities of the research, but the basic thrust can be captured by a brief description of what Levin and Banaji call Experiment 2. All conditions involve presentation of realistic, 2D male human face images, presented in precisely the same shade of grey. Here researchers first create a racially ambiguous face by morphing the image of a prototypical black male face with an image of a prototypical white male face; they then confirm the racial ambiguity with a preliminary controlled experiment. Subjects are then presented with an instruction screen involving both the racially ambiguous face and an unambiguously black face or an unambiguously white face, where the latter would be labelled

[7] This is only a rough summary, skirting over the many complexities of details of each of these experiments. For detailed analysis of the Delk and Fillenbaum, see Macpherson 2012 and Zeimbekis 2013. For detailed discussion of the Hansen et al 2006 and the Witzel et al 2011, see Stokes and Bergeron (2015). And for discussion of Olkennen et al 2008, see Deroy 2013.

accurately as 'BLACK' or 'WHITE' respectively, and the former labeled oppositely (thus for example: the ambiguous face would be labeled 'BLACK' and an unambiguous face white face would be labeled 'WHITE'). A subject is then then presented with one of the same instruction phase faces adjacent to an adjustable greyscale rectangle. The task is to adjust the rectangle to match the target face in luminance. In all conditions, the reports co-vary significantly with the semantic label given on the instruction screen. Perhaps the most striking result is this: the very same ambiguous face results in an adjustment that is .465 levels darker (than the objective luminance of the face) when labelled 'BLACK' and 15.95 levels lighter when labelled 'WHITE'.[8] A change in label appears to affect racial classification (a cognitive process) which in turn affects basic lightness perception. This looks like a plausible instance where higher-level mental states (beliefs or concepts about race) directly influence visual experience. And in this case, there could be consequences for moral philosophy and psychology.[9]

Differences aside, there are important features common to all of these studies. First, the task performance is "online", where subjects are asked to make a report on the basis of current perceptual experience (by contrast to post-perceptual memory reports). Second, the report method is non-verbal, typically involving some kind of matching task. Finally, colour is a basic phenomenal feature of visual perception if any feature is (by contrast to the high-level contents that some argue are admissible contents of experience). These features prove important for the theorist of cognitive penetration in defending against the critical, alternative explanations discussed below.

II.2 Critics and discussion

Because cognitive penetration is supposed to be a two-part relation between cognition and perception, challenges to any alleged case may take three basic forms: one for each *relatum* and one

[8] Levin and Banaji used a computer monitor with 265 greyscale measures

[9] See Siegel 2012; Macpherson 2012; Stokes and Bergeron (2015) for discussion. See Firestone and Scholl 2016 for criticism. See Payne (2001) and Payne et al. (2005) for related work on race and shape perception and kind-identification.

for the relation itself. First, one may argue that the penetrating state or process is not in fact cognitive (or that there is no relevant antecedent relatum). Second, one may argue that the apparent effect is not in fact one on perceptual experience. Finally, one may argue that the relation between cognition and perception is mediated such that the phenomenon is not of the type of interest. All forms of challenge to alleged cases have been made in extant literature but have a harder time sticking to cases involving colour perception.

The most common example of the third type of challenge is what has been dubbed the *attention-shift interpretation* (see Macpherson 2012; Stokes 2012). Fodor articulates this reply to alleged cases in a number of places. In reply to theorists like Hanson (1958; 1969) and Churchland (1979; 1988), Fodor argues that some perceptual stimuli can be changed, so to speak, by the subject depending upon her beliefs and goals. So for example, once one "knows the trick", one can shift one's focus of attention from certain parts of the ambiguous duck-rabbit image to other parts and thereby "flip" from seeing the image as a duck to seeing it as a rabbit.[10] This flipping may well be a change in visual phenomenology, and one dependent upon knowledge and goals concerning the duck-rabbit image, but it is mediated by an agent-driven act of attention. Accordingly, Fodor suggests, if this is supposed to be cognitive penetration, then the phenomenon is relevantly trivial.[11]

Suppose Fodor is right about this kind of case. Notice, however, that it involves not just basic shape perception, but visually perceiving an image as falling under one category or other.[12] The colour cases discussed in II.1 are importantly different, involving more basic colour perception. In these cases, there is no obvious place where active shifts in attention would affect changes in colour

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[10] See http://www.illusionsindex.org/i/duck-rabbit

[11] Trivial how? Well, for example, these common phenomena would not impugn the modularity *of perception* nor its role in providing knowledge. The attention-shift interpretation has been recently challenged by Mole 2016; Wu 2017; Stokes, forthcoming.

