PHILOSOPHICAL TRANSACTIONS B

rstb.royalsocietypublishing.org

Research

Check for updates

Cite this article: Phillips I. 2018 The methodological puzzle of phenomenal consciousness. *Phil. Trans. R. Soc. B* **373**: 20170347.
http://dx.doi.org/10.1098/rstb.2017.0347

Accepted: 2 April 2018

One contribution of 17 to a theme issue 'Perceptual consciousness and cognitive access'.

Subject Areas:
cognition, neuroscience

Keywords:
phenomenal consciousness, cognitive access, methodological puzzle, phenomenal overflow, partial-report paradigms, no-report paradigms

Author for correspondence:
Ian Phillips
e-mail: ianbphillips@princeton.edu

The methodological puzzle of phenomenal consciousness

Ian Phillips[1,2]

[1]Department of Philosophy, Birmingham University, Birmingham, West Midlands, UK
[2]Cognitive Science, University of Princeton, Princeton, NJ, USA

IP, 0000-0003-2932-8045

Is phenomenal consciousness constitutively related to cognitive access? Despite being a fundamental issue for any science of consciousness, its empirical study faces a severe methodological puzzle. Recent years have seen numerous attempts to address this puzzle, either in practice, by offering evidence for a positive or negative answer, or in principle, by proposing a framework for eventual resolution. The present paper critically considers these endeavours, including partial-report, metacognitive and no-report paradigms, as well as the theoretical proposal that we can make progress by studying phenomenal consciousness as a natural kind. It is argued that the methodological puzzle remains obdurately with us and that, for now, we must adopt an attitude of humility towards the phenomenal.

This article is part of the theme issue 'Perceptual consciousness and cognitive access'.

1. The methodological puzzle of phenomenal consciousness

At the *Association for the Scientific Study of Consciousness* in 2012, Ned Block confidently wagered that disputes over whether phenomenal consciousness constitutively requires cognitive access would be settled within the decade. Since then, much innovative work has been undertaken. Yet, no consensus has emerged. This reflects a deep methodological puzzle confronting consciousness science that Block himself highlights [1,2]. The study of consciousness must begin with putative cases of consciousness and unconsciousness. However, the evidence used to identify such cases (e.g. verbal report or intentional action) is equally evidence of the presence or absence of cognitive access. Thus, all our initial cases of consciousness will be presumptive cases of both consciousness and access, or of neither. Given this starting point—so the puzzle goes—how could we ever establish whether consciousness can occur without access?

The present paper offers a critical review of recent experimental and theoretical responses to the puzzle. Section 2 clarifies the issue at the centre of recent disputes. Section 3 reviews and extends earlier criticisms of partial-report studies commonly put forward as evidence of consciousness without access. Section 4 explains why such criticisms equally apply to studies intended to support the contrary claim that consciousness requires cognitive access. Section 5 challenges the contention that no-report paradigms can help resolve our quandary. Finally, section 6 offers a sceptical assessment of an important theoretical framework intended to overcome the methodological puzzle due to Shea [3].

2. The access hypothesis

Consider a state of a subject, *S*, with content, *p*. To say that phenomenal consciousness constitutively requires cognitive access is to impose a condition on *S* being a conscious state. Current debate focuses on the following condition [2,4,5].

> *Access Hypothesis*: *S* is a conscious state only if its content *p* is 'directly' available to its subject (that is: exploitable without the need for any further processing) to perform a

THE ROYAL SOCIETY PUBLISHING

wide-range of cognitive tasks such as reporting that *p*, or reasoning or acting on the basis of *p*.

More or less demanding access hypotheses can be formulated. More strongly, one might insist that *S*'s content must actually be exploited for *S* to be conscious. More weakly, one might drop the requirement of 'direct' availability. Here, I focus on the access hypothesis as stated.

Pressing a version of the methodological puzzle, Cohen & Dennett [6] contend that because the hypothesis of consciousness without access 'cannot be empirically confirmed or falsified' (p. 358), it is unscientific and so 'doomed' (p. 363). However, Cohen and Dennett's considerations at best establish that the hypothesis of conscious without *function* is unscientific.[1] Despite the impression they give, such a claim falls far short of the access hypothesis. This is for two reasons. First, the cognitive functions mentioned in the access hypothesis do not exhaust all psychological functions. For example, Cohen and Dennett hold that 'affective, emotional or "limbic" reactions are . . . types of functions' by which the presence of consciousness could be evidenced (p. 361). But these are not themselves cognitive functions as construed by the access hypothesis. Second, one can reject the access hypothesis on the basis that some conscious contents are only indirectly available. Yet, indirect availability remains a functional characterization (cf. [8]).

The access hypothesis maps onto well-established views concerning the neural and informational underpinnings of cognitive access. For example, in developing their influential global neuronal workspace model, Dehaene and Naccache distinguish three levels of accessibility: 'Some information encoded in the nervous system is permanently inaccessible (set I_1). Other information is in contact with the workspace and could be consciously amplified if it was attended to (set I_2). However, at any given time, only a subset of the latter is mobilized into the workspace (set I_3)' [9, p. 30] (see also [10]). The access hypothesis corresponds to the claim that only mobilized information (set I_3) is conscious. Critics of the access hypothesis instead contend that information that is merely in contact with the workspace (set I_2) can be phenomenally consciousness [1]. Similarly, Lamme makes a critical distinction between 'Stage 3' localized recurrent processing restricted to occipito-temporal areas and that 'cannot directly influence motor control and other functions necessary for direct report' [11, p. 219], and 'Stage 4' widespread recurrent processing involving fronto-parietal circuits that directly supports executive functions. The access hypothesis corresponds to the claim that consciousness requires stage 4, global processing. Lamme thus rejects the access hypothesis when he argues that phenomenal consciousness is associated with stage 3, localized recurrent processing.

