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SYMPOSIUM

Responses to critics

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Responses to replies can be boring if they are about who said what but I'll try to keep my responses interesting by focusing on the most significant issues, putting any textual issues in separate sections that can be skipped. (References to page numbers are to my book (Block 2023) unless specified otherwise.)

1 | CRITIQUES BY THE TWO JAKES

Jake Beck and Jake Quilty-Dunn make opposite (though compatible) criticisms of my way of drawing the border between perception and cognition.

Beck thinks I am wrong about a species of cognition while Quilty-Dunn thinks I am wrong about a species of perception. Beck thinks that cognition can have the properties I regard as constitutive of perception; he thinks my characterization of perception as iconic, non-conceptual and non-propositional also applies to an important species of cognition and that I neglect this species of cognition. Quilty-Dunn thinks that the properties I ascribe to paradigmatic cognition (discursive, conceptual, propositional) apply to an important species of perception—object perception. From my perspective, Beck inflates the category of the non-conceptual, non-propositional and iconic whereas Quilty-Dunn inflates the category of the conceptual, propositional and discursive.

Both critiques centrally involve my claim that when perceptual representations are used in cognition, they are enclosed in what I call a cognitive envelope that adds a discursive, conceptual and propositional shell to perceptual representations that do not in themselves have these properties. This challenges Beck because the cognitive aspect of the representations that he emphasizes should be thought of in terms of cognitive envelopes and it challenges Quilty-Dunn because object perception itself is not enclosed in a cognitive envelope unless encoded in working memory. I explain the notion of a cognitive envelope and its relation to working memory in the Précis in the section on what a cognitive envelope is. *Please read that before continuing*.

2 | REPLY TO JAKE QUILTY-DUNN

Jake Quilty-Dunn holds that the representations of object perception—but not other kinds of perception– are discursive, conceptual and propositional. He is a "dualist" about perceptual representations, holding that object representations are discursive while other perceptual representations, e.g. perceptual representations of color and orientation, are iconic (Quilty-Dunn, 2016). (See also (Quilty-Dunn, 2020, Quilty-Dunn & Green, 2021, Quilty-Dunn et al., 2023).) He makes two criticisms, both focused on speed:

1. Encoding in working memory is fast (too fast for me to explain).
2. Perceptual categorization (especially high level perceptual categorization) is fast (too fast for me to explain).

I'll start with 1.

2.1 | Is the speed of encoding in working memory too fast for me to explain?

As I explain in the Précis, I see encoding in working memory in terms of the global workspace model. (I am ignoring "activity-silent" working memory—see the Précis.) Broadcasting in the global workspace takes about 270 ms. at a minimum, so the speed of encoding in working memory is a potential vulnerability for me. Before we get to an explicit discussion of that issue, there are two preliminary issues. The first is whether perception and working memory speak different languages (requiring a time-consuming translation) and the second is what working memory is for. I will proceed to discuss those two issues before getting to an explicit discussion of how fast encoding in working memory really is and why that matters.

Quilty-Dunn assumes that I am committed to the claim that perception and working memory "speak different languages" (iconic for perception, discursive for working memory) and that view requires a time-consuming process of translation. Here are passages in which he describes the basic issue.

> Does the way perception and cognition interact seem to suggest that they speak different languages and rely on some intermediating translation? Or do they use a common interlingua that allows for free transfer of information?… Our key question: does perception seem to hand information off in a way that suggests a common interlingua, or in a way that suggests a format discontinuity? … is the information transfer fast or slow? Are the same representations at the interface point usable for both cognitive and perceptual processes, or only ever one or the other?

Quilty-Dunn's point here is that a view that says that perception and cognition speak the same language has a marked speed advantage when it comes to explaining the fast speed of encoding perception in working memory.

Quilty-Dunn says I have a translation problem where he does not. This is where the concept of a cognitive envelope comes in. On my view, what is enclosed in the cognitive envelope can be iconic representations of perception, modified but still iconic. The discursive elements can be contributed by the envelope. For the perceptual representations in the back of the head to be broadcast is for them to be linked by activated mutually reinforcing reverberating coalitions to the discursive, conceptual and propositional cognitive apparatus in the front of the head. The envelope is constituted by broadcasting in the global workspace and of course that takes time—but, as I will explain below, *consolidation* of perceptual representations in working memory can happen quickly, well before broadcasting.

In sum, I don't have a translation problem because my view entails similar representations of perception and what is enclosed in working memory. Further, as we will see, Quilty-Dunn's pluralism (2020) may give him a translation problem.

Before we get to the issue of how fast perceptual representations can be consolidated, there is another issue, what working memory is for.

2.2 | What is working memory for?

Quilty-Dunn contrasts two alternative pictures of the function of working memory:

1. For ongoing perceptions—to store information from part of a perceptual episode to be applied to a later part of the perceptual episode.
2. For cognition: to be used in reasoning, decision making, some kinds of action planning and other cognitive tasks

He argues that if working memory is for interacting with ongoing perception, we could expect it to have the same format as perception. If it is for use in cognition, we could expect it to have the format of cognition. Of course, as he recognizes, working memory is for both 1 and 2. His argument is that his view satisfies both 1 and 2 because if the format of object perception is discursive, then it has the same format as cognition.

I have a different way of satisfying both 1 and 2: 1 is satisfied by the iconic representations enclosed in the working memory envelope and 2 is satisfied by the envelope itself. One way to put the point is that my account of the working memory aspect of cognition is "dualistic", involving both iconic and discursive format. So I don't think his view has an advantage here.

Now, on to the crucial issue of just how fast consolidation of visual representations in working memory really is and whether it is incompatible with my picture of working memory.

2.3 | How fast is consolidation in working memory?

For convenience I reproduce Quilty-Dunn's Figure 2 from (Vogel et al., 2006) as Figure 1 below., Vogel, et al. presented a memory array of 1–4 colored squares, then a blank screen (not pictured) of varying length, then a mask that is intended to disrupt processing, then a test array that half the time differed from the original memory array by a change of color of one square. The task was to press one key if there was a change in color and the other key if there wasn't. The delays between onset of the memory array and mask spanned from 117 ms to 584 ms.

For 4 items at the shortest delay before the mask, subjects were only about 60% correct on the change detection task but their performance improved with bigger delays–and there were similar results for 2 and 3 items. A display of one item though was unaffected by the mask at 117 ms and longer times as well suggesting that 117 ms was enough for one item to make it into

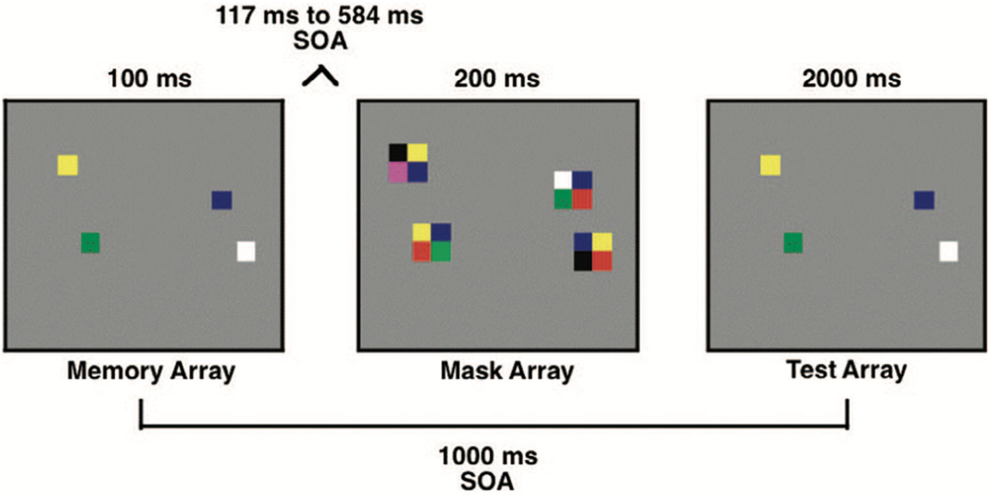

FIGURE 1 From (Vogel, Woodman et al. 2006).

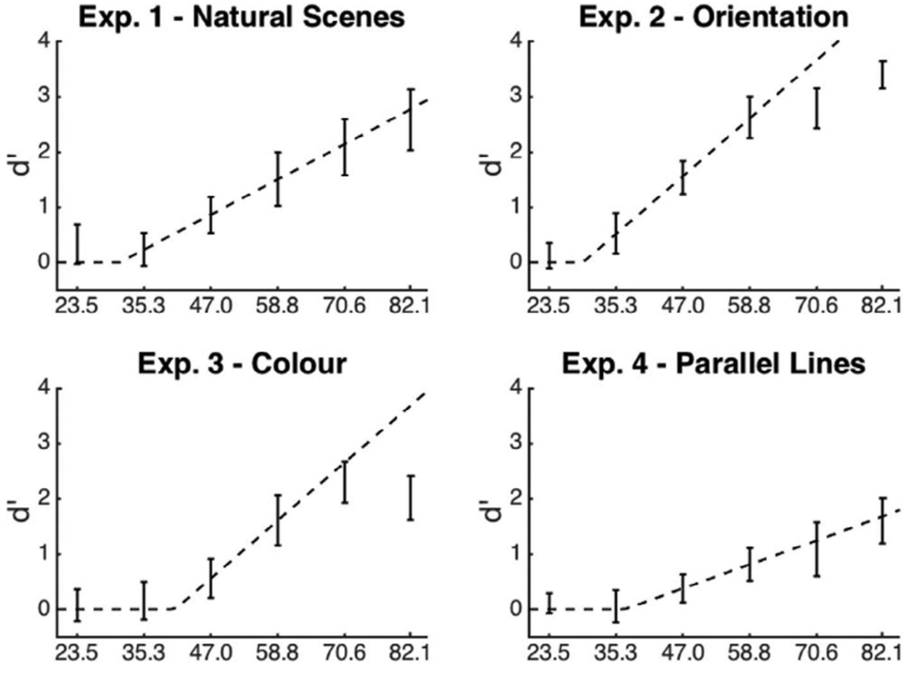

FIGURE 2 Thanks to Piers How for the diagram. See Figure 3 of (Howe 2017).

durable storage—i.e. consolidation– in working memory. Vogel, et al. were able to calculate that 50 ms of further processing was required for each additional item to be encoded into durable storage. Quilty-Dunn concludes that working memory consolidation is too fast for cross-format translation. My reply is that I can accommodate fast consolidation because consolidation is the formation of a durable representation that happens before broadcasting in the global workspace, as I will explain.