[12] As discussed below, philosophers debate whether this kind of *seeing as* (or, related but distinct, *seeing that*) is after all a perceptual phenomenon rather than a post-perceptual judgment or belief. Put in related terms, philosophers debate whether perception can represent a high-level property like 'being a rabbit' at all. But ignore this complication for the present discussion.

perception, and for at least two reasons. Looking harder or more carefully at some sub-section of the visual field (say at the right side of Delk and Fillenbaum's love-heart cutout) will not yield the result that that portion (or the entire field) looks differently coloured, say more red. Second, and related, there is no compelling reason to think that the experimental procedures would encourage this shift in attention. Here the contrast with the duck-rabbit is apt: one way to teach a newcomer to "see" the rabbit and then "see" the duck is to direct her attention to specific parts of the image. Likewise for the Necker Cube and other familiar ambiguous figures. By contrast, what cognitive state would drive a subject to attend differently to some part of a heart-shape cutout or a greyscale racially ambiguous face? At bottom, then, application of the attention-shift interpretation to these colour cases simply looks unprincipled.[13]

A memory interpretation alleges of a case that an apparent effect is one on memory rather than perceptual experience. This kind of explanation is most plausible when the target stimulus is removed from view and the subject then must make some kind of report based on the now past perceptual experience. For example, food deprived experimental subjects might be shown ambiguous inkblot images and then asked, once the images are removed, whether they perceived images of food or not. The memory interpretation has very little plausibility, however, for any of the above experiments since, as stressed above, each experiment is online, involving a report simultaneous with perceptual experience of the target stimulus.

Similarly, a judgment interpretation claims that an alleged effect is only one on post-perceptual judgment, maintaining that perceptual experience is not penetrated. Here the interpretation is applied by simply maintaining that colour experiences are veridical (and thus

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[13] Of course there may be other colour perception phenomena where attentional shifts are relevant. For example, one can willfully undo colour constancy effects by attending more carefully to, for example, a patch of green in the shade and then comparing it to a patch of green in direct sunlight (where both patches are in the same visual field). But there is no reason to think that the above experiments involve constancy mechanisms. And one might worry, with respect to the Levin and Banaji 2006 studies specifically, that contours of typical black faces versus typical white faces are different in such a way that attention is drawn differently to more/less luminant parts of the face. However, Levin and Banaji devised an additional study that used either white line or black line drawings, with no additional shading or contour, and the same results are obtained. This discounts the contour/attention-shift interpretation.

invariant across experimental manipulations where the target stimulus is unchanged, as in Experiment 2 of Levin and Banaji 2006). The reports of experimental subjects (that the extra-red background matches the orange love-heart cutout, that the greyscale 'WHITE' labelled face matches an objectively much lighter grey rectangle, and so on) are then explained by errors in judgment, not perception. So, subjects enjoy veridical visual perception, on the basis of which they make errors in judgment.

One might resist this interpretation as follows. In many of these experiments, there is some kind of error made as evidenced by the report data. Thus subjects report a match between cutout and background when the second is objectively more red than the first; they report that a banana image is perfect grey when in fact it is noticeably tinged with blue; they match a greyscale face to a noticeably lighter or darker shade. An explanation must then account for the error. The judgment interpretation makes this a person-level error, where subjects enjoy veridical experience but then make judgments that are inconsistent with that experience even while on the basis of that experience. The "on the basis" of qualification here is key: these experiments all involve online methodologies, where subjects are encouraged to use what they see to make a report. This requires consistent mistakes about what one is seeing: somehow, while seeing the target accurately, the experimental subject makes a judgment and accordant report that mischaracterizes that very seen target. Introspection is notoriously fallible, but it may seem implausible that subjects could be so badly mistaken in judgments about their own current experience. Subjects are not being asked to perform any complex judgment or report; they are only asked to make colour matches or simple colour adjustments. In this light, the judgment interpretation may look even less plausible.[14] Alternatively, a cognitive penetration interpretation explains the error as a perceptual one: subjects

[14] See Macpherson 2012 for a defense of this sort against the judgment interpretation. See Stokes 2012 for a similar defense against the judgment interpretation when applied to experiments on the visual perception of size.

make the reports they do because they are *not* enjoying veridical colour experience, where this is a consequence of background cognitive states.