Critics of the access hypothesis often also contend that conscious perception is rich, whereas cognition is sparse. For example, Block rejects the access hypothesis on the grounds that the *capacity* of perceptual consciousness exceeds or 'overflows' the capacity of cognitive access. However, the claim that conscious perception is rich is not, in and of itself, inconsistent with the access hypothesis. The apparent conflict arises from two further assumptions. First, that cognitive access is identifiable with presence in working memory. Second, that working memory has a strictly limited (say, four item) capacity.

Both assumptions can be challenged. Carruthers [4] accepts that working memory is capacity-limited but denies that cognitive access equates to presence in working memory. Instead, he argues that cognitive access requires either of two forms of global broadcasting. The first form corresponds to working memory. This is capacity-limited because it lacks support from bottom–up, stimulus-driven activity, and so must exclusively rely on top–down attention to sustain its contents. The second form corresponds to online perception. This, Carruthers claims, allows much richer broadcast of information due to the support of bottom–up sensory activity, rendering rich perceptual consciousness consistent with the access hypothesis. Gross & Flombaum [12] offer an alternative way of combining rich perception with the access hypothesis by appeal to a conception of working memory as a continuous, flexibly distributed and capacity-unlimited resource (see [13,14] as well as the rather different model of [15] discussed in [5]). This again affords a reconciliation of phenomenal richness with the access hypothesis (see also [16] discussed in [17]).

For these reasons, the main focus herein is neither overflow nor richness but the access hypothesis. That said, I do press the methodological puzzle by disputing studies purporting to evidence overflow because overflow is inconsistent with the access hypothesis. Moreover, because the theoretical contentions of Carruthers, and Gross and Flombaum remain controversial, I do not rely on either in what follows. Note though that decoupling the access hypothesis from overflow does not resolve the methodological puzzle. The question remains whether a state can be conscious without access, and correspondingly whether consciousness should be associated with localized as opposed to globally recurrent processing, or with being in contact with the workspace as opposed to actual mobilization into it.

3. Retrocueing paradigms and a recipe for puzzlement

A substantial body of work exploiting variants on Sperling's classic partial-report paradigm [18] claims to provide evidence against the access hypothesis, and in favour of overflow. Phillips [19] proposes a two-step recipe for replying: (i) accept (for argument's sake) whatever interpretation is offered of the relevant data construed in purely representational or informational terms; (ii) dispute the 'bridging assumptions' used to move from this representational account to claims concerning consciousness.

Take Sperling's original task, widely viewed as evidence of phenomenology without access (e.g. [1,20–23] though cf. [9, p. 8] and [16] on which [17]). Following our recipe, we accept the informational import of Sperling's data, granting that they evidence a brief-lived, high-capacity 'iconic memory' store selectively transferable to a stabler, low-capacity store supporting verbal report. We then deny that the full capacity of the iconic store figures in phenomenal consciousness. Instead, we propose that only those contents that ultimately reach explicit or working memory do. For variations on this theme, see [6,24–28].

More recently, a series of studies from Lamme's Amsterdam Group exploit a change detection task with retrocues at delays of 1–4 s to argue for the existence of a fragile sensory memory store with roughly twice the capacity of working memory [29–31]. In the version of this paradigm used in Vandenbroucke *et al*. [32], subjects view a *memory* display of oriented rectangles for 250 ms followed by a blank interval. In 'iconic' and 'sensory memory' conditions, this is followed by a 500 ms *retrocue* highlighting the location of one of the rectangles after either 50 ms (iconic condition) or 1000 ms (sensory condition). After another 500 ms, a *test* display is then presented in which the cued rectangle differs in orientation on half of trials. Subjects then indicate whether a change has occurred. In the 'working memory' condition, the test display is shown 900 ms after memory display offset, followed 100 ms later, by a 500 ms *postcue*. The test display then remains visible until the subject has made their change judgement. The headline finding is that capacity (reported as number of items stored) is substantially greater in iconic and sensory when compared with working memory conditions.

This work is controversial. Critics have questioned the postulation of a distinct, high-capacity fragile memory store, either disputing the capacity claim [33] or arguing that the retrocueing effect can be understood in terms of interference and cue-driven stabilization effects *within* a single store [34,35] (see further discussion of these results in the light of more recent models of working memory in [12]). However, let us set these issues aside and focus on the relation between the fragile representations postulated by the Amsterdam Group and conscious experience. The Amsterdam Group's view [11,30,36] and Block's [1,8] who follows them is that such fragile representations are conscious despite not entering (or being stabilized within) working memory. They thus contradict the access hypothesis.

Our recipe above provides a response on behalf of proponents of the access hypothesis. First, accept the existence of fragile representations as required to explain the retrocueing effect. Second, deny that all such representations correspond to elements in conscious experience. Of particular interest are the representations of items that are retrocued but were not spontaneously attended when the memory display was first shown. Cohen & Dennett [6, p. 362] claim that such representations 'are stored unconsciously until the cue brings them to the focus of attention', at which point they become conscious. Phillips [25, p. 406] suggests that such representations may never reach consciousness. Instead, he suggests that, when cued, they may lead the corresponding test display rectangle to be experienced as '(un)familiar' or '(un)changed' (despite the earlier rectangle never having been consciously experienced). In the case where the rectangle has not changed orientation, experienced familiarity may reflect perceptual fluency due to prior exposure to a matching stimulus in the relevant location (cf. [37–39], and esp. [40]). Conversely, where the rectangle has changed, a lack of fluency or perceptual 'hesitancy' due to mismatch may be experienced as unfamiliarity.