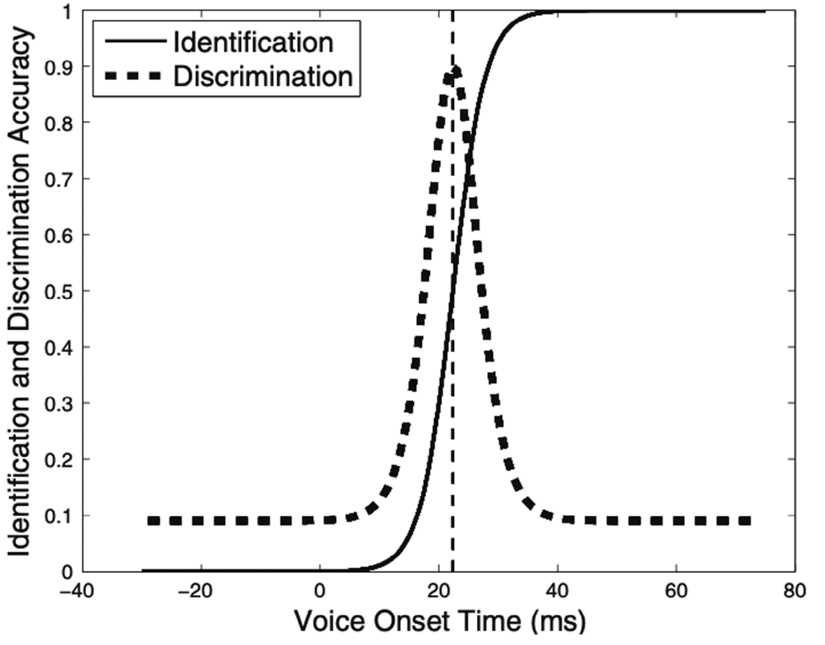

FIGURE 3 Hypothetical curves for discriminating /ba/ from /pa/. The solid curve represents the probability that a sound will be identified as a /ba/ as a function of "voice onset time", which is the point at which vocal cords vibrate in a manner that can be detected by placing one's finger on one's throat while pronouncing /ba/. The dotted curve represents accuracy in discriminating the sounds. From (Kronrod, Coppess et al. 2016).

Note first that I don't postulate cross-format translation since I hold that working memory uses iconic representations in a cognitive envelope. What is the cognitive envelope in this case? The subjects are told to look for a color change and respond on that basis. This is a cognitive task involving using perceptual contents in the service of thinking and decision. Subjects have to mobilize cognitively organized feature-based attention to color and differences in color. Subjects were instructed to prize accuracy over speed, requiring cognitive direction of strategic decision making. Two randomly selected digits were presented at the beginning of each trial that the subjects had to repeat throughout the trial—the purpose of which was to frustrate verbal coding of the stimulus, so subjects have to adjust their strategy to deal with these conditions.

It would be tempting to think that the 117 ms for the first item (the Y intercept in Quilty-Dunn's Figure 3) is the time it takes to remember one item and the additional 50 ms required to consolidate the next item shows 167 ms is the time it takes to remember two items. But this would be a mistake. From the point of view of the global workspace model, *consolidation of the perceptual representation* can be accomplished by the reverberating loops in the back of the head *prior to ignition* of the full global workspace activation. (This is stage 2 of the 3 stages of global broadcasting described in the Précis.). Note that the test array appears after 1000 ms. That allows plenty of time for broadcasting in the global workspace before a response is required. After the 1000 ms. the subject has time to make a comparison with the first array before the trial is over.

A further point is that as Vogel et al. note, their results do not distinguish between a serial consolidation model and a parallel model. Here is what they say (p. 1440):

> The finding that more time is required to consolidate larger memory arrays may seem to imply that consolidation is performed in serial. However, this pattern is equally compatible with a limited-capacity parallel consolidation process, in which all of the items in the array are encoded simultaneously but each item is consolidated more slowly as the load increases. The current results cannot distinguish between these two candidate modes of processing.

Again, on a parallel model of consolidation, the 1000 ms before the test array gives ample time for global broadcasting.

2.4 | The hybrid view of working memory

Quilty-Dunn notes that I say visual working memory representations contain perceptual materials and that suggests a hybrid view. He points out that I suggest that

> VWM representations are "perceptual" (p.113) and contain "perceptual materials" (p.258) or "remnants of perception" (p.260) enclosed in a "cognitive envelope" (p.249). In that case, perhaps his view is that some of the iconic outputs of perception are simply held as such in VWM (these are the perceptual materials), but are accompanied by discursive representations (this is the cognitive envelope).

This is closer to my actual view. The way I would put it however, is that broadcasting in the global workspace can link perceptual representations to cognitive machinery, often involving discursive representations and the cognitive mechanisms that operate on them (in creatures that have those cognitive mechanisms).

As I mentioned at the outset, Quilty-Dunn has two criticisms: one is appeals to the speed of working memory consolidation; the other appeals to the speed of perceptual categorization. But the two issues interact. Quilty-Dunn considers two possibilities of how the hybrid view could be compatible with facts about the speed of consolidation. On one, iconic elements could be added in 10s of milliseconds with alleged discursive elements added more slowly—the latter slow addition being allegedly incompatible with fast visual categorization. He considers a line of evidence that visual categorization takes only 10s of milliseconds. I now turn to that argument.

2.5 | Speed of visual categorization

Quilty-Dunn begins the discussion of fast visual categorization with Eric Mandelbaum's argument (Mandelbaum, 2018) that a line of work started by Molly Potter (Potter et al., 2014) shows that visual categorization takes 10s of milliseconds. Mandelbaum concludes from this and other arguments that I won't discuss (but see pl 327–333) that visual categorization is too fast for it to be accomplished by a distinct cognitive system and must be accomplished within perception itself. (His focus is on the perceptual system having conceptuality rather than discursivity, the format issue that Quilty-Dunn is concerned with, but I'll ignore that difference, just talking in terms of format.)

Potter did many versions of this experiment but in the version under discussion she presented a stream of very briefly presented pictures with each picture "masking" the one before it.

(As mentioned in the Précis, a stimulus of the right sort presented after another stimulus can make the first one harder to see—that is backward masking.) At the end of the series, subjects were given a description (e.g. 'flowers', "children holding hands", "boats on a beach") and had to say whether the description fitted one of the briefly presented pictures. She found that with times as short as 13 ms. between picture and mask (i.e. the next picture) subjects were above chance in answering the question. Later articles (Maguire & Howe 2016, Howe, 2017) used essentially the same method (with categories like barn, beach, bathroom) but with masks of randomly oriented lines that are better at impinging on processing in V1, showing that a 35 ms. delay was the minimum time between picture and mask for above chance recognition of a variety of stimuli.

I discussed Mandelbaum's arguments in the book in a section labeled "Fast Perception" (p. 325–333). The point I made then and I think can be shown even more decisively on the basis of Howe's data (but see (Mandelbaum, 2024) for an opposed view) is that what is important for the time of perceptual categorization is not the *duration of the stimulus prior to masking* but rather *how long the stimulus is processed*. These are different because the stimulus is processed in the visual stream after the mask. Quilty-Dunn quotes Mandelbaum apparently approvingly but doesn't actually explicitly sign on to his argument.

Let me say what Mandelbaum's argument is and what I think is wrong with it; and then move on to the somewhat different point that Quilty-Dunn is making and why I don't accept it. I can explain with regard to the data from (Howe, 2017), below in Figure 2 showing the effect of the oriented line mask on perception. Howe's procedure differs from Potter's in a number of ways. A series of masks made of oriented lines was presented with a picture at a randomly chosen position in the series. At the end of the series another picture or a phrase was presented and the subject was asked respond to the question of whether there was a picture in the series that matched either the picture or the phrase. Whether the subjects matched to a picture or a phrase did not change the results much.

The y axis in these graphs is a measure of accuracy. You can think of it as just percent correct modified to account for guessing. The x axis shows the number of ms between the stimulus and the mask. What you can see from the graphs is that if the mask was presented closer to the stimulus than about 35 ms, the subjects' accuracy was zero. If the mask was presented after about 35 ms. accuracy increased, and more or less in the same manner both for natural scenes (upper left) and low level perception in the other three quadrants. Since 35 ms. is within the span of processing in the first cortical area involved in visual perception, V1, Howe put his results in terms of V1. He concluded that 35 ms. or more of processing in V1 is necessary for seeing and categorizing the stimulus.

Mandelbaum seems to assume that the short times of processing before the mask is the duration of the perception itself. What is wrong with this assumption (put in terms of the Howe article) is that 35 ms. is the minimum V1 processing time to categorize a stimulus, but the V1 processing time *is not the duration of the perception or of perceptual categorization*! For mask presentations of 35 ms., or longer the whole visual hierarchy is activated and that takes much longer. A mask before 35 ms. of processing stops the whole stream and the subject cannot categorize at all. Visual processing has many "stages" in the occipital and temporal lobes, orientations in early vision, then surfaces, shapes, objects, and at very high levels, faces, causation and agency with much of the categorization localized in the temporal lobe, There are many sources of evidence for the visual hierarchy (described in pages 83–85), both behavioral and neural. For example, the visual system contains as many as 30 distinct retinotopic maps in different areas (Silver et al., 2005). A more specific example: bilateral damage in area LOC results in perception of color and texture without shape (Goodale & Milner, 2005). To categorize natural scenes requires cascading analysis taking way longer than the processing time in V1. (To be sure, Mandelbaum (Mandelbaum, 2018, Mandelbaum, 2024) gives other arguments for fast perception of basic level categories which I can't discuss here. See p. 330–333 for further discussion.). In sum, the experiments just described do not tell us the speed of visual categorization.

