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SYMPOSIUM

Précis of *The Border between Seeing and Thinking*

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Despite the title, this isn't so much a précis as an update about my current thinking on some of the most important issues of the book as they are relevant to the excellent critiques in this issue. (References to page numbers are to my book (Block, 2023a) unless specified otherwise.)

The book is mainly about perception, the best understood aspect of the mind, and hence our best window into how the mind works and how it is grounded in the brain (Mandelbaum, 2024). The book starts with armchair indicators of perception, then moves to scientific indicators of perception, adaptation, speed, pop-out and illusory contours, using them to try to pinpoint the most basic characterization of perception and cognition. Of these indicators, the most controversial has been adaptation, mainly because of two issues: whether there can be cognitive adaptation (Helton, 2016) and whether all perceptual systems show it (Block, 2023d; Phillips & Firestone, 2023),

The main claim of the book is that perception is constitutively iconic, non-conceptual and non-propositional while cognition is paradigmatically (but not constitutively) discursive (non-iconic), conceptual and propositional. Perception constitutively has these properties in that its nature does not allow for discursive, conceptual or propositional representation. Cognition is necessarily discursive, conceptual and propositional but it also can make use of perceptual materials in a cognitive envelope, as when we use perceptual imagery in the course of reasoning. This is my main approach to the perception/cognition border though I also accept a moderate level of modularity of perception (Mandelbaum, 2024), as explained in Chapter 11.

Much of the book was devoted to distinguishing between low-level and high-level perception where low-level perceptual representations are the products of sensory transduction that are causally involved in the production of other (mid and high-level) perceptual representations. I argued that there are high-level perceptual representations and discussed how to distinguish them from cognitive representations, most importantly minimal immediate direct perceptual judgments. The latter notion comes up briefly in my reply to Jake Beck.

I argued in Chapter 6 that infant color perception is non-conceptual on the basis of the fact that the infants in question do not normally deploy and probably don't have any concept of color. (My argument has been critiqued in (Green, 2024). I argued that the point generalizes at least to adult color perception. There has been a lot of controversy over claims that perception is discursive, conceptual and propositional (Block, 2023c; Quilty-Dunn et al., 2023). Jake Quilty-Dunn and EJ Green (Green & Quilty-Dunn, 2021; Quilty-Dunn & Green, 2021) argue that object perception—but not perception of features such as color– is discursive, conceptual and propositional, so although they are opposed to my main claims, non-conceptual color perception would be compatible with their view (Block, 2023b).

One chapter of the book is devoted to core cognition. It has been argued that core cognition is a third category, intermediate between perception and cognition, but I argued that core cognition is a mongrel notion whose phenomena can be apportioned between perception and cognition, and in that sense core cognition is a heterogeneous mixture.

Much of the book was devoted to perception, irrespective of whether the perception is conscious or unconscious. I argued that this perspective has a number of significant advantages in uncovering ideas that can then be applied in arguing against cognitive theories of consciousness. Although I argue against cognitive theories of consciousness in the book, I have recently started taking them more seriously, having been persuaded by the advantages of "pointer" versions of these theories (Block, 2024b; Michel, forthcoming).

The concept in the book that is most in need of further explanation is the notion of a cognitive envelope and its relation to perception and working memory. I turn to that topic now.

1 COGNITIVE ENVELOPE

The term 'cognitive envelope' is best explained with respect to the "global neuronal workspace", often offered as a theory of consciousness (Dehaene, 2014) but which I argue is better thought of as a theory of how perceptual representations are conceptualized. The idea of the global neuronal workspace is that activated representations in perceptual areas compete with one another, with a small number of "neural coalitions" winning out that then trigger "ignition", linking them up with frontoparietal circuits via long range "workspace neurons" that connect the front with the back of the head[1] (See pages 7–8 and p. 320 (of the book).) These activated neural coalitions involving both the front and back of the head make the contents of the representations immediately available to a range of cognitive faculties, reasoning, reporting, deciding, and the like, at least in creatures like adult humans that have these cognitive faculties. It is the links to cognitive faculties in the global workspace that constitute the "cognitive envelope".