Both these stories are consistent with the access hypothesis. Phillips' story avoids the concern that it is 'implausible that unconsciously perceived stimuli can evoke conscious memories' [41, p. 223]. However, it faces its own objection, namely that subjects in a variant of the change detection task using pictures of familiar objects are significantly above chance at identifying the pre-change item from a set of four options when they successfully detect a change [31]. However, this can again be explained in terms of fluency: subjects' previous unconscious exposure to one of the four options causes it to be experienced as more familiar than the other three items.

More recent studies from the Amsterdam Group purport to provide evidence of the association of fragile memory and consciousness (and so against the access hypothesis) on the grounds that metacognition is insignificantly different between fragile and working memory representations. In particular, Vandenbroucke *et al*. [32] (also [41]) extended the basic Amsterdam Group paradigm by asking subjects to indicate their confidence in their change detection judgement. Consistent with previous results, Vandenbroucke *et al*. found that memory capacity decreased from around 10 items in the fragile condition to just under six in the working memory condition. Factoring in a further experiment, and exploiting a measure of metacognition—meta-*d*′-balance [42], intended to avoid the influence of varying response bias—the authors report broadly similar metacognition in both conditions. Vandenbroucke *et al*. [32] conclude that 'the higher capacity of fragile memory is not based on implicit, unconscious information' and thus that 'sensory memory items are a meaningful part of visual experience' (pp. 868, 870).

This interpretation assumes that if metacognitive performance concerning fragile memory is equal to that of working memory, then the information in fragile memory is conscious information. Against this, one might doubt that all working memory representations are conscious [43,44]. One might also question the association between metacognition and consciousness [45–48].

A more basic objection faces the interpretation, however. Metacognition was only measured for judgements concerning cued representations. These representations have, according to Vandenbroucke *et al*. [32], been 'made robust and available for report and for cognitive manipulations' (p. 861). To conclude from this that there is accurate metacognition for *all* items in fragile memory requires generalizing from this cued representation. Yet, strictly all that can be inferred is that 'information required to support high metacognition on the entire capacity . . . must have been present up to the point of cue presentation' [32, p. 870]. This does not entail that subjects actually have metacognitive access to the entire capacity. Information required to detect changes in most of the rectangles must have been present up to the point of the cue. Yet, plainly it does not follow from this that subjects are able to detect changes in most of the rectangles independent of the cue. Without a cue (and the attentional processing attendant on it), they mostly cannot. By the same token, we cannot assume metacognition in the absence of a cue and its attendant processing. The access hypothesis is thus unscathed by Vandenbroucke *et al*.'s data. Again, we see the yawning gap between an informational story offered in explanation of certain task-performance data, and a corresponding phenomenological story. This gap precisely reflects the methodological puzzle at the heart of our discussion.

4. The methodological puzzle is a two-way sword

This section offers two examples to illustrate that the methodological puzzle applies equally to evidence that allegedly favours the access hypothesis.

(a) Sergent *et al*. [49]

In previous work [24,25], I suggested that Sperling's partial-report paradigm fails to provide compelling evidence against the access hypothesis because it is equally subject to a 'postdictive' interpretation on which subjects' experiences are not determined independently of the postcue. In an elegant subsequent study, Sergent *et al*. [49] purport to provide clear evidence of this type of effect. Using postcues at delays of up to 400 ms, they argue that 'postcued attention can retrospectively trigger the conscious perception of a stimulus that would otherwise have escaped consciousness' (p. 150). However, the response recipe offered above can be used to supply an informationally equivalent but phenomenologically quite distinct interpretation of the postcueing effect found by Sergent *et al*. On this alternative interpretation, the postcue does not trigger conscious perception but improves attention-based retention and subsequent access to already conscious experience. This interpretation (effectively the traditional interpretation of cueing in Sperling's paradigm) is consistent with theories according to which recurrent local interactions are sufficient for consciousness, and hence with access-free phenomenology.

Sergent *et al*. [49] claim their 'data . . . favour a perceptual interpretation', reasoning as follows: 'Postcueing's major effect was to reduce the number of trials where participants claimed they did not see any target at all . . . if postcueing only improved memory of an already conscious percept, one would expect participants to shift their ratings from low, but still above 0%, visibilities towards higher visibilities, but not to change their claim of having seen the target at all' (pp. 152–153). However, there is no reason why the overflow theorist should predict shifts of the kind Sergent *et al*. suggest. Overflow theorists can perfectly well hold that all-or-nothing encoding is a requirement for *reporting* visibility. This is evident if we think in terms of the response recipe provided above. Following this, the overflow theorist can simply adopt Sergent *et al*.'s own informational story concerning which representations are encoded for explicit report, disputing only the further claim that these are the only representations corresponding to conscious awareness.

(b) Ward *et al*. [50]

Bronfman *et al*. [51], exploiting a modified Sperling paradigm using coloured letters, find that subjects can judge the colour-diversity of letters in uncued rows significantly above chance and, apparently, without cost to letter recall. They argue that this ability requires the conscious representation of the individual colours that ground the diversity judgement, and so constitutes novel evidence of overflow (see also [52]). Disputing this claim, both I [19] and Ward *et al*. [50] argue—in line with the recipe above—that even if the diversity judgement requires the representation of the individual colours, there is no reason (either in Bronfman's primary or supplementary data) to assume that such representations are conscious. Instead, it may simply be summary statistic representations (e.g. of 'diversely coloured letters' in uncued rows) that correspond to consciousness.

