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Iconic memory and attention in the overflow debate

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Abstract: The overflow debate concerns this following question: does conscious iconic memory have a higher capacity than attention does? In recent years, Ned Block has been invoking empirical works to support the positive answer to this question. The view is called the "rich view" or the "Overflow view". One central thread of this discussion concerns the nature of iconic memory: for example how rich they are and whether they are conscious. The first section discusses a potential misunderstanding of "visible persistence" in this literature. The second section discusses varieties of attention relevant to this debate. The final section discusses the most prominent alternative interpretation of the Sperling paradigm—the postdiction interpretation—and explains how it can be made compatible with a weaker version of the rich or overflow view.

Subjects: Behavioral Sciences; Psychological Science; Philosophy; Philosophy of Psychology

Keywords: iconic memory; attention; consciousness; overflow; postdiction; modulation

1. Iconic memory and conscious awareness

This short piece reviews historical and recent works concerning iconic memory and attention in the overflow debate. The larger background of this is the relation between attention and conscious awareness, which has been nicely reviewed by Giorgio Marchetti (2012). In that review, Marchetti

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Tony Cheng is finishing a dissertation on the connections between object cognition and self-consciousness at University College London. Before this, he has been focusing on attention and related topics. The current paper is a result from the attention project, which he will keep pursuing later in the career. He is also conducting part-time projects with Patrick Haggard's Action and Body Lab at Institute of Cognitive Neuroscience, University College London, with the Psychology Department at Birkbeck College, University of London, and with the CenSes Lab led by Colin Blakemore, Institute of Philosophy, University of London. During his visit to University of California, Berkeley, in 2014, he was involved in works with Alison Gopnik's Cognitive Development Lab and Martin Banks's Visual Space Perception Lab. His other academic interests include cognitive development, multisensory integration, the Molyneux's Question and traditional questions in philosophy of mind and perception.

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PUBLIC INTEREST STATEMENT

We often hear this from parents: "pay attention, otherwise you wouldn't get what teachers' are saying!" This kind of daily remarks indicates the close connections between attention and consciousness. But does it imply that attention is necessary to and/or sufficient for consciousness? And if so, are these implications warranted? These are questions that can be studied with empirical methods. The relevant scientific investigations are not only theoretically interesting for psychology, neuroscience and cognitive sciences more generally, but also practically relevant since it might have educational applications that can help us improve the relevant pedagogical principles.

has a short section on iconic memory; the present piece can be regarded as an expansion of the discussion there, with an emphasis on the relation with the overflow debate, which is not covered by Marchetti. Ian Phillips (2015) also reviews the overflow debate, but in what follows I will discuss aspects that are not covered by his paper, and eventually disagree with him about how we should understand the postdictive interpretation in the final section. In order to be focused, how some substantive theories—such as higher–order theory (Lau, 2008; Lau & Rosenthal, 2011), cognitive theory (Cohen & Dennett, 2011; Dennett, 1991) and global workspace theory of consciousness (Baars, 1988)—would say about this debate is not covered.

Recent works on iconic memory, attention and the overflow debate stemmed from a paper by Ned Block (2007a); the focal debate concerns the famous George Sperling partial report superiority paradigm (1960). At the beginning of the experiments, participants look at a blank screen with a fixation point in the middle of the screen. An array of letters constituting a grid then comes in as stimuli for 15–500 ms. After the stimuli disappear, there will be a delay with a blank screen; the period of delay depends on specific experimental settings. Then crucially, a cue tone comes in signifying which row the participants are supposed to report (high tone for the high row, etc.). Since there is a delay between the stimuli and the cue, one might expect that the cue will not have any significant effect, since it comes too late. Surprisingly, however, participants are actually very good at reporting the given row accurately, even though the cue comes much later than the stimuli.