Mandelbaum assumes that the matching procedure is a matter of using the discursively represented conceptual category that is the output of perception to match to a discursively represented conceptual category decoded from the words in the phrase but another possibility is that an iconic non-conceptual output of perception is matched to the iconic representation generated from the phrase, or in the case of most trials of Howe's version, a picture. In short, the visual categorization could be iconic.

As I said, Quilty-Dunn does not explicitly sign on to Mandelbaum's point but makes a different point. Here is what he says:

> … our question here is whether encoding conceptual categories is significantly slower than encoding low-level features. In a follow-up to the follow-up, Howe (2017) found that the minimal presentation time for categorization was about the same as that for detecting color and orientation (~35ms). It's implausible that consolidation of discursive representations into VWM is significantly slower than consolidating iconic elements.

Quilty-Dunn's focus is on a matter visible by noting the similarity of the different quadrants in Figure 2. He assumes that processing of the natural scenes diagrammed in the upper left is a matter of object perception which from his point of view is a matter of discursive representation. Color and orientation (upper right and lower left) are iconic lower level features. His overall point is that the V1 processing time is the same for both, supposedly showing visual categorization happens quickly regardless of the type of perception.

I agree with Quilty-Dunn that the line masks are effective in impinging on processing in V1 and I acknowledged that in the book (p. 329). But again the minimal gap between stimulus and mask only tells us about processing time in V1 and not the time of visual categorization of any of these properties, lines, colors or natural scenes. At times under 35 ms, there is no transmission to the visual stream and no recognition and no visual categorization. At times over 35 ms., all these kinds of visual representations are processed in other parts of the visual stream. The Potter and Howe experiments give no estimate of how long that takes, nor are they intended to.

I can't resist adding that Quilty-Dunn should be puzzled by this result since on his view, visual categorization of color and texture—iconic representations on his view as well as mine—do require translation and visual categorization of the objects in natural scenes—discursive representations– does not. So why doesn't the object categorization take longer?

It is important to understand that none of the articles that Quilty-Dunn is relying on (Potter et al., 2014, Maguire & Howe, 2016, Howe, 2017) claim that perceptual categorization takes place fast or in 10s of milliseconds or that encoding in working memory is fast or anything of the sort. The studies are not designed for that purpose. The themes of how long a perception takes or how long encoding in working memory takes are simply not mentioned. The purpose of all of these studies is to show that substantial perception can occur in a feed-forward manner without feedback processing to V1 as alleged in some very influential articles (Hochstein & Ahissar, 2002, Lamme, 2003, Lamme, 2006).

To understand the methodology of these studies, one must understand Jeremy Wolfe's "carwash" model of visual processing (Moore & Wolfe, 2001). Wolfe's carwash model of rapid serial visual presentation says that a mask will often interfere at one stage of processing, while leaving intact the representations of previous stimuli at other stages of processing. The main idea of all of these studies is that the mask affecting V1 precludes the effect of feedback processing on V1 because by the time that feedback processing could arrive, the original V1 processing of the stimulus would be over.

Howe, like Quilty-Dunn focuses on the comparison between natural scenes and low level features. The title of the article is "Natural scenes can be identified as rapidly as individual features. But as with Potter and her colleagues, what Howe is interested in is not the speed of visual categorization but rather whether feed-forward processing is sufficient for perception.[1]

Quilty-Dunn concludes the quoted passage by comparing consolidation in working memory of the iconic representations of orientation and color (we agree they are iconic) with what he regards as the discursive representations of natural scenes. Perhaps his reasoning is that visual categorization is a matter of encoding in working memory. But that reasoning would buy into the Mandelbaum argument that I take myself to have refuted.

In sum, my view can handle the evidence for fast perceptual categorization and for fast transitions from perception to working memory.

3 | REPLY TO JAKE BECK

Jake Beck is mainly concerned with my category of cognition. He says my border is the border between perception and an elite species of cognition rather than cognition per se. He proposes a distinction that differentiates perception from cognition in terms of stimulus dependence: perception constitutively depends on proximal stimulation for its initiation and maintenance whereas cognition does not. He acknowledges that his distinction is more superficial than mine but rejects my characterization of his proposal as "pre-scientific", saying that many scientifically useful distinctions wear their essences on their sleeves. In the book, I raised an objection to this view, Beck replied, and I have a response here.

He uses a wonderful analogy. He says what I am doing is analogous to explaining the difference between a youth hostel and a hotel by characterizing the difference between a youth hostel and a 7 star hotel, ignoring all the lesser hotels. It is this category of the 1–6 star hotels that is at issue, the alleged entirely non-conceptual, non-propositional and iconic cognition of young children and animals without any cognitive envelope. Beck thinks such cases are legion and very important. If he is right, there is an important category of cognition that is entirely non-conceptual, non-propositional and iconic. As you might guess, my reply is that the 1-6 star hotel category that he is talking about is enclosed in a cognitive envelope and so not entirely non-conceptual, non-propositional or iconic.

A reminder on my position: I argue that perception is–but cognition is not– constitutively non-conceptual, non- propositional and iconic. Cognition is, paradigmatically but not constitutively conceptual, propositional and non-iconic (discursive). What is the difference between what is

[1] Howe's line of argument is to simply *assume* the extremely controversial view that perception of color and orientation can be done in a purely feedforward manner. 'He argues that since the same masks work equally well (or badly) for color and orientation as for meaningful scenes, it must be that meaningful scenes can be processed in a purely feed-forward manner too. He says (p.1680): "the main assumption I made was that the colour and orientation of an isolated line can be processed in a purely feedforward manner. It could be that this assumption is false and that the conscious perception of an image always requires reentrant feedback to be established from higher visual cortical areas to lower ones."

constitutive and what is paradigmatic? Being constitutively non-conceptual, non-propositional and iconic precludes these representations from being even in part conceptual, propositional or discursive. Cognition is more catholic, in that it often—though not always– uses perceptual materials, as when we use perceptual imagery to decide whether the sofa will fit through the doorway, or a mental map to choose the shorter route, so cognition sometimes involves perceptual representations—enclosed—or so I argued—in a cognitive envelope. (See the Précis for the concept of a cognitive envelope.)

Influenced by Burge (2010), I speculated on a category of perceptual memories, perceptual anticipations, mental maps and even perceptual simulations that could be used entirely on their own in thinking but without being in any sort of cognitive envelope. I now reject that speculation.

The use of perceptual representations in imagistic simulations is enough to show that cognition can involve iconic representational elements—see the brief summary of some of Susan Carey's work on iconicity in the Précis. This fact led me to characterize cognition recessively as not being constitutively non-conceptual, non-propositional and iconic. I emphasized that these non-conceptual representations are held in a conceptual cognitive envelope but I didn't realize the extent to which they are themselves recoded and more generally the extent to which the sensory recruitment view of working memory is false. See the Precis.

3.1 | What are propositions?

The term 'proposition' is used differently by different groups of scientists and philosophers. As I emphasize in the book, I define 'propositional' representations as representations that can serve as premises or conclusions in content-based reasoning. Importantly, I allow for the possibility that iconic representations enclosed in a cognitive envelope can be propositional. For me, iconicity is a matter of format whereas propositionality (and conceptuality—concepts are components of propositions) is a matter of function. See p. 196, 220 and 268 on an iconic representation of a triangle functioning as a concept of triangle, as Berkeley seems to have thought.

It may be helpful to discuss the matter in terms of six putative properties of a language of thought set forth in a recent article (Quilty-Dunn et al., 2023):

- discrete constituents
- role-filler independence
- abstract content
- inferential promiscuity
- predicate-argument structure;
- logical operators

I think the first 3 of these are present in perception, but not inferential promiscuity or predicate-argument structure and certainly not the logical operators of negation and disjunction. Still, I think iconic representations enclosed in a cognitive envelope can exhibit inferential promiscuity.

Beck alleges that children and animals reason non-propositionally. My main reply is that there is strong evidence that children over 15–17 months old and many animals are capable of propositional reasoning, as I will explain in the rest of this section.

Consider this version of Josep Call's 2 cup task (Mody & Carey, 2016): a child is shown 2 buckets, a screen is lowered and a desirable object is visibly placed in one of the buckets but behind the screen so the child cannot see which bucket it has gone in. The screen is raised and the child is told they can have the object but they only get one try. One bucket is turned so the child can see it is empty. After 15–17 months, children start to avoid picking the empty bucket.

This shows a failure of infants' "exclusion" reasoning prior to 15–17 months and the beginnings of success after that. Feiman et al. (Feiman et al., 2022, McDermott-Hinman & Feiman, 2024) showed robust exclusion reasoning by 17–20 months. Further, they showed success in another type of exclusion reasoning at the same time, involving causal reasoning, what is called "indirect screening off". Children are shown that A&B cause an effect but A does not. After 17–20 months, these children show a preference for B causing the effect, suggesting that there is a domain general form of negation acquired at this age.

These successes suggest content based exclusion reasoning, using a primitive form of negation in infants. Many animal species have been shown to pass Call's exclusion test, for example, great apes, some baboons, some monkeys, dogs, ravens and parrots (Mody & Carey, 2016) so it would seem that many animals can engage in content based reasoning, though I don't know if the animals' form of negation is domain general.

Contraries cannot both be true but they can both be false. A 2-D figure cannot be both a triangle and a rectangle but it can be neither. The form of negation involved here may be more like a contrary than true logical negation. What they may have learned is to avoid choosing the empty bucket.

Given my functional use of the term 'proposition', this reasoning in animals and children after 15–17 months shows propositional representations. Beck argues that such cases can be explained non-propositionally. For example, he thinks iconic analog magnitude representations can play a desire-like role and a belief-like role, embedded in sophisticated practical reasoning involving expected utility theory without propositional representations, not only in young children but in animals, including perhaps, birds and fish.

But recall that for me iconicity is not the issue. I'm willing to allow that iconic analog magnitude representations in a cognitive envelope can be propositional. So Beck and I are at cross purposes, with our disagreement being partially terminological.

It is worth mentioning that children may have primitive propositional representations well before 15–17 months. In the Précis, I mentioned Kiley Hamlin's experiment in which 6 month old babies (replicated in 8 month old bilinguals (Singh, 2020)) seem to infer that the hinderer of the hinderer is desireable. This looks at least somewhat analogous to inferring from not-not p to p. Of course, even if this speculation is right, these infants have at best a very primitive form of negation, with a less primitive form coming in over a year later in the "exclusion" reasoning just discussed.