This is all illustrated in Figure 1 (from early in the book—p.7). The concentric rings represent levels of processing. (see pp. 83–84 on the visual hierarchy.) The outer ring represents the sensory surfaces of the body whereas the inner rings represent frontal-parietal circuits that govern thinking, decision-making, planning and other cognitive functions. Processors are indicated by small disks, links between them by lines—activated processors and links are darker. Activations in the sensory rings compete for dominance, triggering mutually reinforcing reverberating activity lineking inner and outer rings. The highlighted word is linking. There is no letter e in the word

What Figure 1 illustrates is that when sensory surfaces are stimulated, they cause activations of processors, indicated by darker disks. Those activated processors activate other processors via activated links. Some of those activations die out but others form mutually reinforcing

[1] 'Front' can be precisified as including dorsolateral, ventrolateral, medial prefrontal and orbitofrontal areas of the prefrontal cortex and the anterior cingulate. See (Block, 2024a). 'Back' refers to perceptual areas in occipital, temporal and posterior parietal cortex.

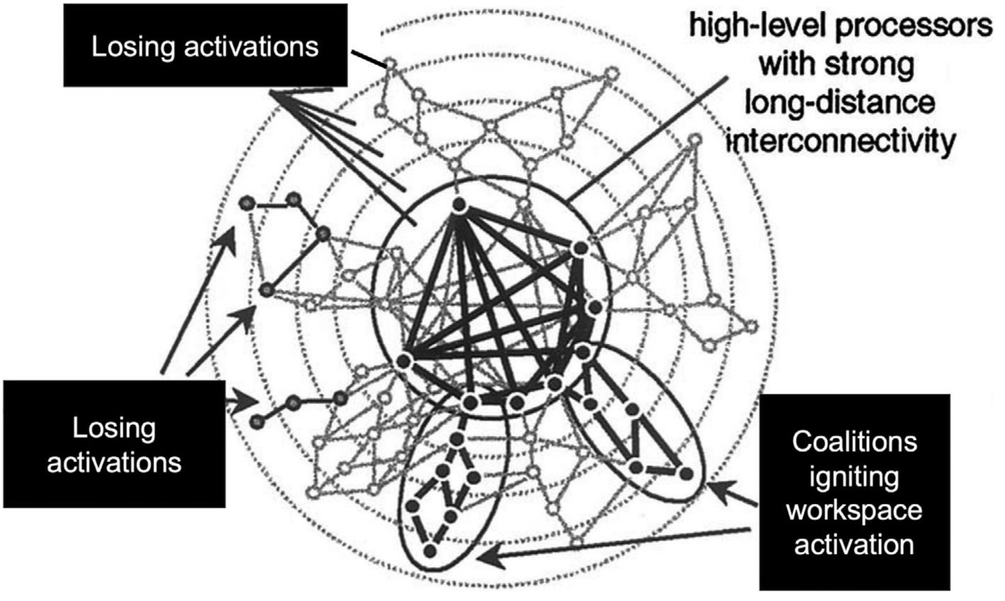

FIGURE 1 Thanks to Stan Dehaene for supplying the original drawing. I added the black pointers.

coalitions—involving both feedforward and feedback connections– indicated by the large ovals, and some or all of those trigger long range activations in frontal/parietal workspace areas.

We can think of global broadcasting in terms of 4 stages: (1) perceptual representations competing (outer dotted rings), (2) some mutually reinforcing coalitions winning (dark ovals), (3) winning coalitions triggering workspace activations (inside the central circle), (4) leading to mutually reinforcing neural activations involving both the front and back of the head. While the details of Dehaene's model are controversial, I think the broad outline of these stages would be widely accepted.

Broadcasting in the global workspace is the main mechanism of "working memory", the active maintenance of representations for use in reasoning. It is that use in reasoning that determines that they are in part discursive, conceptual and propositional.

There may however be broadcasting in creatures whose reasoning capacities are substantially iconic. Ants and bees for example have famously prodigious memory capacities (Gallistel & King, 2011) but perhaps little or nothing in the way of propositional reasoning. Some of the reasoning abilities in infants may also be primarily iconic.