The overflow debate concerns this following question: does conscious iconic memory have a higher capacity than attention does? This is a specific way of investigating the relation between consciousness and attention. Roughly before the 90s, the science community believed that consciousness is elusive and therefore unscientific, so attention was taken as a surrogate of consciousness, since it had been easier to operationalise attention, and its connection to consciousness is close enough. Gradually, however, consciousness made its way back to psychology and even to neuroscience, so this following question became urgent: what is the relation between consciousness and attention, given that they are not identical? One natural way to approach this question is to ask whether attention is *necessary* to and/or *sufficient* for consciousness. Some researchers have argued for the positive answer (Prinz, 2012), while others have argued that neither is the case (Koch & Tsuchiya, 2007; Van Boxtel, Tsuchiya, & Koch, 2010). There might be some middle grounds. Kentridge, who specialises in blindsight and related topics, has been arguing that attention is not sufficient for consciousness (Kentridge, 2011; Kentridge, Heywood, & Weiskrantz, 1999). Ned Block, on the other hand, has been arguing that consciousness is not sufficient for attention (2007a, 2011, 2014). It is this aspect of the question, i.e. the one initiated by Block, that we will focus on. To make it scientifically more trackable, Block has formulated the question with iconic memory and capacity limit. And this is why we will go back to the classic Sperling paradigm on iconic memory. One side point of this review is that although science aims for progress so that researchers tend to focus on new researches, e.g. papers no more than five years old or so, in tackling difficult theoretical issues sometimes history of the subject matter might be very important.

Psychologists have attempted to understand the Sperling paradigm in the past few decades. First of all, Ulric Neisser (1967) argues that the visual sensory memory involved is *iconic* in character (cf. "sensory memory", Luck & Hollingworth, 2008). A further distinction between *visible* and *informational* persistence is made later by Max Coltheart (1980). Coltheart argues that Sperling's case is only about *informational* persistence (see also di Lollo, 1980), and it has been further argued that while visible persistence is *negatively* correlated with stimulus duration, informational persistence is *positively* correlated with stimulus duration (Greene, 2007). Also, techniques such as "duration of stimulus technique" (Long, 1980) and "moving slit technique" (Haber & Standing, 1970) are designed to test visible but not informational persistence. This standard conception seems to be at odds with Block's way of conceiving the debate. He writes:

There have to be such specific representations given that any location can be cued with high accuracy of response. The locus of controversy is *whether those specific representations are phenomenal*. (2007a, p. 531)

It is very natural to read this passage as saying that according to Block, in the Sperling paradigm, there is not only *informational*, but also *visible* persistence, or in his terminology, "*phenomenal* persistence" (Block, 2007a, p. 487). But if this reading is correct, then Block has to tell us what his rationale is in disagreeing with the standard conception, i.e. Sperling concerns only informational persistence, and visible persistence is an entirely distinct phenomenon. However, Block does *not* argue against this standard conception: when he discusses Coltheart (1980) and di Lollo (1980), he cites them with approval (2007a, p. 490, p. 494). One possible conclusion is that Block's view is a nonstarter: given that psychology has strongly established that informational and visible persistence are simply different elements of iconic memory and the Sperling paradigm is not about visible persistence at all, Block's view is simply false (Irvine, 2013, pp. 126–129; see also Byrne, Hilbert, & Siegel, 2007). This idea is not responsive to the puzzle that Block does not even attempt to refute Coltheart and Di Lollo; rather, he cites them rather approvingly. A better interpretation is that Block's view is *not* a challenge to the standard conception, and that is why he agrees with the standard conception when discussing them. How can this be? The answer is that Block mischaracterises the dialectic, and since the characterisation is so natural, many of his opponents follow that as well. The correct reading of Block's claim should be this: it is right to say that the Sperling paradigm concerns *informational* persistence only, as the standard conception has it, but there is a further question, namely: whether the persisting information in the visual system is *phenomenal* or *conscious*. As the standard conception says, and Block should agree, *visible* persistence is something else that should be tested with other paradigms and methods. However, based on this shared starting point, one can still ask a *further* question: is the persisting information involved in the Sperling paradigm phenomenal?