The upshot is that there is good evidence for content based reasoning in animals and children over 15–17 months old—creatures that Beck thinks have little or no propositional representations. And there is some evidence for content-based reasoning even younger. It is true that it takes until age 3–4 before children have facility with logical reasoning based on disjunction and modality, but I think Beck overemphasizes the importance of this fact, jumping to the conclusion that children younger than this—and animals—lack much propositional reasoning in my sense prior to that age.

3.2 | Dilemma of logical reasoning

As I mentioned, children younger than 15–17 months fail in the exclusion reasoning required by Call's 2 bucket task and it isn't until 17-20 months that they robustly understand exclusion reasoning. Beck thinks this fact shows I am stuck with a dilemma. He says

> …infants fail at even the most basic tests of disjunctive syllogism before 17 months and don't pass a more demanding test until age three (Mody & Carey, 2016). Success at similar tasks among nonhuman animals are limited as well, suggesting that infant cognition and the cognition of some animals is nonpropositional and nonconceptual.
>
> Block might agree; he says that infants have "proto-concepts" rather than concepts (p. 267). But if so, this puts him in a bind since his main argument that perception is nonpropositional is that perception lacks logical structure (Ch. 4). There is no negation or disjunction in perception, he says, since you cannot perceive something as *red or green* or as *not red*. Thus, if he gives up on logical structure being a mark of propositionality, he loses his main argument for perception being nonpropositional. Alternatively, if he sticks with that criterion, he seems committed to the existence of nonpropositional cognition, at least in animals and infants."

The dilemma is that I say perception is nonpropositional because it lacks logical structure but children's cognition also lacks logical structure so how can it be cognition?

Starting with the second horn of the dilemma, young childrens' cognition does not lack logical structure. Young children are capable of logical inference. No one is suggesting that young children cannot infer from A&B to A. More relevantly, as I noted, children over 15–17 months and many animals (as mentioned, great apes, some baboons, some monkeys, dogs, ravens and parrots) are capable of exclusion reasoning. As I mentioned, it may be that even 6 month olds are capable of some content-based reasoning analogous to double negation elimination.

Moving to the first horn, I take logical structure as relevant to propositionality only insofar as it affects the functional role definitive of propositionality. Propositionality is functional. Here is what I say (p. 178):

> "Wait, why am I talking about logical structure of contents and logical relations among contents, when the sense of "nonconceptual" I am using concerns states, not contents? In my view, contents are grounded in the functional roles of representational aspects of states. Further, whether a state is nonconceptual or nonpropositional is also grounded in the functional roles of representational aspects of states. In particular, propositionality is a matter of whether representational aspects of states are apt for use in reasoning and other cognitive processes. So content, conceptuality, and propositionality are all ultimately functional."

3.3 | Stimulus-Dependence

Beck favors an account of the perception/cognition border in terms of stimulus dependence. Here he summarizes one of my objections:

> Block raises two objections to the stimulus-dependence approach. The first is that what he calls "minimal immediate direct perceptual judgments" are just as stimulus dependent as the perceptions they conceptualize (p. 42). But while it's true that such judgments depend on proximal stimulation for their *initiation*, they are not dependent on proximal stimulation for their *maintenance*. If you see Times

> Square and then close your eyes, you can continue to hold the minimal immediate direct perceptual judgments you formed about Times Square in mind. So, they are stimulus-*independent* in my sense.

I introduce the idea of a minimal immediate direct perceptual judgment on page 12. I define ‘immediate as follows: “The cognitive state that is hardest to distinguish from a perception is a minimal immediate, direct perceptual judgment based on that perception. If I am perceiving a face, I often simultaneously judge on the basis of that perception that there is a face. When I speak of immediate perceptual judgment, I am talking about a cognitive state that is noninferentially triggered by perception.” While this might not be as clear as it should have been, the kind of judgment that I was trying to specify was one that incorporates the perception *while it is happening*. *That* kind of judgment is just as stimulus dependent as perception. Beck may feel that this kind of judgment is just a made up artificial category but I don’t think so. Once you close your eyes, perception stops. In certain conditions, there can be an iconic representation that lasts a couple of hundred ms. To generate one of the mental images that Beck is talking about takes more than a second. (See the discussion on pages 374–377). Those mental images are much coarser than perception.

Consider a judgment about two very similar paint chips that you see side by side, deciding which one to use for the living room. There is a kind of judgment that one can make when one is actually seeing them that cannot be made easily after one closes one’s eyes. Or: look at this sequence of letters: W W I I. Are the spaces between the ‘W’s bigger or smaller than the spaces between the ‘I’s. People have very different levels of imagery abilities but speaking for myself I can do this with my eyes open and not with my eyes closed. Beck thinks that “A capacity belongs to perception if it can be exercised in a stimulus-dependent manner and to cognition if it can be exercised in a stimulus-independent manner.” But the kind of cognition of what one is perceiving just illustrated is just as stimulus-dependent as perception.

4 | TEXTUAL MATTERS

4.1 | Format vs Role

There is a misunderstanding in Beck’s response (and in (Beck, 2023).) that is responsible for the verbal element in our disagreement mentioned above. I have put it off for last because I think our more interesting disagreements can be discussed independently of it.

Beck mis-reads what I mean by ‘proposition’ and ‘concept’.

> “Block pursues an approach grounded in representational format: whereas perception is constitutively nonpropositional, nonconceptual, and iconic (NNI), cognition is constitutively none of those things. Paridigmatically, it is the opposite: propositional, conceptual, and discursive (PCD).”

He says I take propositionality and conceptuality to be a matter of format. I do take iconicity as a format property of perception and discursivity as a format property of cognition, but I do not ever mention format as part of the definition of propositionality and conceptuality. I define those concepts in terms of functional role.

I discuss views of non-conceptuality based on content and compare those to views based on mental states (referencing Heck), firmly committing myself to the state conception and defining that in terms of functional role. There are many matters in which what I say is vague, ambiguous, unclear—maybe even contradictory–but not this. I am at pains to explain that while iconicity is a matter of format, non-propositionality and non-conceptuality are a matter of functional role, specifically role in inferences.

Chapter 4 concerns what conceptual and propositional representations are. At the beginning of Chapter 4, I explain what I mean by 'concept' as follows (p. 166):

> In the representational sense, the sense that I will be using, concepts are representational (paradigmatically predicative) elements that constitutively function in propositional thought, reasoning, problem- solving, evaluating, deciding, and other cognitive processes and states.

I start the section entitled "Format/ content/ state/ function" (p. 172) by saying "As I have been saying, what makes propositional representations propositional is their role in content-based transitions in cognitive processes such as reasoning, inferring, thinking, and deciding." I go on to discuss the aspect of functional role that makes a concept conceptual, saying (174), "…there can't be entirely nonconceptual propositional representations, since the characteristic inferential role that determines that a representation is propositional will inevitably determine conceptuality for some of the proposition's constituents."

As I said, I never consider a format-based account of propositionality or conceptuality of the sort Beck has in mind, focusing on whether these ideas should be spelled out in terms of content or state. I favor the state conception, concluding (p. 174) "Conceptuality is a matter of role."

Beck's understanding of my view of conceptual and propositional representations as based on format leads him to claim that I am led into contradictions.

> "Block concedes that "perceptual materials"—materials that are NNI—can be enclosed in a "cognitive envelope," as when you use imagery to determine if a sofa will fit through a doorway. Sometimes Block seems to take this to mean that perceptual materials are placed in working memory. But if that's right, then we need to ask why being in working memory makes something cognitive. And if the answer appeals to a non-format property—say, being broadcast in the non-modular global workspace; or being stimulus-independent—then the real work of distinguishing perception from cognition is no longer being done by format."

Right, format cannot do the work of distinguishing perception from cognition: function is needed. Being broadcast in the global workspace is not a format property but it is part of the functional role of a representation that is, as I just explained, crucial to its conceptuality. Beck's interpretation also affects his view of what a "cognitive envelope" is:

> "So, when Block talks about perceptual materials being placed in a "cognitive envelope" he must instead mean that they are joined to a representation that is PCD, with the result being a hybrid representation, like the sentence "My grandmother looks like this __" in which the blank is filled in by a picture." [PCD is Beck's abbreviation of "propositional, conceptual and discursive"]

Since Beck thinks I take “cognitive envelope” to mean a kind of format, he has to postulate an appropriate format.

5 | RESPONSE TO STEVEN GROSS

It is wonderful to respond to a critique by Steven Gross because he has not only made insightful criticisms that challenge my basic assumptions, but he has also told me how to respond …once again (Block, 2023, Gross, 2023)!

The problem he addresses in this critique is that the concept of iconicity that I use requires degrees of difference in what is represented mirroring degrees of difference in the vehicles that are doing the representing. Both the representer and the represented must be degreed to be iconic in my sense, but on the face of it, categorical perception is not degreed in either way: Neither the categorical concepts nor the world properties they designate would seem to be degreed. Some may say that our concept of a face does not allow degrees of being a face (as contrasted with degrees of looking like a face) any more than our concept of pregnancy allows for degrees of pregnancy. And at least at first glance, the world corresponds to these concepts. Some may say that a person is pregnant or not. The difference between the /b/ of ‘bin’ and the /p/ of ‘pin’ does not seem degreed, and our representations of it don’t seem to differ in degree. So how can perceptual representations be iconic?

Let’s start with an example of categorical perception from the beginnings of cognitive science, phoneme perception. What Figure 3 shows on the X axis is a vocal tract variable that differentiates certain phonemes, the voice onset time. You can feel voicing by noting the difference between ‘bin’ and ‘pin’ while placing your finger on your throat when pronouncing the words. The Y axis graphs two things: the percent of the time that subjects classify the sound as /b/ vs /p/ and accuracy in discriminating the sounds. Discrimination is typically measured by the “triad” task in which subjects are given 3 sounds and asked which are the same; or the AB/X task in which subjects are given 3 sounds and asked which of the first two matches the last; or the A/X test in which subjects are asked whether A and X are the same or different. (I regard these as very different kinds of discrimination, a matter to be discussed in the response to Schellenberg, et al.)