I defined "working memory" as "active". Sometimes the term "working memory" is used in a looser sense to refer to any temporarily retained perceptual information that can be used in a subsequent task. Active working memory is conscious but several studies suggest maintenance of information in unconscious perception for up to 4 seconds in what is sometimes termed "activity-silent working memory" (Soto et al., 2011) or a "blindsight effect" (Trübutschek et al., 2017). Subjects could localize a target presented in unconscious perception better than chance 4 seconds after presentation of the stimulus. There is some evidence that this information is maintained in temporarily changed synaptic weights (Trübutschek et al., 2017) but later work suggests that perhaps a low level of activation is involved (Barbosa et al., 2021; Fields, 2022)

This form of information persistence is totally different in its fundamental properties from active working memory and it is just confusing to give it the same name (Carruthers, 2015, p. 91). I will ignore it in what follows.

2 | WORKING MEMORY

As I emphasize in the book, working memory is required for any content-based reasoning in which premises are put together to reason to a conclusion because the premises have to be held in working memory.

How early do babies show signs of content-based reasoning? Kiley Hamlin showed 6 month old babies events involving small colored squares, triangles and circles with eyes made of wood. One figure, say the triangle, appeared to be “trying” to get up a slope. Later, another figure played the role of a “helper”, pushing the triangle up the slope while another played the hinderer, pushing the triangle down the slope. When offered the choice of blocks in these shapes, the babies preferred the helper and rejected the hinderer. They distinguished accidental from intentional helping and hindering (Hamlin et al., 2007). Most importantly for content-based reasoning, the infants preferred the hinderer of the hinderer. This was replicated with 8 month old bilinguals (Singh, 2020).

8 month olds were shown two scenarios in which an agent tried but failed to help, or alternatively, to hinder a “protagonist” open a box. Even though the protagonist did open the box, the infants preferred the helper to the hinderer. (Woo et al., 2022) report many results of this sort and they address concerns about replication showing that the main results have been replicated many times even though there have been some notable failures to replicate.

My conclusion is that these results provide some reason to believe that the infants have content-based reasoning involving multiple items in working memory, categorized appropriately, put together to draw conclusions. Leaner accounts of this thinking in purely iconic terms are not ruled out however. This issue will come up in my reply to Jake Beck.

What I’ve said so far might suggest that my view of working memory is that it is a hybrid: perceptual representations pretty much unchanged are part of a reverberant (self-sustaining feed forward and back) network with cognitive representations, allowing the perceptual representations to participate in perceptually based reasoning. However, part of this picture is likely wrong.

The accepted view of working memory has shifted radically in the last few years. The outmoded “sensory recruitment” view of working memory (D’Esposito & Postle, 2015) assumed it could be understood in terms of purely perceptual representations and so could be studied using stimuli of shapes or colored circles or oriented lines. It was assumed that working memory capacity was fixed in terms of numbers of objects or a fixed pool of resources for each visual feature (Asp et al., 2021). More recent approaches (Chung et al., in press; Duan & Curtis, 2024; Kwak & Curtis, 2022) have treated working memory representations as task specific and as linked to knowledge structures in long term memory. Asp et al. presented ambiguous “Mooney faces” and related figures in paradigms in which the same figure would be seen as a face by some subjects and as a meaningless pattern by others. They found across a number of different methods higher working memory capacity for faces vs the same figures as meaningless patterns. As Chung et al. note, other studies have shown that when stimuli are seen in terms of semantically meaningful categories, working memory capacities are increased.

One strong piece of evidence in favor of the sensory recruitment hypothesis was that working memory representations of perception could be decoded using brain imaging from the earliest visual area V1. However (Duan & Curtis, 2024) showed that even for oriented grids, the working memory representations in V1 are reformatted versions of the perceptual representations in V1. They showed this by biasing the stimuli with a sophisticated form of an "aperture bias" which in its simplest form is just looking at the stimuli through a shaped aperture which can have the same or orthogonal orientation of the grid. They used aperature biases that could be the same orientation as the stimuli or orthogonal to the orientation of the stimuli and contrasted a perception task with a working memory task.

They found that the aperture biases affected the decoding of the perceptual representations in V1 in a perception task, but not in a comparable working memory task. When they trained a decoder on the perceptual representation of a grating in V1, the same decoder only worked during the working memory representation if the aperture bias was aligned with the grid. They conclude (p.1), "These results provide strong evidence that visual WM representations are abstractions of percepts, immune to perceptual aperture biases…"

3 | EVIDENCE DIFFERENTIATING WORKING MEMORY FROM PERCEPTUAL REPRESENTATIONS

Working memory representations differ from perceptual representations in a number of important ways some of which I will list below. The point of the items on this list is not to argue for any specific difference but just to indicate difference.