Further clarification is needed here. In experiments, to ask whether a target is *visible* is in effect to ask whether the participant *consciously* see the target. If we use "being conscious" and "being phenomenal" interchangeably here, then "being visible" and "being phenomenal" should also be interchangeable. But if so how can we distinguish "visible persistence" from "phenomenal persistence"? A good way to escape this linguistic muddle is to see how these notions are operationalised. Works cited above (Greene, 2007; Haber & Standing, 1970; Long, 1980) do a reasonable job in this regard. With knowledge about the properties of different varieties of persistence (e.g. being positively or negatively correlated with stimulus duration), and also how to tease them apart empirically (e.g. moving slit technique), we have a better grip of what they actually mean empirically. Now we have operationalisations only for informational and visible persistence, but not phenomenal persistence in Block's sense. This partially explains why the question Block raises—"bracketing visible persistence in the technical sense defined above, is persisting information in the Sperling-style case phenomenal?"—is so far neglected in the literature: if there is no suitable operationalisation of a certain notion, empirical researchers tend to skip them to avoid speculations. But it does *not* follow that the question itself, with notions not being operationalised so far, is not an intelligible one.

It is crucial to have spent some time on the above clarification, since no one in this debate so far clearly sees this subtlety. Irvine (2013) makes a substantive contribution in noticing what psychologists actually think about *visible* persistence, and her way of interpreting Block is certainly a possible one, but I believe it is more fruitful to adopt the interpretation presented here and pursue the debate further.

In pursuing this debate, we need to consider newer paradigms and discussions, but there is one more point to be made here. In the original Sperling discussion he and his contemporaries did not use the term "consciousness": as stated above the experiment is about *informational* persistence, which can be unconscious. In making claims about consciousness, theorists have gone beyond Sperling's original purposes. Now, in contemporary discussions, newer paradigms are designed to be about consciousness explicitly. For example, Landman, Spekreijse, and Lamme (2003) is supposed to

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further vindicate Block's view that conscious iconic memory is richer than attention. In the crucial trial, the participants need to indicate whether the cued item has changed its orientation after the delay. Like the Sperling original experiment, what is surprising is that if the cue appears after the first set of stimuli, and the gap between is quite large (hundreds of milliseconds), trained participants can still perform the tasks quite well. In this series of experiment, the delay is much longer than many other paradigms (i.e. can be up to 1,500 ms). Block takes it that the longer delay further supports his view. However, it has been pointed out (Phillips, 2011, p. 405) that here the measurement is forced choice, which is much less demanding than the original Sperling case, in which participants need to come up with the identities of letters. The forced choice method, though useful for many purposes, is crucially different from our original case. This is not a decisive objection, but it significantly weakens Block's attempt to use Landman et al. (2003) to vindicate his rich view.

Another crucial notion in understanding the overflow debate is attention. The next section discusses relevant notions of attention and their relations to the overflow debate.

2. Varieties of attention

What do and should we mean by attention in this context? Psychologists have drawn the following two basic distinctions here. The first is between overt and covert attention. When one shifts one's attention by moving one's eyes or heads, it is a case of *overt* attention. By contrast, when one shifts attention without any observable behaviours, then we have a case of *covert* attention. The second distinction is between endogenous and exogenous attention. *Endogenous* attention is also known as top-down attention; it involves subjects' intention to direct her/his attention, while *exogenous*, bottom-up attention does not. So for example, if you are attending to a lecture and suddenly get distracted by the siren outside the building, your endogenous attention to the speech is interrupted by exogenous attention drawn by the siren. Of course in real cases the distinction is fuzzier, but the conceptual distinction should be clear. Now, Sperling (1960) and Landman et al. (2003) both involve covert attention, since participants are asked to fixate at the center; it also involves perhaps both endogenous and exogenous attention, since they are told to pay attention to cues and targets, but auditory or visual cues naturally draw attention anyway. There is a third distinction concerning *diffused/distributed* and *focal* attention (e.g. Treisman, 2006), and sometimes it is not so clear which one is at stake in this debate. According to the original formulation, i.e. conscious iconic memory overflows attention, it seems that what is at stake is attention *in general*, so it should include both diffused and focal attention. However, sometimes the discussion becomes only about focal attention, for example Block (2014). But in doing so the debate thereby becomes less interesting, since to argue that conscious iconic memory overflows focal, spotlight attention is much easier than arguing for the stronger claim that conscious iconic memory overflows diffused attention as well. This is not to say that works done to show things about focal attention are unimportant, but it is crucial to recognise that those works would not settle the original debate directly.