Here it is worth saying a bit more about the basic-ness of colour perception, and how this figures into possible interpretations of the relevant experimental data. There is a long philosophical tradition of taking colour perception to be a basic form of visual experience. Aristotle took colour to be the proper sensible of vision; colour is represented only by vision, by contrast to shape, a sensible feature common to vision and touch. Berkeley took colour to be an essential feature of visual experience, and indeed famously used this observation to argue against Locke's primary/secondary quality distinction. Early sense datum theorists maintained that colours are among the features given by experience, either as bound with other features like shape and size (as in, plausibly, Price 1932) or as unbound features out of which objects are constructed by cognition (as in Russell 1910). The same is true today: theorists of varied commitments maintain that as far as conscious visual experience goes, colour is foundational or "bedrock". Accordingly, enjoying visual experience of colour requires much less cognitive sophistication than, by contrast, seeing something as being of a kind (supposing for the moment that the latter is a possible kind of visual experience). One way to articulate a relevant point here is in terms of Fred Dretske's distinction between nonepistemic seeing vs. epistemic seeing.[15] As Dretske illustrates:

> The first time I became aware of an armadillo (I saw it on a Texas road), I did not know what it was. I did not even know what armadillos were, much less what they looked like. My ignorance did not impair my eyesight, of course. I saw the animal. I was aware of it ahead of me on the road. That is why I swerved. Ignorance of what armadillos are or how they look can prevent someone from being conscious of certain facts (that the object crossing the road is an armadillo) without impairing in the slightest one's awareness of the things-the armadillos crossing roads-that (so to speak) constitute these facts (Dretske 1993: 266).

Dretske saw, as in visually identified and then avoided, a moving object with armadillo-like features, but without identifying *that* they were armadillo-like features, or seeing *that* the object with those

[15] Dretske uses a number of pairs of terms, in a number of places, to mark the same distinction: seeing vs. seeing that; thing-perception vs. fact-perception; awareness of things vs. awareness of facts. See Dretske 1969, 1979, 1993. Hanson 1969 marks a very similar distinction.

features was an armadillo. Achieving the latter requires the deployment of the concept ARMADILLO which, as the story goes, Dretske lacks at the time. As he suggests, one can be aware of, can have a conscious visual experience of, complex *things* like armadillos without being aware of the *fact* that the thing seen is an armadillo. To do the latter, one must apply the concept to what is seen (see Dretske 1993: 265).

A couple points to note: first, theorists debate whether the second kind of seeing—epistemic seeing—is really a kind of seeing at all. Indeed, most of what Dretske says characterizes epistemic seeing as a kind of belief, where the basic contents of the relevant perceptual experience (say, as of an armadillo) are the same for the case when one just sees an F and the case when one sees that x is an F. What's different is that only in the second case has one formed a belief about a fact involving Fs. Epistemic seeing is then, on this line, really perceptually based belief or judgment, where seeing only provides access to basic features like colour and shape.[16] The second point follows from here. Focus just on nonepistemic seeing for a moment. Note how seeing a thing—an armadillo crossing the road—is already a fairly complex visual achievement. It requires seeing colours, shapes with varying size, all bound together and in motion. Even if one lacks the concept ARMADILLO, any reports made on the basis of this visual experience may be rather sophisticated. One could make errors about a variety of features in addition to colour: size, shape, texture, speed, how the creature moves, and so on. So it is an experience that encourages a variety of judgments, it encourages the formation of numerous beliefs). So even if one lacks the concept ARMADILLO, one probably has a variety of other relevant concepts and so may judge that (see that) there is an animal crossing the road, or that the thing crossing the road is low to the ground or oddly shaped or frightened. Contrast that with the kinds of visual experience had by subjects in the above experiments. In those experiments, the stimuli are dramatically simpler, lacking motion and presented only on a computer monitor or paper. And importantly the experimental tasks only

[16] The related topic of the admissible contents of experience is taken up in III.1 below.