What Figure 3 is supposed to illustrate is that for most values of voice onset time, perception is of one or the other phoneme and that discrimination is much greater at the boundary.

However, the classifications graphed in Figure 3 may be largely post-perceptual. Indeed, Bob McMurray has argued (2022) that the entire phenomenon of categorical perception of phonemes may be post-perceptual. One point he makes is that as noted early in the study of categorical perception (Pisoni, 1973) the identification and discrimination behavioral tasks used to show categorical perception must use working memory since the stimuli cannot be presented simultaneously. At least one of the sounds must be held in working memory (and thus influenced by post-perceptual categories). Consider the AB/X paradigm that is standardly used in discrimination experiments. Both the A and B sounds are held in working memory while being compared to the X sound while it is being perceived. Even the A/X paradigm requires a remembered sound to be compared with a perceived sound. As McMurray puts it (3823-3824), “…Any differences among discrimination tasks may derive from differences in the degree to which a given task (or stimulus) differentially emphasizes category-level or perceptual-level information when making the judgement…”

In the section of the book on the phoneme restoration effect (p 64–69), I presented a variety of evidence that this phenomenon really is an effect on the perception of phonemes, not just on cognitive judgments of phonemes. One experiment that I think is particularly relevant to this discussion used a technique in which replacing a phoneme by noise made a word-sound ambiguous between two words. For example, replacing the /s/ in 'faster' or the /k/ in 'factor' with noise resulted in stimuli that were ambiguous between the two words. The appropriate sentential context could bias which word subjects reported hearing. Using direct recording from the brains of patients who were being prepared for brain surgery, Leonard, et al. (Leonard et al., 2016) showed that the sentential biasing produced the same activations in auditory cortex as the actual sounds /k/ and /s/. They also showed that the cognitive area that analyzed the sentences did not actually represent the phonemes, suggesting a "cognitive penetration" top-down effect on phoneme perception that is not just a matter of cognitive categorization. (See p. 65 for a fuller description.).

In Chapter 6, I mention non-verbal evidence for color categorization used on infants. Perhaps the most convincing evidence is that if shown a uniformly colored screen with a disk of a different color that is perceived as a different color, infants (and adults) will tend to move their eyes to the disk, but faster if the disk is in a different color category from the background, suggesting that the different color category looks more different. As I mention in Chapter 6, this method can be used to map the color categories of infants and this method agrees with the other methods described in Chapter 6. What is especially impressive about this method in the current context is that it requires no memory and so the chances of conceptual contamination are decreased, making this a pretty pure measure of color categories. It is worth emphasizing that, as argued in Chapter 6, infants who show robust perceptual color categories do not normally deploy color concepts or protoconcepts, bolstering the conclusion that their categorical color perception is perceptual rather than post-perceptual.

And there is evidence for categorical perception from adaptation experiments. I mentioned a few examples of cross-modal adaptation—visual and tactile motion– and one case of both cross-modal and cross format perception. Thus motion perception is a category that is more abstract than the modality. Further, subjects showed similar adaptation curves for numerosities shown in clusters of dots, serially presented light flashes and finger-tapping. They exhibited adaptation effects from one format to another suggesting a perceptual numerosity category that included all these formats. (See pages 86–89.). (This work has been critiqued and there has been a response to the critique (Myers et al., 2024, Yousif et al., 2024).

So there is good reason to think that categorical perception is perceptual—but how can it be iconic?

5.1 | Warping and smooshing

As Gross points out, it is not clear that this kind of categorical perception is incompatible with the degreed notion of iconicity if one thinks of the degreed space as warped. Indeed, warping is not necessary given that the degreed notion of iconicity does not require a linear mapping. The transition between stimulus values in Figure 3 can be thought of as degreed, though according to a metric that doesn't map uniformly onto the stimulus values as normally quantified. Further, the lack of difference in classification among most of the stimulus dimensions reflect a "ceiling" effect in which performance is maximal in the conditions used. Discrimination under noise would be a lot more visibly degreed (Wong et al., 2023). So iconicity is saved. Further, as Gross notes with regard to a different example, the mappings associating vehicular values with stimulus values would preserve ordinal relations thus satisfying the "mirroring" clause in my definition of iconicity

Indeed, the property of being pregnant is arguably degreed too. Becoming pregnant is a temporal process with intermediate phases that can be construed as degrees of pregnancy. Consciousness is often regarded as an all or nothing property. Consider continuous flash suppression (pp 360–361) in which an image presented to one eye is suppressed from consciousness by a rapidly moving color changing stimulus presented to the other eye. (Stein et al., 2022) compared suppression of fearful faces with neutral or happy faces, finding that fearful faces became conscious—breaking through the suppression—faster than the other faces. The process by which the perception of the fearful face becomes conscious takes time and so one could reasonably regard some changes in intermediate states as reflecting degrees of consciousness. A similar argument could be given for any property that has physical underpinnings, including the property of being a face.

5.2 | What are categories in the first place?

The natural picture of what perceptual categories are that goes with the warping and smooshing account is that they are constituted behaviorally, for example by faster and more accurate discrimination at borders and by classification behavior in between the borders, as illustrated in Figure 3. But how can those behavioral dispositions be explained? And how can we explain the fact that classification of stimuli at the border between categories are repulsed by the border and hence are likely to be classified as in one category or the other, with the effect increasing in memory after the stimulus stops? One approach to answering these questions appeals to what E.J. Green calls the perceptual magnet hypothesis (Green, 2024), according to which the visual system assigns higher prior probabilities to some shades (focal shades) than others and consequently lower probabilities to the extent that shades differ from the focal shades. This hypothesis could also explain why discrimination is better at category boundaries. As Green puts it, shades at the boundary will tend to be "pulled" in different directions, magnifying small differences.

I argued in the book for a stronger view of what perceptual categories are in which the behavioral facts just described can be explained by discrete mental representations for certain categories. The perceptual magnet hypothesis can be regarded as an "anti-realist" approach to perceptual categorization if categories are thought of as discrete representations. Or: the perceptual magnet hypothesis can be regarded as a "realist" proposal of a conception of perceptual categories as dispositional.

A recent series of studies suggests that there may be a uniform explanation of both categorical perception and categorical working memory in terms of "dual" models that combine discrete mental representations with continuous sensory information (Bae et al., 2015, Hardman et al., 2017, Bae & Luck 2019, Zhou et al., 2022).

Bae and Luck (2019) asked subjects to remember an orientation while they did various other tasks. They found that interposing a visual discrimination task—but not an auditory discrimination task–resulted in memory distortions towards cardinal axes. As Zhou, et al. (2022) note, representations in the visual areas in the back of the head are fragile and disturbed by a visual discrimination task that does not disturb cognitive representations in frontal and parietal areas, so it may be that discrete representations of the cardinal axes are more dominant when the continuous sensory information is disrupted.

A number of studies have shown that models based on both discrete category representations and continuous but fragile sensory information can better explain a variety of perceptual and working memory results than either kind of model separately (Bae et al., 2015, Hardman et al., 2017, Bae & Luck, 2019, Zhou et al., 2022). Those results include effects of increased memory load, visual interference, and the passage of time.

But to the extent that discrete category representations are involved, we can re-ask Gross's question: how is that compatible with iconic representations? One answer would be that the discrete representations could be iconic "exemplars". The two competing theories in the psychology of categorization are "prototype" and "exemplar" theories (Murphy, 2004). According to the prototype theory, categories are represented in terms of weighted features. In the representation of the category of bird, flying would have a high weight which would explain why people are slower in answering that penguins are birds than that sparrows are birds. According to the exemplar approach, categories consist in many remembered examples. But how are the examples themselves coded? One possibility is that the examples are represented iconically.

To the extent that "dual" models of perception and working memory are correct, and if the discrete representations are not iconic, both perception and working memory would involve a mix of discursive and iconic factors, with the discursive factors having higher weight in working memory than in perception.

One caution I have about the "dual" models is that the empirical basis for them may not have factored out post-perceptual effects to a sufficient extent. Some languages, Russian and Greek for example, have distinct words for light blue and dark blue. Subjects whose native language has distinct words for light and dark blue have been repeatedly shown to be faster at distinguishing those two colors and faster and more accurate on between than within category discrimination. However, it has also been repeatedly noted that these effects disappear when subjects do a simultaneous verbal task, e.g. repeating numbers in the native language (Regier & Kay, 2009). As I noted (p. 396) this result shows that the language dependent effects are due to simultaneous effects of cognitive categories rather than changes to the perceptual systems induced by language specific color classification. In other words, the result shows that the effects are post-perceptual, not perceptual—also noted in (Winawer et al., 2007).

It should be noted that this point does not apply to the color categories of the infants discussed in Chapter 6 since they show category effects at 4–6 months, years before they show any sign of grasping color vocabulary. Further, infant color categorical perception can be explained in terms of the opponent processing of color in early vision (Maule & Franklin, 2019) and infant color categories are based in the right hemisphere instead of the left (language) hemisphere as with adults.

These "dual" models fit with Gross's interesting analogy to political boundaries. I may live closer to my brother than to my sister even though my sister lives across a political boundary in a different country. Metric effects and political boundary effects are distinct kinds of differences. Musical experts have categorical perception effects for pitches that are not present for novices (Goldstone & Hendrickson, 2010). We can see this as their having learned the boundaries, superimposing them on a metric space.

Gross cautions that this approach requires families of representations but there are some perceptual categories that are representational loners, e.g. the property of being colored or being shaped. I am skeptical as to whether these really are perceptual categories—can one perceive something as *having color*—as opposed to having a specific color?

5.3 | Phenomenology

There is an interesting question of whether we can know that categorical perception is real by consulting our own phenomenology. That is why I reproduced the photo of a rainbow on p. 272. The rainbow colors look substantially stripy despite the continuous band of wavelengths. Subjects report seeing about 7 colored bands (Goldstone & Hendrickson, 2010).

Further, there is a phenomenological similarity of the sounds that people classify as one phoneme that differs from the phenomenal similarity of sounds that people categorize as a different phoneme even though, as I mention (p. 272–273) subjects do hear differences among the sounds of a single phoneme. One can think of categorical perception phenomenologically—as characterized by the aforementioned phenomenal similarities.