Another complication is to compare notions of attention, selection, access, and accessibility. In Block's dialectic, both access and accessibility are important. The original definition of "access consciousness" in Block (1995) is that "[A state is] A-conscious if it is *poised* for direct control of thought and action …" (1995/2007b, p. 168; my emphasis). This is a dispositional notion, that is, *accessibility*. When talking about attention directly in his works after 2007, Block identifies it with *access*, not accessibility. Prinz (2012) rather uses *accessibility* to understand attention. This is a possible point where theorists can talk past one another. The difference between accessibility and access can be easily understood through mundane examples. My roommate and I both have the key for our room. In this sense, the room is *accessible* for both of us. But when he is actually using the key to enter the room, he *accesses* the room at a specific moment while I am still out for a run and therefore do not access the room at that moment.

Now even if we get clear about the ambiguity between access and accessibility, say we stick to the former, there is yet another relevant distinction, namely the one between selection and access. *Selection* has always been a central theme in understanding attention. The debate between early

and late selection is a classic example (Deutsch & Deutsch, 1963). Against this background, Sperling's paradigm was designed to test this function of attention. This complicates the discussion since when Block invokes Sperling to make his point, he means *access* rather than selection. Contemporary research of selective attention began from Donald Broadbent's experiment on dichotic listening (1952). Typically, participants are presented with two simultaneous but different stimuli to the two ears. And the instruction is to pay attention to the message presented only to a certain ear. There have been many variations in this paradigm. Broadbent himself (1958) interprets the data as showing that stimuli that do not need response are discarded before being fully processed. A "selective filter" is then postulated to explain the phenomenon. In this way, psychologists operationalise selection in informational terms. If relevant information is processed (to the extent that needs to be specified for specific purpose), then it is selected. Later researchers have been trying to resolve this early/late debate with new conceptual frameworks, such as the load theory (Lavie, 1995; Lavie, Beck, & Konstantinou, 2014).

However, in certain contexts psychologists seem to have a more demanding idea of selection. For example, a textbook says that in the Sperling paradigm one wants to know whether participants can "selectively report items from very brief visual displays" (Styles, 2006, pp. 27–28). Here, selection means not only information processing but also reportability, which is a much more demanding notion. It is closer to what Block means by "access". In order to make the contrast clear, I reserve the term "selection" for information processing and use the term "access" to maintain the link to reportability. In the final section, I will introduce "modulation" as yet a further function of attention. Key notions in this section, such as information, reportability, access and attention, fall under what David Chalmers calls the "easy problems" of consciousness (2004), but of course, they are not too easy, even though it might still be easier than the "explanatory gap" problem (Levine, 1983).

Some researchers have attempted to accommodate both selection and access in their frameworks, for example Campbell (2011). Campbell argues that selection and access are "two different aspects of attention" (2011, p. 324). Attention *selects* relevant information for further processing, and it helps us *access* relevant information so that we can use them to make inferences and guide actions. There might be a question about individuating kinds of attention (e.g. what do we mean by "aspect" here?), but this metaphysical query can be bracketed for present purposes. Campbell (2002) first introduced this distinction with Treisman's feature map theory, but in recent works, he elucidates the distinction by referring to the Boolean map theory by Huang and Pashler (2007). Campbell's position is this:

> [W]e should regard experience of a property as a matter of being in a position to use the property as the basis on which an object or region is *selected*, rather than as a matter of *accessing* the property. (2011, p. 324)

Campbell acknowledges that both selection and access are aspects of attention, but he attempts to tie experience to *selection*. With Campbell's own usage, "selection" means "using a property to *select* a region or object", and "access" means "*accessing* a property of a region or object" (2011, p. 325). With this distinction, Campbell proposes a view that comes close to Block's rich view:

> Consider a child, at this stage of development [2-year-old], looking at the kind of display often used to test for color-blindness—a green 5, say, showing against a background of red blobs, with the blobs constituting the 5 differing randomly from each other and from the blobs constituting the background in luminance, in shape, and in every other characteristic except hue ...Whether the child can *see* the 5 is one thing. Whether the child is able to *access* the color of the object is another ... (2011, p. 331; my emphasis)

Although Campbell does not engage with the literature generated by Block (2007a), his considerations lend further supports to the rich view. For a similar perspective, see Jennings (2015). It is not one of the purposes of the current piece to review the huge domain of theoretical studies of attention (and iconic memory), but see Prettyman (in press), Watzl (in press), Rensink (2015), Taylor

(2015), Wu (2014), Brown (2012), Hine (2010), Mole (2011), and Mole, Smithies, and Wu (2011), for more discussions. About the relation between iconic memory and concepts, see Shevlin (in press), Fodor (2007), and Tye (2006). About the relation between iconic memory and change blindness, see Cheng (2017) and Noë (2005). For iconic memory in chimpanzees, see Matsuzawa (2009).