Ward *et al*. go further, however, offering experimental evidence positively in favour of a 'no overflow' interpretation of Bronfman *et al*.'s data. First, subjects were offered a more nuanced colour awareness scale allowing them to report: (i) no sense of colour; (ii) a vague sense of colour, but not of individual letters' colours; (iii) a clear sense of colour but not of individual letters' colours; and finally (iv) a clear sense of individual letters' colours. Ward *et al*. found that most subjects claimed to perceive 'color only in a general sense, without perceiving individual letters' colors' (i.e. chose options (ii) or (iii); p. 83). Moreover, subjects' diversity estimation was above chance just when they chose options (ii)–(iv) and did not appear any more accurate when subjects chose option (iv) as opposed to (ii). Second, Ward *et al*. developed a clever change blindness paradigm in which the colours of letters in uncued rows were reshuffled on half of trials, preserving their diversity. Subjects completely failed to notice such changes despite being equally good at estimating diversity. Understandably, Ward *et al*. conclude that these 'results are consistent with accounts of sparse visual awareness' (p. 83).

The problem with both pieces of evidence, however, is that both sides *agree* that information about individual colours is not encoded in explicit/working memory. Yet, this informational claim suffices to explain why subjects will not report seeing individual colours but only colour-diversity because only the latter is encoded in explicit memory. The informational claim also suffices to explain change blindness. Change blindness (or better: difference ignorance, cf. [53]) is predicted because information about individual pre-change colours cannot be compared with information about post-change colours if it is not explicitly encoded. Change blindness is also predicted on the interpretation of change detection in retrocue paradigms mooted in Phillips [25, p. 406], where the memory display item(s) is/are not encoded in explicit memory. For there too change detection depends on cue-driven attentional processing of the pre-change item(s).

It is important to recognize that this is not ad hoc theorizing designed to insulate phenomenal overflow from counter-evidence. Bronfman *et al*. [51] themselves hypothesize that information about individual colours is not transferred 'to a durable working memory store' and so 'not encoded for later report' (p. 1395). As a result, they ought to predict the very same data that Ward *et al*. find. And, indeed, Bronfman *et al*. make essentially this point in reply to [28]. The fact that the data cannot decide between two quite different theories here simply underscores the methodological problem at the heart of this paper—a problem that cuts both ways.

5. No-report paradigms

A number of authors have expressed optimism that so-called 'no-report' paradigms, which attempt to investigate awareness in the absence of explicit reports, will uncover the true neural basis of consciousness, and so resolve the methodological puzzle. Tsuchiya *et al*. [54], for example, emphasize no-report data in making their case that the 'activation and structural integrity of the frontal areas seems to be neither necessary nor sufficient for conscious perception' (p. 762) (see further: [55] and N. Block, *The border between seeing and thinking*, unpublished book manuscript). On the widely held assumption that cognitive access is subserved by frontal areas, this amounts to the rejection of the access hypothesis.[2]

In an ingenious and exemplary no-report paradigm, Frässle *et al*. [61] use two objective measures of perceptual alteration in binocular rivalry (*viz*. optokinetic nystagmus and pupil size) to assess the neural correlates of rivalry both with and without active report. Simplifying for argument's sake, they find that differential neural activity in frontal areas is present only in their active report condition. In their passive condition, differential activation is limited to occipital and parietal areas.[3] Do such findings evidence that phenomenal consciousness is independent of cognitive access? I now argue that such a reaction would be precipitate (cf. [67]).

Frässle *et al.* [61], in keeping with the vast majority of recent work on rivalry, are 'concerned with the search for neural processes that bring about the spontaneous perceptual alternations that characterize multistable perception' ([68], p. 81, my emphasis). Their question is whether frontal activations cause perceptual alterations, or instead whether such alterations originate with earlier processes. This explains why the large majority of studies employ a 'replay' condition in which unambiguous physical stimuli mimic perceptual alterations in the absence of rivalry processes (e.g. [61,62] and review in [68], pp. 86–88). In analysing the relevant data, replay activation is subtracted from rivalry activation before comparing activation in active and passive conditions. Differential activation in an area then evinces its causal role in eliciting a transition.

Our question is not this causal question, however. It is whether cognition is *constitutively* involved in consciousness, and so (granting their association) whether frontal areas form part of the constitutive basis of consciousness. The methodology of subtracting replay activity, however, means that results like Frässle *et al.*'s [61] are silent on this question. For suppose frontal areas do not cause rivalry transitions, and that disambiguation occurs earlier in the perceptual hierarchy. (For evidence that this is at least sometimes the case, see [69].) On this supposition, activity later in the perceptual hierarchy may well be identical in (properly matched) replay and rivalry conditions. Consequently, subtraction analysis will not reveal any differential activity. For all that, frontal activity may be a necessary condition for conscious perception.

In fact, there are two possibilities to consider. First, distinguish between *core* and *total* neural correlates of a given conscious state (NCCs) [70]. A total NCC is the physical state unconditionally sufficient for being in a given conscious state. A core NCC is the part of this total realizer responsible for the state being the specific conscious state it is—crudely, its content. As just argued, results like Frässle *et al.*'s are quite consistent with frontal areas forming part of the *core* NCC [71]. This is because they are quite consistent with content-specific activation in frontal areas being necessary for awareness. However, even if frontal areas exhibit no content-specific frontal activity at all once activity attributable to executive upshots of awareness is factored out, frontal areas may still form part of the *total* NCC. This is because non-differential frontal activity may be a necessary condition of any non-frontal core NCC constituting a total NCC (cf. [72, p. 164] and also [9, p. 15] citing [73]). That even such an extreme finding is consistent with the access hypothesis highlights the limits of rivalry-based paradigms in overcoming the methodological puzzle (see also [74,75]).

6. Approaching phenomenal consciousness as a natural kind

Block [1] claims that, armed with a sufficiently wide range of psychological and neuroscientific evidence, inference to the best explanation will overcome the methodological puzzle. Explicitly building on this idea, Shea presents a 'systematic framework' for investigating the access hypothesis. The core idea of this framework is to study 'phenomenal consciousness as a natural kind', thereby allowing us to 'move beyond initial means of identifying instances ... like verbal report ... [and] find its underlying nature' [3, p. 307].