But can the categorical effects be explained by the phenomenology? I mentioned that unconsciously perceived fearful faces become conscious faster than neutral faces—so that is one kind of unconscious categorical perception. Phenomenological similarities always rest on similarities in the underlying physiology so they will be the best candidate to explain categorical effects in unconscious perception.

The same point applies to categorical adaptation experiments. Adapting to a sound in the category /ba/ causes an ambiguous stimulus to be more likely to be perceived as in the category /pa/. If you follow the instructions on page 63 you will experience a color adaptation effect that shows that the category difference between red/green and yellow/blue is real (more accurately, cherry/teal and violet/chartreuse). That is, adapting to shades in what subjects experience as the red category produces experiences that subjects experience as color in the green category. Categorical adaptation experiments typically vary the adapting cases within a category to avoid adaptation to low level properties. Those results are likely to be explained in terms of the underlying categorical representations.

I expressed some skepticism about the use of introspection in telling whether the different look of a pine tree before and after learning to recognize pine trees (Siegel, 2010) was due to high level perceptual attribution, e.g. of the category *pine tree*. My skepticism was based on the difficulty of ascertaining from introspection whether the change was due to changes in high level properties or in low level properties like color, shape and texture, modified by attentional differences. This is a dimension of vulnerability in the phonemic adaption cases but as I noted (p. 65) these adaptation effects are on the border of phonemic and phonetic.

To conclude, Gross's challenge of fitting categorical perception into the view of perceptual representation as iconic remains, though I hope some of the issues he raised and I discussed will be of use to later discussions.

6 | RESPONSE TO SUSANNA SCHELLENBERG, ANDREW FINK, MARY PETERSON AND CARL SCHOONOVER

The main issue raised by Schellenberg, et al. is whether, as I argued in Chapter 3 (p.142-152)–there is no determinate answer to the question of whether discrimination or attribution is more basic; or whether as Schellenberg, et al. hold, discrimination is more basic. But what are basicness, discrimination and attribution anyway? I'll start with attribution, but most of what I have to say concerns discrimination. As I mentioned in the Précis, I now regard discrimination as a much more problematic concept than I did in the book.

6.1 | Attribution

Attribution is representation. To perceptually attribute a property to a particular is to perceptually represent the particular as having the property. For example, to attribute tallness to Fred is to represent Fred as tall, to attribute the relation taller than to Mary and Fred is to represent one of them as taller than the other. Can there be perceptual attribution that is not attribution to a particular or particulars? As I explained in the first part of Chapter 3 (p. 123–142), I regard existential construals of perceptual attribution as sometimes more useful than construals in terms of attribution to a particular. For example, a ganzfeld perception (to be discussed below) can be construed as having the form: there is F-ness. On this construal, perceptual attribution of F-ness is representing F-ness or that there is F-ness. On both construals of perceptual attribution, perceptual attribution is perceptual representation.

6.2 | What do we Discriminate?

Although all will agree that we can perceptually discriminate between two entities, different theorists disagree about what those entities are, for example whether they are properties, property instances, events, or bodies. I will not be concerned here with what the entities are.

6.3 | Thin vs Thick Perceptual Discrimination

There are two kinds of perceptual discrimination, thick and thin. This distinction is what most of this response is about. Thin perceptual discrimination is perceiving a difference; thick perceptual discrimination is perceiving a difference while at the same time perceiving which is which. Consider an exclusive OR gate (X-OR) that fires when and only when one input is a 0 and the other is a 1. It outputs a 1 when the inputs are different and a 0 when the inputs are the same. Of course an X-OR gate does not perceive at all but it can provide a helpful analogy to perceptual discrimination. If we think of an X-OR gate as a simple mechanical discriminator, it is a thin discriminator, since the information about which input is 0 and which is 1 is lost in between input and output because both the 1-0 and 0–1 inputs produce the same output. Thin perceptual discrimination is a perceptual version of that—perceiving a difference without necessarily perceiving which item has which of the properties that differ. Purely thin perceptual discrimination is thin without thick perceptual discrimination. (I will leave out the term 'perceptual' when it is obvious that I am talking about perceptual discrimination or attribution.)

I can illustrate the difference between thick and thin in a real experiment by reference to the paradigm depicted in Figure 4. This experimental paradigm has been used (Tinsley et al., 2016) to show that humans are sensitive to even a single photon. There are two intervals of 1 ms (very short!) separated by 800 ms. A single photon can be (but need not be) emitted in either the first or second interval. The subject makes a "forced choice" between one or the other interval as the one which has the flash and gives a confidence rating. This is known as a two interval forced choice procedure. The result is that if there are enough trials, subjects are above chance in choosing the correct interval and that this success is magnified in high confidence trials. This type of experiment is part of what has led to the realization that there is no such thing as a "just noticeable

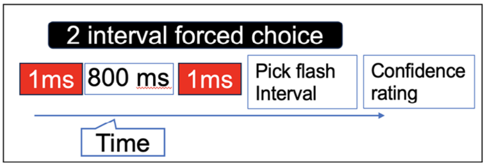

FIGURE 4 Experimental paradigm.

difference" (Sanford & Halberda, 2023). The point made by Sanford and Halberda is that any difference in stimuli that makes a difference in the visual system can have a psychological impact with enough trials.

But the important point for right now is the illustration of thick and thin perceptual discrimination. In this experiment, subjects have to say which interval putatively had the flash ("forced choice"), so this is thick discrimination. Thin discrimination would be perceptually registering that the intervals were the same or different. Purely thin discrimination would be perceptually registering that the intervals were the same or different without attributing the flash to one or the other interval.

Note that thick discrimination involves attribution and non-accidentally so, because the subject has to perceptually *attribute* the flash to one interval or the other. As we will see, there is a question as to whether thin discrimination requires thick discrimination. We will see that many cases—perhaps all cases– of thin discrimination may depend on thick discrimination, that is, to perceive that two items are different you have to perceive a comparative relation between them. If thin depends on thick, thin discrimination cannot be more basic (in a causal sense of 'basic') than thick discrimination. They could be equally basic, or else attribution would be more basic.

A critic might raise this question about the distinction between thick and thin discrimination. Suppose I know a pair of identical twins and I know that one is rich and the other poor but when I see them I can't tell the twins apart and I don't know which is which. Is this thick discrimination without thin discrimination? If so, these notions are flawed since at least as I defined the terms, thick entails thin. This case is not thick without thin however, since my knowledge that one is rich and the other poor isn't perceptual; if I can *perceptually* ascribe richness to one twin but not the other, that would count as both thick and thin discrimination.

Standard perceptual discrimination paradigms are mainly thick discrimination paradigms. As we have seen, two *interval* forced choice is a thick discrimination paradigm because the subject has to say which interval had a certain stimulus, e.g. a flash or a face. In two *alternative* forced choice, one is presented with two stimuli, e.g. on the right and on the left, and has to choose whether, e.g. a face was on the left or the right or whether, e.g. the higher contrast stimulus was on the left or right. Also thick discrimination. And in plain forced choice, subjects are shown a stimulus and asked to decide whether it is, e.g. a face or a house. Also thick discrimination. In the AB/X paradigm, a standard discrimination paradigm, two stimuli are presented and the subject has to decide which one matches a third stimulus. Also thick discrimination. Another paradigm—the triad paradigm—involves the presentation of 3 stimuli; the subject has to say which two are the same. All these standard discrimination paradigms involve attribution. There are some putative thin discrimination paradigms as well, such as making a same/different judgment. There is a strong case that signal detection theory concerns thick discrimination. For example, in the discrimination of signal from noise, signal detection theory requires determination of which is signal and which is noise. Thick discrimination again.

A brief informal survey of the literature leads me to believe that in the contemporary perception literature, discrimination experiments are very commonly experiments on thick discrimination. For example, in (Constant et al., 2023) discrimination involves a forced choice between left motion and right motion.

6.4 | Does Thin Discrimination Depend on Thick Discrimination?

What is the evidence alluded to above that thin perceptual discrimination might depend on thick perceptual discrimination? Over a 50 year period, again and again it has been shown that humans and animals tend to find same/different judgments [thin discrimination] more difficult than comparative judgments [thick discrimination]. But is this perception or cognition? That is, is it due to thin perceptual discrimination [same/different] being more difficult than thick perceptual discrimination [comparative]? Or is it the corresponding difference in judgments that are responsible? This is a difficult issue to resolve since responses in many paradigms are based on judgments. I don't know of any experiment that resolves this question.

(Fetterman et al., 1996) presented humans and pigeons with two stimuli at different durations, e.g. a red square for 4 seconds followed by a white square for 2 seconds. There were three reward structure conditions. In one condition ("same/different"), subjects were rewarded for pressing one key for same and another key for different. This is a thin discrimination in that it just requires a same/different response without attributing any property to one of the stimuli. In another condition ("longer"), they were rewarded for pressing one key for the second stimulus lasting longer and another key for the first stimulus lasting longer. This is a thick discrimination. A third condition was also thick: the reward depended on whether the ratio of the durations of the stimuli was greater than 3. Note all judgments, thick and thin required one of two responses, i.e. there were two keys for responding.

Accuracy results for humans are shown in Figure 5. The Y axis represents a measure of accuracy of the responses. The same/different [thin] judgment is the least accurate whereas the comparative judgments [thick] are substantially more accurate. The differences are large. There were similar results for pigeons. Humans showed the same ordering whether they were told what the rules were or whether they had to infer the rules from the reinforcements.

This is a typical result. Comparative perceptual responses are easier—often much easier– as reflected in greater accuracy and shorter response times than same/different responses for humans and animals. Again, the question arises: Is this due to some kind of extra complexity for thin perceptual discrimination as reflected in same/different responses or is the extra complexity cognitive, introduced by the need to make a same/different judgment? And is the extra complexity a matter of thin requiring thick?