require attention to the most basic feature of the scene, namely, colour. To perform these colour matching tasks, one need no sophisticated concepts (of colours or otherwise); one only need to understand basic sameness and difference relations. It is in this light that the experiments on colour perception look well interpreted as involving cognitive penetration and, comparatively, much less plausibly interpreted as errors in post-perceptual judgment. Making a colour match is not like seeing an Armadillo (let alone seeing that there is an Armadillo). It lacks substantial complexity, requires no sophisticated concepts, and does not encourage a variety of perceptual beliefs in the way that seeing an animal scurrying across the road would. So it is plausible that the subjects' errors are explained not by post-perceptual deployment of concepts but instead by pre-perceptual cognitive effects on perceptual processing (concepts or beliefs about natural and artefactual kinds, for instance). This again highlights why colour cases are especially important for the cognitive penetrability debate.

A fourth alternative interpretation claims of a case that there is no relevant cognitive relatum and instead that the apparent effects are instead some kind of intra-perceptual adjustment, where sensory systems become more sensitive to patterns, in a way that is partially hardwired while partially plastic. One way to describe this is in terms of perceptual learning, on many models of which sensory changes are not ones brought by higher-level or semantic learning, and are not under the control of the agent. Fodor invokes this kind of interpretation in his debate with Churchland (1988), arguing that adaptation to inverting goggles does not involve cognitive penetration. Instead, he claims "For there are, after all, good ecological reasons why you might expect plasticity of this sort.... what needs to be kept open for re-calibration is whatever mechanisms compute the appropriate motor commands for getting to (or pointing to, or grasping) a visible object on the basis of its perceived location. Adaptation to inverted (and otherwise spatially distorting) lenses is plausibly an extreme case of this sort of recalibration" (Fodor 1988: 193). One might think that this kind of interpretation similarly applies to some of the colour cases discussed above. So, for example, the initial Hansen et al 2006 studies were performed with realistic, textured images of fruits and

vegetables, while the Olkonnen et al 2008 studies suggested that the relevant memory colour effects were pronounced only for those realistic images but not for mere outline shapes of fruits and vegetables. One possible explanation is that creatures like us are naturally cued to quickly distinguish food that is safe to eat (ripe yellow bananas for example), and that this sensitivity is enhanced as we mature but not in a way influenced by thoughts or high-level concepts about food. Accordingly, this sensitivity is triggered by realistic looking fruit images (in such a way that perhaps we experience their relevant colours in more pronounced ways, enjoying a kind of pop-out effect), but not for mere outline shapes of those same fruits. Deroy 2013 suggests this kind of explanation, where the results in these particular studies may involve purely perceptual changes that co-vary with other available sensory features, in this case, shape, volume, and texture.

For all that has been said here, the intra-perceptual interpretation may be the most plausible alternative explanation of apparent cases of cognitive penetration of colour. Again, these cases all involve fairly simple colour matching tasks, and so an explanation involving a genuine perceptual effect (by contrast to mere post-perceptual judgment) and little special activity on the part of the subjects (by contrast to agent driven shifts in attention) seems most attractive. The Witzel et al 2011 studies do seem to provide additional leverage for the cognitive penetration interpretation, since here the images used are human-made (smurfs; ping-pong tables; the Pink Panther) and culturally-sensitive (the experimental subjects were German, and so for them items like the UHU glue tube and Nivea tin are highly colour-diagnostic; these same images would not be highly colour diagnostic for most American subjects). Subjects in these studies reported the same memory colour effects, and by the same method of report (though, it is worth noting, with some possibly confounding differences between colours). It is much harder to make the case that there are "good ecological reasons" for this kind of (culturally-sensitive) plasticity. And the same might be said for the cutout shapes of artificial images (love-hearts) in the Delk and Fillenbaum studies, and for semantically primed faces in the Levin and Banaji studies. In any case, colour perception cases provide an

especially interesting testbed for comparing cognitive penetration explanations with intra-perceptual types of explanations. This is a fruitful area for future research.[17]

III. The importance of colour perception research and the cognitive penetrability debate

The above cases and their interpretation may have implications for standard metaphysical questions in philosophy of colour and perception—say about the objectivity of colour or debates concerning phenomenal character versus representational content—but the central emphasis in this final section, like much of the literature concerning cognitive penetration, is on epistemological concerns. The general implication involves concerns about the epistemic status of perception; if perception is cognitively penetrable, does this somehow threaten, or at least force revised epistemologies about, the supposed rational and knowledge providing roles of perception?