1. Working memory is highly resistant to masking of all kinds (Teeuwen et al., 2021). (A mask is a stimulus presented after (or before) a target stimulus that makes the target stimulus harder to see.) But perceptual representations at different stages in the processing stream can be obliterated by the right kinds of masks at different times after the stimulus. Maguire & Howe showed that lines and edges work well as masks when the perception is being processed by early vision, texture masks work well 50 ms later, and shaped objects mask perceptions during shape processing.
2. Because of the need for visual cortex to process ongoing perception, working memory representations are often recoded outside the classic visual cortex (Rademaker et al., 2019)
3. Color representations in perception when moved to working memory are biased away from category boundaries and towards category centers (Bae et al., 2015)
4. Working memory representations for colors are related to color names in a way that perceptual representations of color are not. (Hasantash & Afraz, 2020) showed that although knowing more color names makes for more color representations in working memory, it has no effect on perceptual color matching. Also, subjects who have more color names in a particular area of the color wheel can hold more of those colors in working memory, but they did not do better on those colors in a perceptual matching task.
5. Working memory representations are coarse grained. For example, we can hear many more pitches and see many more colors than we can hold in temporary memory
6. Fundamental computational features of perception are absent in working memory representations. One such computational feature is divisive normalization, a computation governing an aspect of how the perceptions of two items influence one another, including center-surround suppression. (See p. 113 and Chapter 2 of (Wu, 2014).) Divisive normalization is illustrated in Figure 2 where it governs the suppression of the central disk on the right where it is collinear with the surround but not on the left where the two grids are orthogonal. If you look at Figure 2

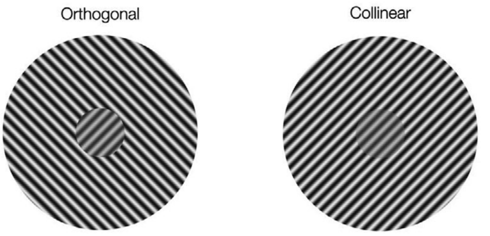

FIGURE 2 The disk in the center is the same on both sides but the right one looks lower in contrast. Thanks to Sam Ling for this figure

you will see that the collinear central disk looks lower in contrast than the orthogonal central disk. Bloem et al. (Bloem et al., 2018) showed subjects central disks and surround donuts of various contrasts either simultaneously or one after the other, separated by one second. They found robust center-surround suppression when the disks were presented at the same time but not when, separated by 1 second, one had to be held in working memory. They summarize (p.1), "…visual memory representations follow a different set of computational rules [different from perception], bypassing normalization, a canonical visual computation."

7. Working memory representations appear not to yield the iconic memory representations of perception. George Sperling showed the classic iconic memory effect by presenting subjects with an array of alphanumeric characters. For example, he presented arrays of 12 letters, 4 in each of 3 rows. On a brief presentation of the array, subjects could recall 3 or 4 letters total even though they said they could see all or most of the letters. Sperling showed that they had a representation of all or most of the letters as follows: he presented the array briefly, then after the array was turned off, he gave an auditory cue for one of the rows. He found that subjects could name 3 or 4 letters from any given row. This classic iconic memory experiment does not work when the auditory cue is presented after they had moved their eyes to a new location, using a transsaccadic working memory representation of the array. (See p 261–262 and (Irwin, 1992).)
8. Iconic memory is much more perceptual than working memory, a fact underlying many differences, including that they have very different decay properties. Working memory becomes less precise with time—according to models that emphasize a pool of resources– and also less precise when subjects are motivated to recall more items (Fougnie et al., 2016). Michael Pratte (Pratte, 2018, 2019) showed subjects 10 colored squares briefly and after a variable retention interval (with no stimulus) up to 1 second, cued a location where there had been a colored square. The subject's task was to pinpoint the color on a varying color wheel. He found that as time went on, subjects could remember fewer colors but with no loss of precision. A "sudden death" model predicted the results much better than a gradual decay model of the sort one would expect with working memory, suggesting a very different decay pattern for the iconic memory and fragile visual short term memory in these conditions.
9. Kwak and Curtis (Kwak & Curtis, 2022) showed that perceptual representations are transformed in working memory depending on the task. They showed subjects moving dots with a dominant direction in one condition and oriented stripes in another. The task was to remember the orientation of the dots or the grid. They scanned the subjects during the delay period, finding that they could not tell the difference between the neural representations of these different stimuli. Evidently, the perceptual representations became more abstract in working memory. The subject's cognitive understanding of the task can in principle add information to

the working memory representation, so that is a reason for thinking the process of cognizing the perception is "ampliative" in the sense of adding content (Gross, 2023), apparently contra Burge (2020).