Shea's precise proposal can be summarized as follows. Our inquiry begins with defeasible evidence, E (e.g. verbal report, intentional action), for the attribution of consciousness. Based on E, we generate a large sample of putative cases of consciousness. We then examine that sample, looking for distinctive neural and functional signatures or tests (T_i). Shea mentions a number of possible examples including: insensitivity to the automatic stem completion effect [76], trace conditioning [77] and gamma-band neural synchrony [78]. Finally, we exploit causal modelling techniques to search for nomological clusters among these signatures. A set of properties form a cluster just if '(i) they are instantiated together better than chance (given background theory); and (ii) observing subsets of the cluster supports induction to other elements of the cluster' [3, p. 326].

How is this procedure intended to overcome the methodological puzzle? The thought is that if we treat consciousness as a natural property then, insofar as it is not always co-instantiated with cognitive access, it will have distinctive consequences that causal modelling will uncover. In this light, Shea [3] suggests that discovering only one cluster would be 'good evidence' (p. 330) in favour of the access hypothesis, whereas the discovery of two clusters would be 'some evidence' (p. 309) against it. In this latter case, our procedure will have arrived at a test (or battery of tests, T_{i-j}) that provides a better indicator of the presence of consciousness than our initial evidence E. This test will be capable of evidencing consciousness in the absence of access, thereby overcoming the methodological puzzle.

Shea's paper is ambitious and important. It deserves serious study. Here, however, I raise a series of critical issues which cast doubt on the contention that a science of consciousness that proceeds according to his framework will eventually solve the methodological puzzle.

First, Shea's proposal supposes that, at the outset of inquiry, we have evidence sufficient to provide us with samples that everyone will agree are, respectively, mostly conscious and mostly not conscious. It is undoubtedly true that some measures such as explicit verbal report of awareness do provide fairly uncontroversial positive evidence of consciousness. However, such superficial consensus masks the fact that even very early on in our inquiry we face profound and longstanding controversies concerning how to measure consciousness. Furthermore, it is not unreasonable to think that our initial choice of evidence will make a dramatic difference to our initial sample—a difference dramatic enough to change the number of clusters eventually found by our causal modelling. For example, consider Marcel's claim that: 'There is really only one criterion for phenomenal experience. This is a person's report ... that they are or were conscious in one or another way...' [79, p. 131] (see also [80, p. 76] and [81, p. 1396]). Contrast this view with the 'conventional' criterion for awareness adopted by many psychophysicists, namely above chance performance in a discrimination task as measured by a bias-free statistic such as d' [82–85]. Both 'subjective' and 'objective' approaches

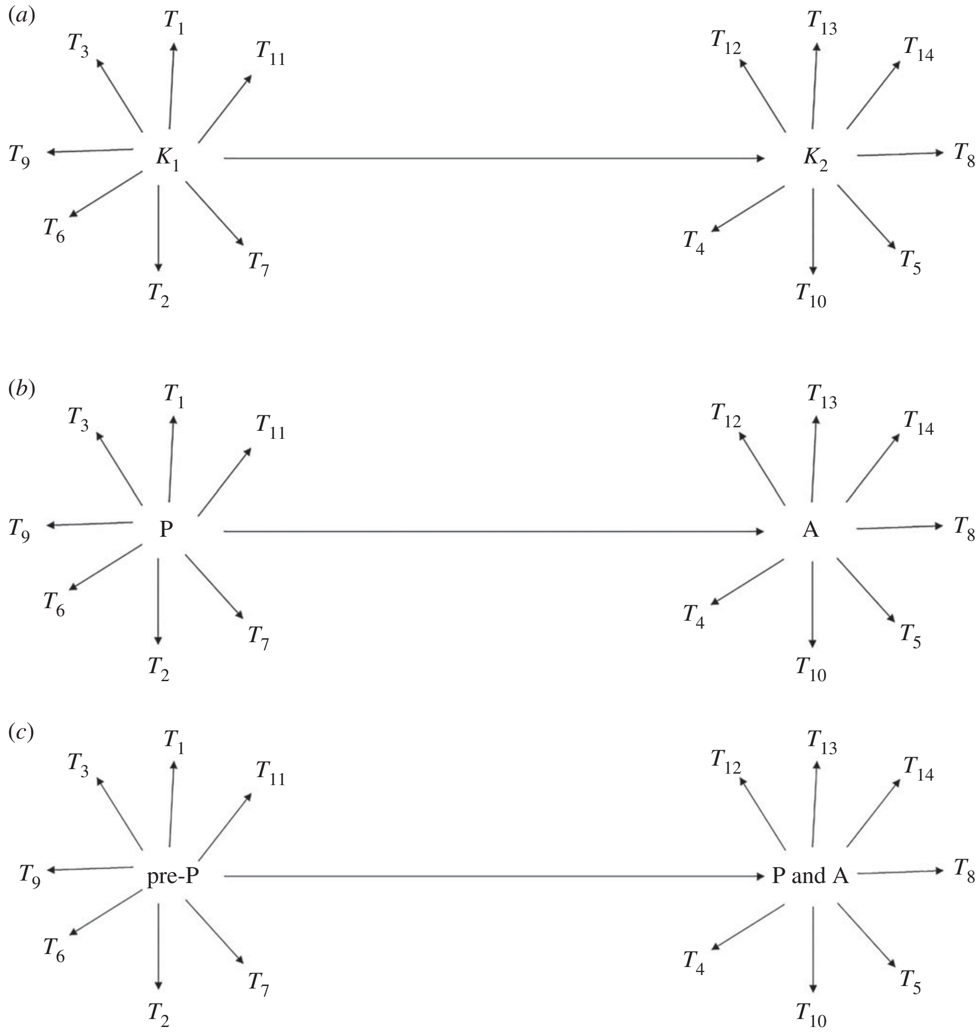

Figure 1. (*a*) Hypothetical situation in which causal modelling uncovers two kinds underlying our range of putative tests for phenomenal consciousness (P); (*b*) the identification of K_1 with phenomenal consciousness, and K_2 with cognitive access (A); (*c*) the identification of K_1 with pre-consciousness and K_2 with both phenomenal consciousness and cognitive access. Based on figures from [3, p. 333].