As discussed in II.2 above, colour is among the basic features represented by vision, the others are typically supposed to be shape, size, depth, and motion. Recently, some philosophers have argued that in addition to these *low-level* properties, visual experience may represent *high-level* properties. Typically included among the latter are emotional properties, causal properties, kind/categorical properties, and agential properties. Siegel (2006; 2010) argues for high-level admissible contents by appeal to phenomenology. Plausibly, overall experience had in the presence of pine trees or Cyrillic text is different before versus after acquiring a capacity to recognize pine trees or Cyrillic text as such. This contrast, Siegel argues, is best explained as a difference in perceptual content, where after acquiring the recognitional capacity one perceptually represents as instantiated the property of being a pine tree or being a word in Cyrillic text.[18] This explanation, however, is highly contested. A plausible reply, and one that Siegel attempts to rebut, is that the phenomenal sensory experience of, say, pine trees is the same before and after. What's different is that in the after-case

[17] For related philosophical discussion, see Connolly (2014). For the psychology of perceptual learning, see Gibson 1963 and Goldstone 1998.

[18] For a cross-section of papers on the topic, see Hawley and Macpherson 2011.

one judges that the object is a pine tree, where this may come with a feeling of familiarity that explains the phenomenal contrast. This position has tradition on its side, according to which perception represents basic properties of colour, shape, size and motion. Being of a kind or being a cause or being an instance of someone trying to perform an action are recognized but at the level of cognition. *We* make judgments that such properties are instantiated, but this is not something that *perception* "picks up".

Notice how this debate connects nicely with the above discussion of the judgment interpretation of alleged cases of cognitive penetration. In that context, like Siegel's pine tree and comparable cases, it is natural to claim that the apparent change (in perceptual report or introspected phenomenology) is one in how the subject makes judgments about the perceived scene. This is plausible if the task involves, for example, identifying objects of a kind. But as suggested above, it is much less plausible for the cases involving mere colour matching. As Macpherson puts the point,

> "[C]olour is a low-level property – it is a property that all people agree is represented by visual experience – as opposed to a high-level property, like a natural kind property. Therefore a common strategy that is employed by low-level theorists to maintain that two experiences are the same and that they represent the same properties cannot be employed here. The strategy is to claim that any evidence that the experiences are different is really evidence that the contents of judgments formed on the basis of those experiences are different, for it is claimed that experiences cannot represent the properties in question, as they are high-level properties. But this strategy can't be applied to this case for the properties at issue – colour properties – are low-level properties" (Macpherson 2012: 42).

So the judgment interpretation seems less apt in two related ways. First, one cannot deploy, as Macpherson notes, a high-level property judgment interpretation since colour is, by all theorists' lights, a low-level property. And second, and for that very reason, these cases less plausibly involve a judgment, let alone one that deviates from current experience. (Recall from II.2 that this is what the judgment interpretation would require: repeated erroneous judgment on the basis of current colour experience). So while alleged cases of cognitive penetration of high-level perceptual content may be

live only for certain theorists, apparent cases of cognitive penetration of colour perception are live for low-level and high-level theorists alike.

In some respects, this renders the epistemological consequences of cognitive penetration (supposing it occurs) more striking. The relevant consequences all concern the normativity of perception, should it be cognitively penetrable. And they all start with the assumption that in an important, foundational sense, experience is first. Experience is what we first…experience. And it is the feature of mental life that receives final appeal when justifying one's beliefs, theories, and decisions. We can then distinguish three questions, each of them prefixed with the antecedent condition: If perception is cognitively penetrated—What does this imply for perception's role in providing justified belief? What does this imply for perception's role in providing true belief or knowledge? Is there some special set of worries that attach to cases involving vision?