These differences between perception and working memory do not show a change in format and even if there is a change in format, it could be within the category of iconic representation rather than a transformation of iconic into discursive representation.

The perceptual representations of working memory may be wholly or partly iconic, while encased in a cognitive envelope constituted by the reverberating circuits involving frontal cognition networks as diagrammed in Figure 1. Those frontal cognition circuits will normally involve propositional reasoning, at least in adult humans.

To summarize: substantial content-based reasoning requires working memory. Perceptual representations are held in working memory in a cognitive envelope in which the nature of the representations is more abstract than perceptual representations and in which these representations are connected to a variety of cognitive modules in the global workspace.

I was aware of much of this data when I finished the book in 2022 but in the last few years, the evidence has poured in that even the most basic perceptions like the perception of oriented lines are recoded when used in substantial reasoning. This has increased my doubts that there are any "raw" perceptual representations used in cognition.

4 | ICONIC FORMAT

I considered two notions of iconicity, the "part" notion in which an iconic representation is one in which iconic representations have parts that represent parts of what the whole represents and relations among the parts represent relations among the parts of what the whole represents. I discussed this idea many years ago (Block, 1983), noting a few problematic aspects. I think the part notion is useful for many purposes but I relied mainly on a different conception of iconicity derived from the work of Roger Shepard. This notion of iconicity appeals to families of representations with relations among them that mirror families of properties in the world and the relations among those properties. The idea is that members of the family of representations represent members of the world family if 3 overlapping conditions are satisfied, two on tracking, one on mirroring. Condition 1 concerns how iconic representations serve to track environmental differences, condition 2 concerns how changes in iconic representations function to change what they represent, and 3 concerns mirroring between the two families. Here are the three conditions:

1. Certain differences in representations function as responses to differences in environmental properties in a way that is sensitive to the degree of environmental differences. For example, as objects are rotated, perceptual representations of the perceiver should change in a way that is sensitive to the degree of rotation.
2. Certain differences in representations function to alter the situation that is represented in a way that depends on the degree of representational change.
3. Certain relations (including temporal relations) among the environmental properties are mirrored by representations that instantiate analogs of those relations.

Burge (2022) has a similar notion of iconicity, also deriving from Shepard. (I had not seen Burge's book before my book was in press.). His notion differs in a variety of ways from mine. Perhaps the main difference is that he requires that the mirroring relation be "natural" in a way that is tied to natural and mathematical sciences. In my (1983) I give what I regard as a highly unnatural example in which points in 2-D space in polar coordinates are represented by electrical parameters that represent angle and magnitude of a vector at points in the cortex. I continue to think that evolution grabs whatever it can use irrespective of naturalness as I understand that term. And we can certainly envision an artificial visual system that uses an unnatural iconic mapping.

Steven Gross both in his (2023) and in this issue challenges the claim that perception is iconic in my sense. In his (2023) he notes that adaptation experiments provide some evidence that there is a perceptual category shared by upper and lower case letters. That might be OK for 'O'/'o' or 'P'/'p' that are similar in shape, but what about 'E'/'e' and 'R'/'r' that are not. How can there be an iconic representation that is neutral between 'AREA' and 'area'?

Gross suggests some explanations of the results that I signed onto as plausible and in need of further testing. The most promising is that there are associations between lower and upper case words. The mechanism of the association might be that one automatically reads any word presented, activating the word representation at both phonological and lexical levels, with the phonological representation mediating associations between the lexical levels. The details are in (Block, 2023d, p. 586).