have been claimed to be traditional starting points for a science of consciousness. Moreover, quite plausibly, which approach one adopts will dramatically alter the course of one's future investigation. For example, many of the tests that Shea mentions as possible differential markers of phenomenal consciousness will count as such on a 'subjective' approach but not on an 'objective' approach (see, for example, [86] on insensitivity to the automatic stem completion effect, and [87] on trace conditioning). Given this, it is unclear whether all parties can even agree how to take the first step within Shea's framework.

Second, a key background assumption of Shea's approach is that cognitive access corresponds to 'an information-processing mechanism ... for making information directly available for use in directing a wide range of potential behaviours' [3, pp. 312–313]. Shea takes the postulation of such a mechanism to be 'plausible' (p. 314), associating it with Dehaene and Naccache's global neuronal workspace. However, he suggests: 'The simplest way in which it could turn out that there is phenomenality without access ... is if we discover that there is no [such] information processing property' (p. 314). We should undoubtedly be live to the possibility that there is no unified mechanism that underlies cognitive access. Dennett [88, p. 221] talks of the global availability of information as 'fame in the brain'. Since plainly societal fame is not the product of any single, unified mechanism, why not also neural fame? However, if we are rightly open to this possibility, then we must also be open to the possibility that no unified mechanism underlies phenomenal consciousness. And once this is appreciated, it becomes clear that a failure to discover a mechanism of access would not falsify the access hypothesis. An alternative possibility is simply that *neither* consciousness nor access have a corresponding unified, subpersonal mechanism. Furthermore, once we acknowledge the possibility that phenomenal consciousness might fail to correspond to a single, unified subpersonal mechanism, we must acknowledge that discovery of only a single kind associated with access fails to support the access hypothesis. For that discovery is quite consistent with access corresponding to a single, unified mechanism but not phenomenal consciousness.

Finally, and most importantly, suppose that we do in fact discover two closely connected clusters or kinds. Call these K_1 and K_2 (figure 1*a*).

In this scenario, Shea suggests that we would have 'reason' [3, p. 337] to suppose K_2 = cognitive access and K_1 = phenomenal consciousness (figure 1*b*). This would contradict the access hypothesis because the merely causal connection between kinds could in principle be broken, leading to the instantiation of consciousness (K_1) in the absence of access (K_2).

However, recall that current workspace models postulate a distinction between information that is 'in contact with the workspace and could be consciously amplified if it was attended to (set I_2)' and information that is actually 'mobilized into the workspace (set I_3)'. Further, recall that current disputes about the access hypothesis are effectively debates about whether to associate consciousness with I_2 or I_3. Thus, Block [1] claims that I_2 representations are plausibly phenomenally conscious, whereas Dehaene and co-workers [9,10] suggest that these are merely pre-conscious (supporting an illusion of rich experience) with only I_3 representations strictly being conscious. In this light, the concern naturally arises as to why we should not think that K_1 (like I_2) = pre-consciousness, and K_2 = *both* phenomenal consciousness and cognitive access (figure 1*c*).

The point is not that being in contact with, and being mobilized into the workspace should be treated as legitimate kind properties. (Although Shea assumes that the latter is an information-based kind for the purposes of his argument, his central point is that debates about the access hypothesis have hitherto failed to proceed in a natural kind-based way, so it can hardly be assumed that we already know which kinds there are.) The point is rather that because defenders of the access hypothesis already recognize a category of pre-conscious representations, a very natural interpretation of the discovery of two clusters is open to them. On this interpretation, the first kind is identified with pre-consciousness, and the second with both access and phenomenal consciousness. Given this, it is difficult to see how the discovery of two clusters would provide significant evidence against the access hypothesis.

Shea defends his identification of K_1 with phenomenal consciousness as follows: 'Our concept (of phenomenal consciousness) refers to whatever property underpins the successful inductions in which it is deployed' [3, p. 335]. K_1 'underpins some of those inductions' (p. 335). Moreover, some of the clustering between our evidential tests, T_i, for K_1 and K_2 'depends on direct causal connections of some of [these tests] to [K_1]' (p. 335). It follows, Shea claims, that our concept of phenomenal consciousness refers to K_1. The problem, however, is that exactly parallel reasoning can be given for treating K_2 as the referent of our concept of phenomenal consciousness. K_2 underpins some of the successful inductions in which the concept of consciousness is deployed, and some of the clustering between evidential tests depends on direct causal connections to K_2.

In short, if we find two clusters, these will both be directly connected to some of our putative signatures for consciousness, and jointly responsible for the normal clustering of these signatures. As a result, the proposal that our concept of phenomenal consciousness refers to whatever property underpins these successful inductions simply leaves us torn. This closely mirrors contemporary debates concerning the access hypothesis where theorists such as Dehaene, Block and Lamme broadly agree on the existence of two categories of representation but dispute whether the first category is phenomenal consciousness or merely pre-consciousness.

7. Conclusion

We have now reviewed both empirical and theoretical attempts to overcome the methodological puzzle facing the study of phenomenal consciousness. All have been found wanting. No argument has been given that the access hypothesis is beyond the reach of empirical investigation. Nonetheless, given our present data and methods, not only do we not know whether consciousness requires cognition, we do not know how to find out. Until that changes, we must adopt an attitude of humility towards the phenomenal.