The first possible consequence concerns the rational role of perception, should it be penetrated by background cognitive states. The structure of the challenge is one familiar in contemporary philosophy of science. If one's perceptual observations are already infected with one's theoretical beliefs, then the former observations cannot provide a neutral arbiter for theory choice or support.[19] Siegel 2012 puts this general epistemic worry in terms of circularity. If I believe, before meeting her, that my friend is angry, and then upon meeting and because of that background belief I have a visual experience as of my friend being angry, the penetrated experience seems undermined as support for the consequent belief that my friend is angry. Lyons (2011) rejects the suggestion that the relevant epistemic consequence concerns circularity, arguing instead that the issue is reliability. He suggests further that it shouldn't be assumed without argument that the consequence is epistemically pernicious (see also Vance (2015)). Instead, it depends upon the particular process of belief formation, rather than the penetrating state. In some cases the process will be of an unreliable type and, accordingly, the resultant belief unjustified; other instances will

[19] For the now classic discussions of theory-ladenness of observation, see Hanson 1958, 1969; Kuhn 1962.

involve a boost of reliability (where beliefs formed via a process of that type are more likely to be true) and the belief is accordingly justified. So if my beliefs regarding morel mushrooms prime my visual system such that I form more true beliefs about the presence of morel mushrooms (more than I would absent that background belief) then this is arguably a good example of penetration. Finally, Siegel (2013a,b) argues that some cases of cognitive penetration are such that when beliefs are formed on their basis, experience is "downgraded" in its justificatory role. Her argument is that when the structure of the etiologies of experience mirrors an epistemically problematic etiology of belief (for example, where one "jumps to conclusions"), then in neither case are the resultant beliefs epistemically justified; in neither case does experience or belief rationally serve what she calls the "endorsement role" (where one rationally endorses the content of the mental state). Siegel attempts to show that this downgrade principle applies widely to epistemologies ranging from process reliabilism to dogmatism to mentalistic internalism.[20] Some of the latter theorists will naturally resist this claim, arguing instead that endorsing the content of the (unknowingly) penetrated experience, absent defeating evidence, is precisely the rational thing to do. As one commentator puts it, "What am I supposed to think?" (McGrath 2013; see also Huemer 2013, Fumerton 2013).

So it is very much debated whether this challenge takes such broad scope, and the points of debate pivot around independent commitments regarding epistemic justification. What's important to note is that, here again, the colour cases could prove extremely important. Colour perception is taken by all of these epistemologists to be basic, in at least two senses. Colours are an admissible content of visual experience; all parties agree that we have colour experiences while all parties do not agree that we have visual experiences as of, say, pine trees. And a perceptual belief about the colour of an object is an uncontroversial candidate for a non-inferential belief Put in Fodorian terms of modularity, colour processing is part of the visual "input system" that is supposed to be informationally encapsulated and, thus, impenetrable by higher-level cognition, and with important

[20] The details of some of these theories are discussed below. See also Tucker 2014; Vance 2014.

stakes for the objectivity of perception (Fodor 1983). So if the colour cases are best interpreted as bona fide cases of cognitive penetration, then each of these epistemologies will have to wrestle with their respective consequences, good or bad.

The second consequence is related, concerning not whether penetrated experience can provide a rational or justified basis for belief, but instead whether these cases are such that they undermine knowledge. This point requires marking the difference between a truth condition for knowledge and a non-redundant justification or warrant condition. The latter is the relevant condition for the first consequence discussed above. But one can imagine some of these cases described in the following ways. According to the seemings internalist, absent any knowledge about the problematic etiology, one should take one's colour experience at face value and relevant beliefs formed on that basis will be (prima facie) justified. Generally, the view claims that how things seem to the subject—thus a state internal and cognitively accessible to the subject—provide the subject with defeasible evidence about how things are. But in the alleged examples of cognitive penetration discussed above, it often seems that the etiology undermines the accuracy of the colour experience (the experience is non-veridical) and the resultant belief is thereby false (for example, one believes that the image is perfect grey when in fact it is bluish). This is still a rationally held belief, but it is not knowledge.

For an externalism like process reliabilism, a belief is justified just in case it results from a type of belief forming process that produces true beliefs with sufficiently high frequency.[21] A traditionally important question for this epistemology is how belief-forming processes should be *typed,* that is, by what criteria and to what specificity should the distinct types of processes that cause beliefs be distinguished. Thus from coarse to more fine, one might think that perception is a belief-forming process type, or that vision is, or that colour vision is, and so on. Now if belief-forming processes are typed coarsely enough, the etiology involved in alleged cases of cognitive penetration

[21] Goldman 1979 is the classic source.

of colour perception might be generally reliable and the resultant belief thereby justified. But here again, the etiology may be problematic vis-a-vis knowledge insofar as it undermines the truth-tracking role of experience and, accordingly, resultant belief.