Moving to some of the evidence for iconic representation in thought, Susan Carey has long emphasized the role of iconic representations in reasoning. One role is the use of analog magnitude representations—see some examples in Jake Beck's article in this issue. But there is another system that has numerical content that also is substantially iconic, what Carey (2009) calls the parallel individuation system in which from 1–4 indexes in working memory represent the world iconically. In one kind of experiment, (p. 246–247) if infants see an experimenter put one very large piece of graham cracker in one bucket and 2 small pieces in the other bucket, infants tend to crawl toward the bucket with more graham cracker. (The area computations fit Weber's Law, showing the analog magnitude system is being combined with the parallel individuation system.) What shows these representations are in the parallel individuation system is that if there are 4 or more pieces in one of the buckets, the infant's choice behavior falls to chance. As I explain (38-40), for certain kinds of items, the infant's working memory system has a capacity of about 3 items, so falling to chance shows that system is in play. The system has up to 3 markers (4 for adults) and those markers can themselves represent in an iconic manner. A further example of this is when the markers are pictorial, representing e.g. a duck, a truck and a car, the child having seen those 3 things placed in the box. The child is surprised if items that look like those are not there on retrieval. Again, this system fails entirely with 4 items rather than 3 (Carey, 2009)

The graham cracker and picture examples shows iconic representation at the level of the individual indexes in working memory, but there is also group iconicity. For example, Carey (2009) reports an experiment in which there are two containers into which a baby can reach but without seeing what is in the containers. If 3 objects have been visibly put in the container, the baby tends to reach into the container 3 times, whereas if the number of items is 4 or more, the babies' reaching goes to chance as just described. The working memory representations taken as a whole mirror the items in the container taken as a whole (Carey, 2009) in respect of number.

More recent papers by Susan Carey, J.R. Hochmann, and their colleagues (Hochmann et al., 2018; Hochmann, 2022; Hochmann et al., under review) show other group iconicity phenomena. For example, consider an array match to sample task in which there are two samples; in one there are 16 items all the same, e.g. 16 scissors; in another sample, all are different from one another, with no two the same. Subjects are given one of the samples and are asked to choose from a number of possible matches, which one matches the sample best. The possible matches include intermediate cases. Adults match all same with all same. In the case of all different, they either base their matches on all not the same, i.e. no two the same, or not all the same, corresponding to the two choices of the scope of 'not'. The children and animals match to a logarithmic function of entropy, that is their responses are predicted by giving all the same 0 entropy, no two the same maximum entropy and intermediate cases along the same lines. The point is that entropy is a group property that mirrors group properties of the stimuli, and so iconic.

All these phenomena involving iconic representation in thinking in infants, animals and also adults contributes to the charge made by Jake Beck in his critique and in (Beck, 2023) that there is an important category of entirely non-conceptual and non-propositional thought. My response is that in cases of the sort just described, the iconic representations are contained in a cognitive envelope, so they are not entirely non-conceptual or non-propositional. I do concede however that I might have scanted the extent of iconic representation in thought but nonetheless in many cases the thought of animals and infants—especially babies over 17 months when they acquire a form of negation—is enclosed in a cognitive envelope that supplies a discursive, propositional and conceptual aspect to the thinking.

5 | ATTRIBUTION AND DISCRIMINATION

Chapter 3 argues that there is no fact of the matter as to whether perception is constitutively singular, and then on pages 142–152 I argued that both perceptual attribution and perceptual discrimination are fundamental to perception and there is no fact of the matter as to whether one is more basic than the other. This is probably the topic on which my views have evolved the most. I still think the conclusion is right but for different reasons than stated in the book, and the concept of perceptual discrimination which I took as unproblematic in the book I now see as importantly ambiguous. My discussion of the response to Schellenberg, Fink, Peterson and Schoonover is mainly concerned with the issue itself rather than my disagreements with Schellenberg, et al. and it is the longest of my replies. Rather than go into the issues now, I defer to the response.

REFERENCES

Asp, I. E., Störmer, V. S., & Brady, T. F. (2021). Greater visual working memory capacity for visually matched stimuli when they are perceived as meaningful. *Journal of Cognitive Neuroscience*, *33*(5), 902–918. https://doi.org/10.1162/jocn_a_01693

Bae, G. Y., Olkkonen, M., Allred, S. R., & Flombaum, J. I. (2015). Why some colors appear more memorable than others: A model combining categories and particulars in color working memory. *Journal of Experimental Psychology General*, *144*(4), 744–763. https://doi.org/10.1037/xge0000076

Barbosa, J., Lozano-Soldevilla, D., & Compte, A. (2021). Pinging the brain with visual impulses reveals electrically active, not activity-silent, working memories. *PLoS Biology*, *19*(10), e3001436. https://doi.org/10.1371/journal.pbio.3001436

Beck, J. (2023). review of *The Border Between Seeing and Thinking*. *Notre Dame Philosophical Reviews*, (2023.6.2). Retrieved from https://ndpr.nd.edu/reviews/the-border-between-seeing-and-thinking/website:

Block, N. (1983). Mental pictures and cognitive science. *Philosophical Review*, *93*, 499–542.