3. Postdiction and the compatibility hypothesis

A recent alternative to Block's interpretation of the Sperling paradigm is that what happens is *cross-modal postdiction*. It is postdiction, because according to the view the cue in effect *retrospectively* modifies what the participants consciously see. It is cross-modal because the cue tone is *auditory*, while the original array of stimuli is *visual*. This second part might not be essential to the discussion, since if in the trials we instead use visual cues such as arrows, we can still get the same effect. However, since normally the cue is auditory, it will be important for the proponents of the postdictive interpretation to also argue that cross-modal postdiction actually happens in standard Sperling cases. It will be interesting to compare *postdiction* with the current literature on *predictive* coding (Clark, 2013, 2016; Hohwy, 2013); in particular, how the brain can do both in a parallel way and still produces a coherent, stable worldview, but for present purposes I do not head to that rather complicated direction.

A basic postdiction case is "backward visual masking". If the timing and the shapes of the stimuli (e.g. a disc and a complementary ring) are suitably designed, the participants will *not* be aware of the first stimulus. If the second target comes in between 50 and 100 ms, the effect will be the strongest (Alpern, 1953; see Bachmann, 1994 for a review). One thing we need to acknowledge immediately is that in the Sperling case, the delay can be much longer than 100 ms, so what we observe in this simple case cannot be applied directly to the Sperling case. Phillips then cites a study by Weisstein and Wong (1986) for the possibility of longer delays (Phillips, 2011, pp. 387–388). The second important thing to be recognised is that we need *cross-modal* postdiction, as mentioned above. For this, consider "sound-induced visual bounce". On the screen disc A and B move towards each other, briefly coincide, and finally move away from each other. Participants either see them as bouncing and reversing directions, or see them as pass through each other without changing the original directions. If a sound is played at the point of coincidence, or close enough, participants more often see them as bouncing. Even when the sound is played with a 150 ms *delay*, the effect is still there (Sekuler, Sekuler, & Lau, 1997, p. 308). Again, the temporal window here is not big enough to apply to the Sperling case. However, in a later study Watanabe and Shimojo (2001) shows that "though a sound presented 300 ms after visual coincidence does not induce bounce, the 'bounce-inducing effect was attenuated when other identical sounds (auditory flankers) were presented 300 ms before and after the simultaneous sound' (p. 109)" (Phillips, 2011, p. 390). A similar view can be found in Stazicker (2011).

Now, Phillips and Block agree that *if* the postdiction interpretation is correct, *then* the rich view is falsified. However, there is room to argue that they are compatible: Block's strong rich view has it that before the cue, there is specific conscious iconic memory for almost every item, and this is what postdiction denies. However, a weaker rich view might be viable even if postdiction is true: before the cue in the Sperling experiment, the participants have conscious *gist* perception of the whole scene, and some parts of it are more specific. The degree of specificity corresponds to the flow (i.e. the distribution and the strength) of attention. *After* the cue, the new flow of attention shapes new pieces of specific conscious iconic memory for reports. In what follows I lay out the argument in detail. The crucial assumption denied by the postdiction interpretation is this:

> [I]t is legitimate to sum partial reports to establish awareness in relevant similar cases …[This is] an *independence* assumption, viz. that a subject's experience of the stimulus in a PR [i.e. partial report] condition is independent of which report is cued because the cue comes only *after* display offset. (Phillips, 2011, pp. 385–386)

Postdiction, at least on the face of it, contradicts this independence assumption because it says that attention *modulates* the phenomenology of the cued row so that it *becomes* specific enough for report (some call this "alteration", for example Carrasco, Ling, & Read, 2004). On this picture, phenomenology for un-cued rows is not as specific as Block has it; it only becomes specific enough for accurate report *after being cued*. This is the core of Phillips's objection. In what follows, I argue that there is a sensible way to reconcile these two perspectives.