So the second lesson is one familiar in contemporary epistemology, beliefs may be justified but false. Most recent attention has been paid to the question concerning justification, but this simple exercise concerning colour cases reveals another simple way that cognitive penetration may be problematic: it may simply undermine our capacity to access the truth about our immediate environments.

The third and final consequence focuses on the epistemic importance of vision by contrast to other sense modalities. It is common to describe humans as "visual creatures", and vision has most certainly dominated the psychological and philosophical research on perception. One might ask why vision is dominant in this way. One plausible answer points to the kind of information that vision provides, and arguably more efficiently than all other sense modalities. Healthy human vision provides, all-at-once, *rich spatial information*, enabling recognition of allocentric, macrospatial properties like shape, size, and orientation (Stokes and Biggs 2014). Upon entering a room, say a movie theater, vision will rapidly provide a perceiver with information about the broad spatial layout of the room, how certain objects are organized into rows (chairs), and set at distinctive distances from a much larger rectangular object (the screen), differences in illumination and colour in various locations in the room, objects (movie goers) moving in between the rows, and so on. For most perceivers, vision will also enable identification of objects at the level of kind: chairs, a screen, lights, people. No other modality can provide this richness of spatial information. For humans, only touch is relevant, but it would require, by contrast, laboriously extensive haptic exploration (and even then one could not acquire, by touch alone, all of the same information, say about lighting conditions or colour).

Stokes and Biggs argue that the distinctively rich spatial nature of the visual explains why visual perception (and visual imagery) dominates human perception in all sense modalities. And, they argue further, this is epistemically virtuous: insofar as one is performing perceptual tasks where rich spatial information is needed, it is good that vision will dominate the *judgments* made on the basis of sensory experience and, as evidenced in a variety of recent empirical studies, sometimes dominate *experience* in those modalities.[22] The lesson here is that the platitude that we are visual creatures is tracking something: vision is the most important means by which humans acquire rich spatial information about the immediate environmental space. The rich spatial information vision provides includes experience of edges and shapes, depth, motion, and of course, colour.

All of this further highlights the epistemic importance of the (possible) cognitive penetrability of colour perception. Visual perception, including visual perception of colour, is generally (which is not to say always) the epistemically best source we have for information about the immediate environmental space, what's "here and now". The cases discussed in §II suggest that, in some instances, visual processing and thus visual experience may be sensitive to more (or less) than the colours (or light reflectance properties) that are here and now. In these cases perception is plausibly causally dependent on what has been learned or cognized independent of the current environmental space, for example the characteristic colours of natural and artificial categories of object, or the lightness/darkness of faces of distinct racial categories. If some theorists are correct, this could be of double (or at least exacerbated) epistemic consequence: since not only does vision dominantly affect the vision-based judgments one makes about rich spatial features, it also appears to dominate (for rich spatial tasks) judgments made on the basis of the *non-visual* sense modalities.

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[22] For visual perceptual dominance over touch, see Rock and Victor 1964, Power and Graham 1976, Power 1980, Ernst and Banks 2002. For visual imagery dominance over touch, see Sathian et al. 1997, Zangaladze et al. 1999, Zhang et al. 2004. Visual dominance over audition, see McGurk and MacDonald 1976 and Rosenblum et al. 1997. Visual dominance over proprioception, see Botnivick and Cohen 1998. Visual dominance over olfaction, see Royet et al. 1999, Sakai et al. 2005. Visual dominance over flavour experience, see Johnson and Clydesdale 1982; Morrot et al. 2001; Spence 2010.

Therefore if basic colour perception is cognitively penetrated, then non-visual perception (or belief) may thereby be cognitively penetrated.

Conclusion

Here is a prediction by way of conclusion. The prediction is ambitious in scope, but safely supported by the above discussions. Possible cases of the cognitive penetration of colour perception will continue to be an important testbed for a variety of empirical, epistemological, and metaphysical questions. These questions concern cognitive architecture and how colour perception fits in the best model of the mind, the epistemic role of vision and perception, and even the reality of colours. How one thinks about colour may influence how one sees colour, and this may properly influence our best theories of colour.

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