Block, N. (2023a). *The Border between Seeing and Thinking*. Oxford University Press.

Block, N. (2023b). Let's Get Rid of the Concept of an Object File. In B. McLaughlin & J. Cohen (Eds.), *Contemporary Debates in Philosophy of Mind* (pp. 494–516). Wiley-Blackwell.

Block, N. (2023c). Perception is iconic, perceptual working memory is discursive. *Behavioral and Brain Sciences*, *46*, e265. https://doi.org/10.1017/S0140525X23001899

Block, N. (2023d). Responses to my critics. *Analysis*, *83*(3), 575–588. https://doi.org/10.1093/analys/anac058

Block, N. (2024a). What does decoding from the PFC reveal about consciousness? *Trends in Cognitive Sciences*, 1–10. https://doi.org/10.1016/j.tics.2024.05.004

Block, N. (2024b). What does decoding from the PFC reveal about consciousness? *Trends in Cognitive Sciences*, *28*(9), 804–813. https://doi.org/10.1016/j.tics.2024.05.004

Bloem, I. M., Watanabe, Y. L., Kibbe, M. M., & Ling, S. (2018). Visual memories bypass normalization. *Psychological Science*, *29*(5), 845–856. https://doi.org/10.1177/0956797617747091

Burge, T. (2020). Entitlement: The Basis for Empirical Epistemic Warrant. In P. Graham & N. J. L. L. Pedersen (Eds.), *Epistemic Entitlement* (pp. 37–142). Oxford University Press.

Burge, T. (2022). *Perception: First form of mind*. Oxford University Press.

Carey, S. (2009). *The origin of concepts*. Oxford University Press.

Carruthers, P. (2015). *The centered mind: What the science of working memory shows us about the nature of human thought*. Oxford University Press.

Chung, Y. H., Brady, T. F., Störmer, V. S., & Brady, T. (in press). Meaningfulness and familiarity expand visual working memory capacity. *Current Directions in Psychological Science*.

D'Esposito, M., & Postle, B. R. (2015). The cognitive neuroscience of working memory. *Annu Rev Psychol*, *66*, 115–142. https://doi.org/10.1146/annurev-psych-010814-015031

Dehaene, S. (2014). *Consciousness and the Brain: Deciphering How the Brain Codes Our Thoughts*. Viking.

Duan, Z., & Curtis, C. E. (2024). Visual working memories are abstractions of percepts. *eLIFE*, *13*, RP94191. https://doi.org/10.7554/eLife.94191

Fields, D. R. (2022). The enigma of working memory: Changing views. *The Neuroscientist*, 10738584211072747. https://doi.org/10.1177/10738584211072747

Fougnie, D., Cormiea, S., Kanabar, A., & Alvarez, G. (2016). Strategic trade-offs between quantity and quality in working memory. *Journal of Experimental Psychology: Human Perception and Performance*, *42*(8), 1231–1240. https://doi.org/10.1037/xhp0000211

Gallistel, C. R., & King, A. P. (2011). *Memory and the computational brain: Why cognitive science will transform neuroscience*: John Wiley & Sons.

Green, E. J. (2024). *Perceptual Categorization and Perceptual Concepts*. Paper presented at the Ranch Metaphysics Workshop, Tucson, AZ.

Green, E. J., & Quilty-Dunn, J. (2021). What is an object file. *British Journal for the Philosophy of Science*, *72*(3), 665–699. https://doi.org/10.1093/bjps/axx055

Gross, S. (2023). Language and the border between perception and cognition. *Analysis*, *83*(3), 541–554. https://doi.org/10.1093/analys/anac057

Hamlin, J. K., Wynn, K., & Bloom, P. (2007). Social evaluation by preverbal infants. *Nature*, *450*(7169), 557–559. https://doi.org/10.1038/nature06288

Hasantash, M., & Afraz, A. (2020). Richer color vocabulary is associated with better color memory but not color perception. *Proceedings of the National Academy of Sciences*, *117*(49), 31046–31052. https://doi.org/10.1073/pnas.2001946117

Helton, G. (2016). Recent Issues in High-Level Perception. *Philosophy Compass*.