Data accessibility. This article has no additional data.

Competing interests. I declare I have no competing interests.

Funding. I received no funding for this study.

Acknowledgements. Thanks to Morten Overgaard and Peter Fazekas for organizing a splendid workshop in Aarhus at which an early version of some of this material was presented, and to the other participants for lively discussion. Thanks also to Nick Shea, Steven Gross and an anonymous referee for very helpful written comments. Thanks finally to Ned Block and participants in our joint seminar at NYU for helpful feedback on various aspects of this material.

Endnotes

[1]'At best' because it is equally unclear how the contrary hypothesis that consciousness requires access (or function) can be empirically confirmed or falsified. Thus, absent *a priori* strictures, we would seem to face an instance of underdetermination of theory by empirical data (cf. [7]) to which humility, not partisanship, would seem the rational response.

[2]Though granted here, the assumption that frontal activity is essential for cognitive access is far from beyond question. Even on a global workspace picture, Dehaene & Naccache [9] 'see no need to postulate that any single brain area is systematically activated in all conscious states' (p. 14), and later emphasize the contributions of neurons in inferior parietal cortex (p. 26). Moreover, recent evidence suggests that simple working memory tasks may be performed without any frontal activation (see [56], cited and discussed in [57]). Greater clarity about cognitive access and its neural basis is of critical relevance in assessing the significance of the so-called visual awareness negativity (VAN) sometimes claimed to be an index of awareness independent of global broadcasting [58–60].

[3]Strictly, while Frässle *et al.* [61] found no significant differential activation in the dorsolateral prefrontal cortex, significant activations were found in other frontal regions, including frontal eye fields and inferior frontal gyrus. This is consistent with other work suggesting differential, report-independent frontal activity in rivalry [62–65]. However, such activity might reasonably be argued to reflect residual executive consequences of shifts in awareness (e.g. attentional reorienting) that passive viewing fails to eliminate. This view is supported by Brascamp *et al.*'s inspired 'inconspicuous' rivalry paradigm in which displays of statistically and chromatically identical quasi-randomly moving dots were used to induce unnoticeable perceptual shifts, thereby minimizing executive consequences of transitions [66]. In this paradigm, no differential (switch-related) frontoparietal activity was found. Controversy remains since Brascamp *et al.*'s univariate voxel-wise analysis of the imaging data cannot be relied on to guarantee an absence of differential activity (see also [55, p. 10884]).

References

1. Block N. 2007 Consciousness, accessibility and the mesh between psychology and neuroscience. *Behav. Brain Sci.* **30**, 481–548. (doi:10.1017/S0140525X07002786)
2. Block N. 2008 Consciousness and cognitive access. *Proc. Aristotelian Soc.* **108**, 289–317. (doi:10.1111/j.1467-9264.2008.00247.x)
3. Shea N. 2012 Methodological encounters with the phenomenal kind. *Philos. Phenomenol. Res.* **84**, 307–344. (doi:10.1111/j.1933-1592.2010.00483.x)