6.5 | Systematic Exploration of Thin and Thick

The differences between same/different perceptions and comparative perceptions were explored systematically in Marisa Carrasco's lab (Anton-Erxleben et al., 2010). They presented stimuli in which a pair of oriented grids (Gabor patches) were very briefly presented, one on the right one on the left. Subjects either had to judge whether the contrasts were the same or different (confusingly, the same/different judgment is called an "equality judgment") or a comparative

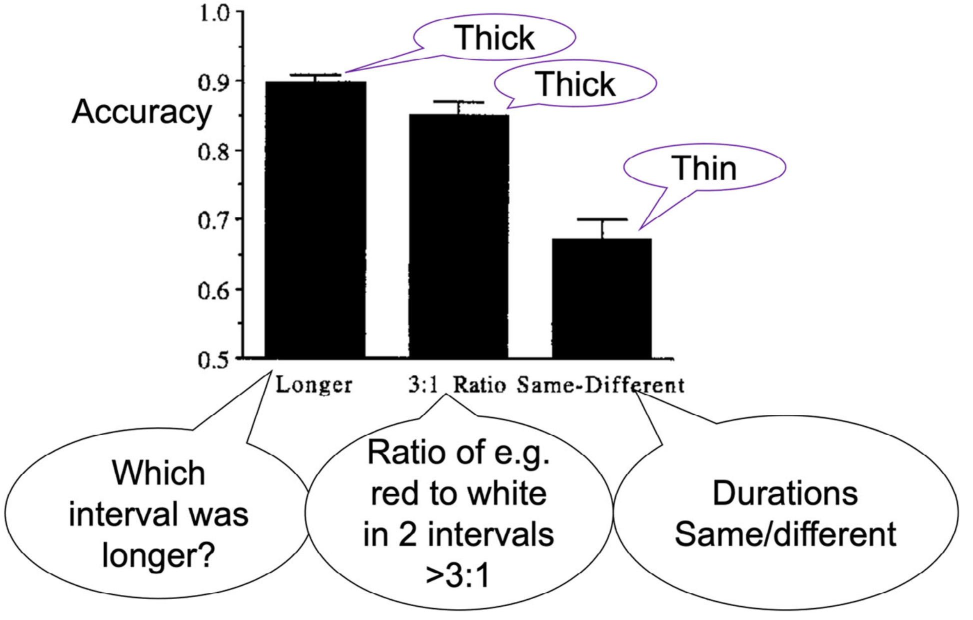

FIGURE 5 Accuracy results for humans.

judgment—which stimulus had the higher contrast. The former is thin, the latter thick. See Figure 6.

There were three main findings of relevance here. First, subjects were faster to push the button in the comparative [thick] task than in the same/different [thin] task. The thin task took 515 ms whereas the thick task took 380 ms., a large difference for this sort of experiment. Second, there was greater variation in the same/different [thin] task as compared with the comparative task [thick] and third, there was a systematic distortion in the same/different task as compared with the comparative [thick] task.

The authors conclude that "Generally, in an equality judgment, the relation between criterion settings and the parameter estimates can be complex. The equality judgment [NB: thin] replaces the one criterion of the comparative judgment [NB: thick] with two criteria for "different because greater" and "different because lesser" responses" (Anton-Erxleben et al., 2010). That is, in this paradigm it looks as if the thin discrimination depends causally on a thick discrimination.

In sum, in a variety of conditions, a thin discrimination of responding same or different is more complex than giving a comparative response such as greater than or less than. The added complexity shows itself in slower responses, more error and more variability in the thin discrimination. And there is some reason to believe that the thin discriminations depend causally on thick discriminations.

In the two paradigms I have been talking about, judgments of same and different seem to require or involve comparative judgments—of longer intervals or higher contrast. Again, the issue arises as to whether perception of sameness or difference depends on comparative perception or whether a judgment of sameness or difference depends on comparative judgment? Or both?

Could it be that same/different judgments are harder than comparative judgments because same/different judgments involve two options, same and different whereas comparative judgments involve just one, comparison? No there are two options in all these experiments. In

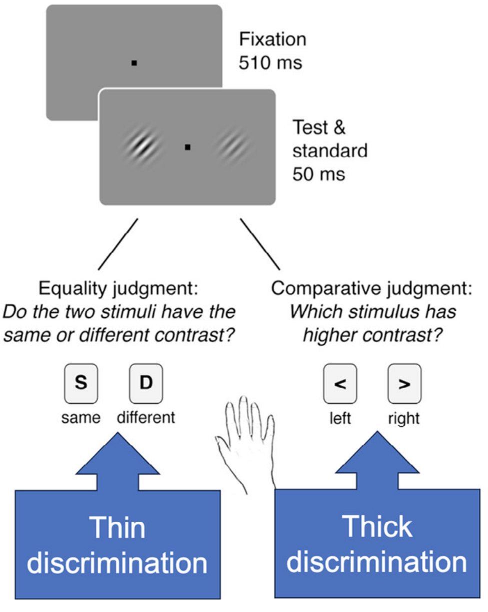

FIGURE 6 Thanks to Marisa Carrasco for the original version of this figure. Note that there are two responses in both tasks.

Carrasco's paradigm, comparative judgments require the subject to choose one or the other stimulus as longer or having more contrastThe. Note that in Figure 6 there are two buttons on both sides.

I've been talking about experimental paradigms that require the subject to make a response but there is another kind of evidence that concerns what people do spontaneously. For example, a sudden motion in the periphery of the visual field causes one to attend to that motion (so called exogenous attention) and move one's eyes to it (Carrasco, 2011). Does that involve thin discrimination of motion from non-motion? Maybe, but maybe not, since it may simply be a matter of attending to motion, or of a thick discrimination that depends on attributing a relational property—more motion there– in the periphery.

Let me introduce another perhaps relevant phenomenon, the "fast-same" effect in which subjects are much faster to decide that two stimuli are identical than they are to decide that two stimuli are different (Walker & Cousineau, 2019). This result, which has been repeatedly verified over a 50 year period, has seemed paradoxical because to verify that two items are the same one must verify that they are the same with regard to every property whereas to verify that two stimuli are different, one needs only one difference. Nonetheless, as Farell puts it, "A "same" response to red circle-red circle usually takes less time than does a "different" response to red circle-blue circle or to red circle-red square." (Farell, 1985). Many mechanisms have been proposed for this effect and it may be that there is no uniform explanation, but two related possible contributing mechanisms are (1) the extra perceptual cost of cost of a difference perception or (2) the extra cost of a cognitive judgment of difference.

In this case there is slight evidence for (1). (Hochmann et al., 2018) presented 7 and 12 month olds with colored figures on both sides of a screen. On some trials if the figures were the same, a wonderful (to a child) event occurred on either the right or the left according to a rule used for that child. On other trials, if the stimuli were different, an event would appear on one side

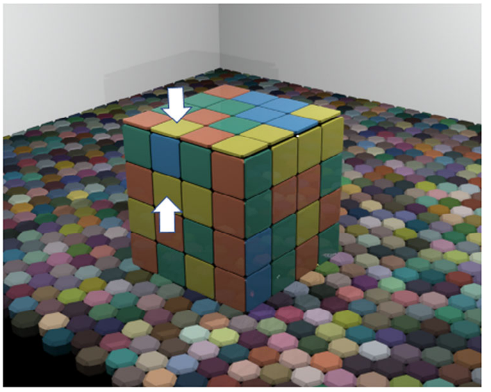

FIGURE 7 The arrows point to squares that appear to have the same material color but different hue-saturation-brightness colors. Thanks to Bob Kentridge for the figure. Colors can be seen in the electronic version of this article.

if the figures were different. (See p. 287–288 for a fuller description of the setup.). The question was: would the children learn the rules? The result was both the 7 month olds and the 12 month olds learned the same rule but not the different rule. This doesn't show the added cost of difference is perceptual, but since at least the 7 month olds were substantially pre-linguistic, it does suggest that the language system is not involved. One further indication that the effect is perceptual is that children do not have more trouble learning the word 'different' than the word 'same'.

I have been arguing for a causal dependence of discrimination on attribution but there are many other kinds of dependence that are distinct from causal dependence, for example, conceptual dependence, metaphysical or constitutive dependence and epistemic dependence. For example, it has been alleged that 'kill' means 'cause to die', but there is evidence that understanding 'kill' in the course of a sentence does not require decomposition in terms of causation and death (Fodor et al., 1980). So one kind of (alleged) conceptual dependence of X on Y may not require a causal dependence of X on Y. Schellenberg, et al. often seem to be talking about metaphysical or constitutive dependence, but I don't know of any good reason to regard either of discrimination and attribution dependent on the other in any of these senses.

6.6 | Discrimination in a respect

I said in the book that discrimination is normally—though not always—discrimination with regard to some specific property. The point I was making about discrimination in a respect can be illustrated with regard to Figure 7. Subjects can make two kinds of color discriminations, with respect to two ways of seeing color, hue-saturation-brightness color and material color (Arend & Reeves, 1986, Norman et al., 2014). In Figure 7, the arrows point to squares that look like they are made out of the same material. When given examples of one material in different illuminations subjects can make discriminations with respect to material color. But when told to focus on how the color "appears", and given examples of stimuli that are the same in hue, saturation and brightness, they can tell you that the colors in Figure 7 appear different and they can discriminate according to the hue-saturation-brightness way of discriminating color.

7 TEXTUAL ISSUES

Now I move to textual issues.

7.1 Ganzfeld perception

I will start with one of the phenomena that Schellenberg et al. and I disagree on, the ganzfeld perception.

The ganzfeld perception occurs when the perceiver is subjected to an unstructured uniform illumination. There are a number of methods for doing this, but there is one method you can do at home: If you cut ping pong balls in half and put the halves on a person's eyes in say red illumination or with red ping pong balls, subjects report experiencing a uniform surfaceless red fog-like light. This is described in detail on p. 136–141 of my book and I won't repeat the details mentioned there. Summarizing, the main properties of a ganzfeld perception are these:

1. Perception of surfaceless fog-like light colored according to the illumination field
2. Perception of fog-like light changes and fades fades after a few minutes—as long as 7 minutes
3. On removal of the ping pong balls, perception of the opposite opponent color to the illumination field.