First, under suitable interpretation, the cross-modal postdiction view is compatible with the weak version of the rich view, or the Overflow view. Recall Block's strong version of the view: before the cue, we have specific phenomenology (in his sense) for all or almost all letters. This view is not well supported by his arguments since it presupposes the unargued independence assumption. Some of Block's opponents go for the other extreme and argue that there is *only* generic phenomenology before the cue, for example Kouider, de Gardelle, Sackur, and Dupoux (2010). However, this view does not seem to do justice to the fact that in the trials in which there is no cue at all, the participants can still report about four letters accurately. If without the cue we enjoy only generic phenomenology, it is not clear how we can accommodate the full report condition, and indeed, gist perception. Now, even if the cross-modal postdiction interpretation is correct, we can and should still hold that before the cue, the participants will have specific phenomenology, though not for almost all letters, but for perhaps 4 letters or so. The reason is that before the cue, given the fixation point and the pre-cue attention, some parts of the visual field will still be more salient than other parts. But overall, the pre-cue phenomenology still overflows (i.e. is richer than) what attention can later capture, since before the cue there is also generic phenomenology. In a sentence, something between Kouider and Block is right (i.e. there are specific phenomenologies before the cue, but not as much as Block supposes), and this in-between view is compatible with the cross-modal postdiction interpretation. Perhaps Kouider would reply that he does not think that before the cue subjects have only generic phenomenology. Perhaps the view is that for *entirely unattended* stimuli phenomenology is purely generic. In that case I would have no objection here.

Secondly, the cross-modal postdiction view sits well with some findings by Morten Overgaard and his colleagues, which I also endorse. In what follows I first introduce the view, then explain its plausibility, and finally connect it to the current debate.

The leading question for Overgaard et al. is this: "Is conscious perception gradual or dichotomous" (Overgaard, Rote, Mouridsen, & Ramsøy, 2006, p. 700)? According to Sergent and Dehaene (2004), it is dichotomous. The idea is that there is a clear threshold for being conscious, and after reaching that threshold consciousness is more or less stable. In showing this, Sergent and Dehaene design a scale consisting of 21 nodes, with the two extremes defined as seen or unseen. They then use this scale in experiments of attentional blink, "the phenomenon that the identification of a stimulus hinders an explicit report of a second stimulus if the two are temporally separated by between 200 and 500 ms" (Overgaard et al., 2006, p. 701). What Sergent and Dehaene found is that subjects report in an all-or-none fashion: they are either conscious of the second stimulus, or not conscious of it at all.

As Overgaard et al. point out, however, this result from Sergent and Dehaene is flawed. For one thing, as Sergent and Dehaene themselves notice, subjects' reports show a more continuous pattern when the experiments are purely about masking, i.e. are not combined with attention blink. For another, and more importantly, the Sergent–Dehaene scale is biased: only two extremes are explicitly defined, and there are too many nodes (i.e. 19) in between (Overgaard et al., 2006, p. 702). To see the problem, recall whatever demos with short stimuli you have seen before, and ask yourself: is it possible to decide in a given case, the degree of conscious awareness is, say 6, as opposed to 8? If participants have a feeling that they clearly see the stimuli, does it make sense to choose, say 18, as opposed to 20? It is predictable that given the design of the scale, participants will tend to give all-or-none verdicts.
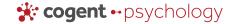
In order to make plausible the view that consciousness is a gradual phenomenon, Overgaard et al. propose another scale of measurement, Perceptual Awareness Scale (PAS). It is "a four-point scale categorized as 'not seen,' 'weak glimpse' (meaning 'something was there but I had no idea what it was'), 'almost clear image' (meaning 'I think I know what was shown') and 'clear image'" (Overgaard et al., 2006, p. 702). The improvements are, first, all nodes are clearly defined, and secondly, there are only two options between the two extremes. With this scale, subjects report in a "continuous manner" (Overgaard et al., 2006). With these two improvements, PAS is better than the Sergent-Dehaene scale, and PAS supports, though non-decisively, that consciousness is gradual, not dichotomous.