Hochmann, J.-R., Carey, S., & Mehler, J. (2018). Infants learn a rule predicated on the relation same but fail to simultaneously learn a rule predicated on the relation different. *Cognition*, *177*, 49–57. https://doi.org/10.1016/j.cognition.2018.04.005

Hochmann, J. R. (2022). Representations of abstract relations in infancy. *Open Mind (Camb)*, *6*, 291–310. https://doi.org/10.1162/opmi_a_00068

Hochmann, J. R., Zhu, R., & Carey, S. (under review). Conceptual combination same/different/all/not.

Irwin, D. (1992). Memory for position and identity across eye movements. *Journal of Experimental Psychology: Learning, Memory, & Cognition 18*(2), 307–317.

Kwak, Y., & Curtis, C. E. (2022). Unveiling the abstract format of mnemonic representations. *Neuron*, *110*(11), 1822–1828. https://doi.org/10.1016/j.neuron.2022.03.016

Mandelbaum, E. (2024). The border between seeing and thinking, by Ned Block. *Mind*, fzae032. https://doi.org/10.1093/mind/fzae032

Michel, M. (forthcoming). The perceptual reality monitoring theory. In M. Herzog, S. A. Schurger, & A. Doerig (Eds.), *Scientific theories of consciousness: The grand tour*. Cambridge University Press.

Phillips, I., & Firestone, C. (2023). Visual adaptation and the purpose of perception. *Analysis*, *83*(3), 555–575. https://doi.org/10.1093/analys/anac060

Pratte, M. S. (2018). Iconic memories die a sudden death. *Psychological Science*, *29*(6), 877–887. https://doi.org/10.1177/0956797617747118

Pratte, M. S. (2019). Swap errors in spatial working memory are guesses. *Psychonomic Bulletin & Review*, *26*(3), 958–966. https://doi.org/10.3758/s13423-018-1524-8

Quilty-Dunn, J., & Green, E. J. (2021). Perceptual attribution and perceptual reference. *Philosophy and Phenomenological Research*.

Quilty-Dunn, J., Porot, N., & Mandelbaum, E. (2023). The best game in town: The re-emergence of the language of thought hypothesis across the cognitive sciences. *Behavioral and Brain Sciences*, 1–55. https://doi.org/10.1017/s0140525x22002849

Rademaker, R. L., Chunharas, C., & Serences, J. T. (2019). Coexisting representations of sensory and mnemonic information in human visual cortex. *Nature Neuroscience*, *22*(8), 1336–1344. https://doi.org/10.1038/s41593-019-0428-x

Singh, L. (2020). Bilingual infants are more sensitive to morally relevant social behavior than monolingual infants. *Journal of Cognition and Development*, *21*(5), 631–650. https://doi.org/10.1080/15248372.2020.1807987

Soto, D., Mäntylä, T., & Silvanto, J. (2011). Working memory without consciousness. *Current Biology*, *21*(22), PR912–R913. https://doi.org/10.1016/j.cub.2011.09.049

Teeuwen, R., Wacongne, C., Schnabel, U., Self, M., & Roelfsema, P. (2021). A neuronal basis of iconic memory in macaque primary visual cortex. *Current Biology*, *31*(24), 5401–5414. https://doi.org/10.1016/j.cub.2021.09.052

Trübutschek, D., Marti, S., Ojeda, A., King, J.-R., Mi, Y., Tsodyks, M., & Dehaene, S. (2017). A theory of working memory without consciousness or sustained activity. *eLIFE*, *6*, e23871. https://doi.org/10.7554/eLife.23871

Woo, B. M., Tan, E., & Hamlin, J. K. (2022). Human morality is based on an early-emerging moral core. *Annual Review of Developmental Psychology*, *4*, 41–61. https://doi.org/10.1146/annurev-devpsych-121020-023312

Wu, W. (2014). *Attention*. Routledge.

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