Here is a description from a recent paper of what happens after 5–7 minutes of ganzfeld perception, i.e. after 5–7 minutes of perceptual experience of surfaceless fog-like light (Wackermann et al., 2008). I present it to illustrate that the appearance of fog-like light does not simply fade away after 5-7 minutes of ganzfeld perception: "The visual field's luminance diminishes and the field shows diffuse inhomogeneities, often described as a 'cloudy fog'. In case of a colour ganzfeld, the field's colour gradually bleaches, up to the point of a loss of the sensation of colour: the field is of indefinite grey, sometimes with an undertone of the complementary colour, e.g., greyish-green if red light is used. In addition, more distinct structures may appear against the diffuse 'foggy' background: dots, zig-zag lines, or more complex patterns."

Focusing on the color after-effect, if the surfaceless fog was perceived as red, subjects experience a field of green. The explanation in my terms is that on attributing redness for an extended time, the red/green opponent channel adapts (see p. 69–83) moving the set-point to the green end of the channel, leading to the experience of green when the ping pong balls are removed.

Here is what Schellenberg, et al. say about the ganzfeld phenomenon:

> Block cites the ganzfeld case as if it were a problem for the discrimination view. But in fact, the ganzfeld effect is evidence for the discrimination view and evidence against the attribution view. A ganzfeld is a homogenous field of fog-like light. In discussing ganzfelds, Block seems to be talking about detection, which, as he acknowledges elsewhere, is just discrimination.[7] Discrimination can happen over any dimension. One important such dimension is time. Let's assume that at time *t1*, we see a regular scene. At time *t2*, we see a ganzfeld. So at *t2*, we detect the fog-like expanse by discriminating it from the null-stimulus at *t1*.

> A null-stimulus is a relative term. If at *t2* a perceptual system detects stimulus *A*, then the null-stimulus at time *t1* is the absence of *A*. The null-stimulus need not be the absence of any stimulus. It is the absence of the stimulus that gets detected at *t2*. Of course, the perceptual system does not need to represent the null-stimulus as such. The point is that if a system detects *A*, it must be able to differentiate the occurrence of *A* from when *A* was not occurring.

> How does the ganzfeld effect support the discrimination view? When one sees a ganzfeld case there is a change, namely before and after the subject is exposed to the ganzfeld. That change allows the perceiver to see the ganzfeld. Due to lack of any further change, the sensory system shuts down and the ganzfeld effect sets in. No new stimulus enters the response fields of sensory receptors and so no signal is sent to downstream neurons. Without discrimination of something new, perception ceases. So the ganzfeld effect supports the thesis that if there is no difference, there can be no discrimination, and so no perception. On the attribution view, the relevant color is attributed, and it is unclear why the ganzfeld effect sets in.

Now they are right that without discrimination of something new, perception ceases. *But this effect is gradual and there is perception of a uniform surfaceless fog for minutes—as long as 7 minutes—prior to the gradual fading*! I quoted that long description to illustrate this point. Judging from what I just quoted, what they would have to say is that after 7 minutes of seeing fog-like light one is still discriminating it from a perception 7 minutes earlier. This is an obviously false claim from the point of view of perceptual psychology. A perception of a stimulus at t2 can "postdictively" influence a perception of a stimulus at t1, for example in masking, but the maximum gap between the stimuli must be well under a second. This is one of many measures that converge on the time of a conscious perception as well under a second. There are occasional estimates of the time of a conscious perception as long as 3 seconds (Pöppel, 1997), but a span of minutes is just out of bounds.

I can't resist adding a minor textual point: they say that I say that detection is just discrimination but when they quote what I say in the footnote, it is a sentence beginning with "Of course, it is always open to an objector to insist that …" I do not say that detection is just discrimination but only that an objector might say that.

7.2 | Where are features?

I say that tomatoes are often red and that we often visually represent them as red. They speak in rather different terms, for example:

> In short, features are in the environment and statistical regularities are extracted from the environment. Since the features are already in the environment, there is no need to attribute them. Block does not deny that features are in the environment. So the questions arise: Given that features are in our environment, what empirical evidence is there that we do not simply discriminate the features in our environment? What empirical evidence is there that in most cases of perception we discriminate features that were first attributed?

My view, by contrast is that features—in the sense of properties of objects such as the odors, colors and shapes of foods—are properties of objects in the environment. The need for representing properties is so that we can know about them and use our knowledge for a variety of purposes. The Gibsonian paradigm in psychology and naïve realism in philosophy tried to do without perceptual representations, but modern vision science helps itself to a cornucopia of representation, including representations of uncertainty. For example, a recent introductory text (Ma et al., 2023) contains 348 words starting with 'represent'. Some involve perceptual representations of uncertainty or representation by graphs, but many concern representation of world states or world features. A recent article that I happened to be reading (Duan et al., 2024) uses the word 'represent' 188 times in discussions of different kinds of perceptual representations at different stages of visual processing, with representations later in the processing stream more likely to represent task relevant features than representations earlier in the stream. They also develop a notion of representational strength.

7.3 | Attribution first?

In the passage just quoted and elsewhere in their reply, Schellenberg, et al. ascribe to me the view that attribution comes first in most cases. What I say is this (147): "Here is an argument that attribution is more fundamental than discrimination. If two items are different, they have to be different in some specific property. Discrimination is always discrimination with respect to some specific property and it is hard to see how there can be discrimination with respect to a given property without that property being attributed." Note that I do not say that attribution comes first. Attribution can be more basic even if attribution and discrimination occur in parallel.

Note that the passage from p 147 quoted in the previous paragraph starts with "Here is an argument." The very next sentences after that passage starts with "But wait" where I introduce some doubts.

Some of my disagreements with Schellenberg, et al. involve whether there are cases of discrimination without attribution. They cite the ganzfeld case already discussed as one such case. They also think the two interval forced choice paradigm is such a case. They say

> In the two-interval-forced-choice (2IFC) method, observers view two successive slides shown briefly and report whether a stimulus appeared in the first or second interval. The stimuli could be anything – e.g., dim color patches or flashes of light). The task requires discriminating, for each interval, whether something or nothing appeared. There is no evidence that the feature is attributed to anything

However, as I noted earlier, reporting whether the stimulus appears in the first or second interval involves attribution of an event or stimulus property to one of the intervals and so involves attribution.

7.4 | Does attribution require particulars?

Schellenberg, et al. say, speaking about my views:

"So to attribute *F* is to represent *x* as *F*. So there must be an *x* to which the *F* is attributed."

They go on to describe their own view, opposing what they say is my view:

> "By contrast, on the discrimination view, there does not need to be an x to which the F is attributed. *F* could be represented without representing any *x* as *F.*"

They seem to think that a major dispute between us is that they allow for attribution of F without a particular to which it is attributed. But because I allow for existential attribution, that is not a point of difference. The two main issues discussed in Chapter 3 are (a) whether perception is constitutively singular in content (123-142) and (b) whether either of attribution or discrimination is more basic (142-152). I have been discussing mainly (b) in this response, since those 10 pages are the focus of Schellenberg, et al. But with regard to (a), I argue that the question of whether perception is constitutively singular or existential has no factual answer and that the existential form is more useful in regard to the ganzfeld perception in which one can attribute fog-like light without attributing it to a particular.

7.5 | Borders fuzzy?

Are the borders between perception and cognition "fuzzy"? they say:

> More generally if the borders of the mind are fuzzy and permeable in all directions with information processing circuits distributed, then the question arises of how much we can learn about the nature of perception from attempting to specify and delineate borders and joints in the mind and brain.

Yes, cognition and perception are mixed together in the brain—even though cognition is primarily localized prefrontally with spatial perception localized mainly in the back of the head (Raccah et al., 2021, Block, 2024). On my picture of perception and cognition, the difference is a matter of format and functional role, not location in the brain. Further, cognition often uses perceptual materials despite being paradigmatically conceptual, propositional and non-iconic (discursive). So I allow that perceptual representations often play a role in cognition.

7.6 | Binding

Schellenberg, et al. say "It should be noted that one seeming advantage of the attribution view over the discrimination view is that the attribution view solves the binding problem from the outset. After all, if the fundamental form of perception is to attribute features to some *x*, then there will not be a question as to which features in the environment are bound with which *x*."

The binding problem as usually conceived is the problem of how, if one sees, for example, a red spherical moving object, the perceptual systems puts representations of redness, motion and sphericalness together with an object representation. Sample proposed solutions to the binding problem have been (1) synchronization of spiking activity in neural ensembles that code the different properties that are bound together and (2) conjunctive neural coding (Schneegans & Bays, 2017). It is no solution to the binding problem to say the system attributes the property of being a red, spherical moving object. The binding problem is: how does it do that? (See p. 181–182 of my book for more on binding.)

As I noted, I discuss existential approaches to the form of perceptual representation, arguing that there is no matter of fact as to whether these construals are better than attribution to objects. I discuss many cases in which construals in terms of what I call “non-singular seeing” on pages 135–136 including the ganzfeld, crowding, ensemble perception, and seeing motion without a moving object. But even in cases in which some x is represented as having both F and G, the binding problem arises in the question of what the machinery behind the conjunction is.

7.7 | News

Schellenberg, et al. raise the issue of whether a major purpose of perception is acquisition of news. See Block, N. (2023). “Adaptation, Signal Detection and the Purposes of Perception: Reply to Ian Phillips and Chaz Firestone.” Analysis Reviews. This is my response to Phillips, I. and C. Firestone (2023): “Visual Adaptation and the purpose of perception.” Analysis **83**(3): 555–575.

7.8 | Philosophy of Mind vs Epistemology

Finally, let me turn to the issue of philosophy of mind vs epistemology. Schellenberg, et al. say

> Block’s focus throughout is on issues in philosophy of mind. It is neither on the epistemological role that perception plays in justifying beliefs and yielding knowledge about particulars in our environment nor on the role it plays in grounding demonstrative reference and bringing about singular thoughts. So it is not surprising that he has little patience for the idea that perceptual content is singular.

I discuss the issue of the interplay between epistemology and philosophy of mind at a number of points. Here is what I say (p. 57):

> Traditionally, the philosophy of perception has been geared toward illuminating the epistemology of perceptual judgment— what justifies the judgments about the world that we base on perception (Stoljar, 2009). This project has often ignored the science of perception. The presumption of this book is that epistemologists would do well to find out what perception is from the science of perception and to base the epistemology of perception on that scientific answer.

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