Now this discussion supports the weak rich view cum postdiction because the view requires that consciousness is a gradual phenomenon. According to the view, when we fixate at the middle and are cued to report the upper row, the phenomenology for letters in the upper row will probably be as specific as one can get, i.e. specific in Block's sense. The phenomenology for the middle row would be less specific, but given that it is around the fixation point, and it is not that far away from the cued row, it might still be possible to sustain reports to some extent. For the lower row, on the one hand, it is not around the fixation, and on the other it is further away from the cued row, the visual phenomenology for it would be least specific, but still not *purely* generic, since it does not make sense to think that purely generic phenomenology, i.e. without any specificity, exists at all. Now, it is obvious that this view requires the gradational view of conscious experiences, since it involves talks such as "most specific", "less/least specific", and so on. For the postdiction part, the view says that attention can retrospectively *modulates* a certain piece of phenomenology so that it becomes *more* specific, and again this requires the gradational view in question.

Now, the conclusion is *not* that Block's version of rich view is rejected. Rather, it is a more modest view that the Sperling's case does *not* support Block's version of the rich view. To get the argumentative structure clearer, we can restate Block's rationales as follows:

(I) If a row had been cued, participants would be able to report on it accurately.

(II) Introspectively, participants believe that they read off answers from residual phenomenology.

(III) It is legitimate to sum the results of partial reports across trials to establish the overall capacity of iconic memory.

They are not supposed to be elements of a deductive argument, since as Block likes to say, his arguments for the rich view are always inference to the best explanation. So what we can do is to examine his rationales individually and see whether they do support Block's view. Now I take it that I is uncontroversial; it is simply a factual description about participants' performances in Sperling. III has been challenged by Phillips's idea that attention retrospectively *modulates* our conscious percepts. I concur with this idea with some disagreement specified above. Now the key point of my argument so far is about II: there is no denying that the "reading off" idea is what many participants think. But there are several complications here. For example, one may hold an error theory about it and say that participants massively misunderstand their own phenomenology. This is a possible view, but I tentatively side with Block that if there are other views available, error theories should be avoided. But even assuming that, there is a further question about how to understand this "reading off" introspection. The hypothesis being put forward here is that after being cued, the relevant *matching profiles* become narrow enough to sustain accurate reports, so from participants' point of view they do read off answers from phenomenology. It is just that according to the current hypothesis what they read off is also what their attention helps *modulate* after being cued. What is a matching profile? For direction, the "matching profile is a set of directions: a given direction is in the set if and only if it is not discriminably outside the apparent direction of the end of the perceived arm" (Peacocke, 1986, p. 4). Similar things can be said about distance, length, and other visible/perceptible properties. The notion of matching profile can capture the "subject's perceptual acuity"

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(Peacocke, 1986, p. 4). Matching profile can accommodate the fact that humans' powers of discriminatory capacities are limited (Williamson, 2000), and relatedly, it can help explain veridicality (Williamson, 2000, p. 5): an experience being veridical is a matter of degree. If we were to require perfect correspondence between objects' properties and what is presented in experience, then almost no visual experience can be veridical. The idea of matching profile takes non-discriminable difference into consideration. One way to think about matching profile is to say that it is a set that specifies how the world could be given in that experience. There are many ways the world could be that are compatible with one's current experience. For a similar approach, see Stazicker (in press); for more on perceptual precision, see Block (2015) and Fink (2015).

Now, what we have offered here is quite different from Block's view because in his picture, the matching profiles are *independent* of attention's allocation, i.e. no *modulation*. For Block, before the cue the un-cued rows' matching profiles look like this:

{E, E, E, E}

That is, it is specific enough for reporting that it is letter "E", though perhaps remains neutral between different fonts or typefaces. In the picture I have argued for, the matching profiles of the un-cued rows would be like this:

{E, E, E, E, F, F, F, F}

That is, a given profile would not only be neutral between different fonts of "E", but also other similar letters such as "F". As a review paper, here I leave the readers to decide which perspective is more plausible, but above has offered some initial reasons for preferring the compatibility approach.

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