4. Carruthers P. 2017 Block's overflow argument. *Pacific Philos. Q.* **98**, 65–70. (doi:10.1111/papq.12152)
5. Gross S. 2018 Perceptual consciousness and cognitive access from the perspective of capacity-unlimited working memory. *Phil. Trans. R. Soc. B* **373**, 20170343. (doi:10.1098/rstb.2017.0343)
6. Cohen M, Dennett D. 2011 Consciousness cannot be separated from function. *Trends Cogn. Sci.* **15**, 358–364. (doi:10.1016/j.tics.2011.06.008)
7. Overgaard M, Grünbaum T. 2012 Cognitive and non-cognitive conceptions of consciousness. *Trends Cogn. Sci.* **16**, 137. (doi:10.1016/j.tics.2011.12.006)
8. Block N. 2011 Perceptual consciousness overflows cognitive access. *Trends Cogn. Sci.* **15**, 567–575. (doi:10.1016/j.tics.2011.11.001)
9. Dehaene S, Naccache L. 2001 Towards a cognitive neuroscience of consciousness: basic evidence and a workspace framework. *Cognition* **79**, 1–37. (doi:10.1016/S0010-0277(00)00123-2)
10. Dehaene S, Changeux J-P, Naccache L, Sackur J, Sergent C. 2006 Conscious, preconscious, and subliminal processing: a testable taxonomy. *Trends Cogn. Sci.* **10**, 204–211. (doi:10.1016/j.tics.2006.03.007)
11. Lamme VAF. 2010 How neuroscience will change our view on consciousness. *Cogn. Neurosci.* **1**, 204–220. (doi:10.1080/17588921003731586)
12. Gross S, Flombaum J. 2017 Does perceptual consciousness overflow cognitive access? The challenge from probabilistic, hierarchical processes. *Mind Lang.* **32**, 358–391. (doi:10.1111/mila.12144)
13. Bays PM, Husain M. 2008 Dynamic shifts of limited working memory resources in human vision. *Science* **321**, 851–854. (doi:10.1126/science.1158023)
14. Ma WJ, Husain M, Bays PM. 2014 Changing concepts of working memory. *Nat. Neurosci.* **17**, 347–356. (doi:10.1038/nn.3655)
15. Oberauer K, Lin H-Y. 2017 An interference model of visual working memory. *Psychol. Rev.* **124**, 21–59. (doi:10.1037/rev0000044)
16. Haun AM, Tononi G, Koch C, Tsuchiya N. 2017 Are we underestimating the richness of visual experience? *Neurosci. Conscious.* **3**, 1–4. (doi:10.1093/nc/niw023)
17. Phillips IB. 2018. Commentary on Haun et al. (2017): Are we underestimating the richness of visual experience? In *Neurosci. Conscious. The Brains Blog*, 13 April 2018. (http://philosophyofbrains.com/2018/04/13/symposium-on-haun-tononi-koch-and-tsuchiya-are-we-underestimating-the-richness-of-visual-experience.aspx)
18. Sperling G. 1960 The information available in brief visual presentations. *Psychol. Monogr.* **74**, 1–29. (doi:10.1037/h0093759)
19. Phillips IB. 2016 No watershed for overflow: recent work on the richness of consciousness. *Philos. Psychol.* **29**, 236–249. (doi:10.1080/09515089.2015.1079604)
20. Dretske FI. 1981 *Knowledge and the flow of information*. Cambridge, MA: MIT Press.
21. Baars B. 1988 *A cognitive theory of consciousness*. Cambridge, UK: Cambridge University Press.
22. Block N. 1995 On a confusion about a function of consciousness. *Behav. Brain Sci.* **18**, 227–287. (doi:10.1017/S0140525X00038188)
23. Tye M. 2006 Content, richness, and fineness of grain. In *Perceptual experience* (eds TS Gendler, J Hawthorne), pp. 504–530. Oxford, UK: Oxford University Press.
24. Phillips IB. 2011 Attention and iconic memory. In *Attention: philosophical and psychological essays* (eds C Mole, D Smithies, W Wu), pp. 204–227. Oxford, UK: Oxford University Press.
25. Phillips IB. 2011 Perception and iconic memory. *Mind Lang.* **26**, 381–411. (doi:10.1111/j.1468-0017.2011.01422.x)
26. Stazicker J. 2011 Attention, visual consciousness and indeterminacy. *Mind Lang.* **26**, 156–184. (doi:10.1111/j.1468-0017.2011.01414.x)
27. De Gardelle V, Sackur J, Kouider S. 2009 Perceptual illusions in brief visual presentations. *Conscious. Cogn.* **18**, 569–577. (doi:10.1016/j.concog.2009.03.002)
28. Kouider S, de Gardelle V, Sackur J, Dupoux E. 2010 How rich is consciousness? The partial awareness hypothesis. *Trends Cogn. Sci.* **14**, 301–307. (doi:10.1016/j.tics.2010.04.006)
29. Landman R, Spekreijse H, Lamme VAF. 2003 Large capacity storage of integrated objects before change blindness. *Vision Res.* **43**, 149–164. (doi:10.1016/S0042-6989(02)00402-9)
30. Sligte IG, Scholte HS, Lamme VAF. 2008 Are there multiple visual short-term memory stores? *PLoS ONE* **3**, e1699. (doi:10.1371/journal.pone.0001699)
31. Sligte IG, Vandenbroucke ARE, Scholte HS, Lamme VAF. 2010 Detailed sensory memory, sloppy working memory. *Front. Psychol.* **1**, 1–10. (doi:10.3389/fpsyg.2010.00175)
32. Vandenbroucke AR, Sligte IG, Barrett AB, Seth AK, Fahrenfort JJ, Lamme VA. 2014 Accurate metacognition for visual sensory memory representations. *Psychol. Sci.* **25**, 861–873. (doi:10.1177/0956797613516146)
33. Matsukura M, Hollingworth A. 2011 Does visual short-term memory have a high-capacity stage? *Psychon. Bull. Rev.* **18**, 1098–1104. (doi:10.3758/s13423-011-0153-2)
34. Makovski T. 2012 Are multiple visual short-term memory storages necessary to explain the retro-cue effect? *Psychon. Bull. Rev.* **19**, 470–476. (doi:10.3758/s13423-012-0235-9)
35. Griffin IC, Nobre K. 2003 Orienting attention to locations in internal representations. *J. Cogn. Neurosci.* **15**, 1176–1194. (doi:10.1162/089892903322598139)
36. Lamme VAF. 2006 Towards a true neural stance on consciousness. *Trends Cogn. Sci.* **10**, 494–501. (doi:10.1016/j.tics.2006.09.001)
37. Mandler G. 1980 Recognizing: the judgment of previous occurrence. *Psychol. Rev.* **87**, 252–271. (doi:10.1037/0033-295X.87.3.252)
38. Jacoby LL, Dallas M. 1981 On the relationship between autobiographical memory and perceptual learning. *J. Exp. Psychol. Gen.* **110**, 306–340. (doi:10.1037/0096-3445.110.3.306)
39. Whittlesea BWA. 1993 Illusions of familiarity. *J. Exp. Psychol. Learn. Mem. Cogn.* **19**, 1235–1253. (doi:10.1037/0278-7393.19.6.1235)
40. Jacoby LL, Whitehouse K. 1989 An illusion of memory: false recognition influenced by unconscious perception. *J. Exp. Psychol. Gen.* **118**, 126–135. (doi:10.1037/0096-3445.118.2.126)
41. Pinto Y, Vandenbroucke AR, Otten M, Sligte IG, Seth AK, Lamme VAF. 2017 Conscious visual memory with minimal attention. *J. Exp. Psychol. Gen.* **146**, 214–226. (doi:10.1037/xge0000255)
42. Barrett AB, Dienes Z, Seth AK. 2013 Measures of metacognition on signal-detection theoretic models. *Psychol. Methods* **18**, 535–552. (doi:10.1037/a0033268)
43. Soto D, Mäntylä T, Silvanto J. 2011 Working memory without consciousness. *Curr. Biol.* **21**, R912–R913. (doi:10.1016/j.cub.2011.09.049)
44. King J-R, Pescetelli N, Dehaene S. 2016 Brain mechanisms underlying the brief maintenance of seen and unseen sensory information. *Neuron* **92**, 1122–1134. (doi:10.1016/j.neuron.2016.10.051)
45. Reder LM, Schunn CD. 1996 Metacognition does not imply awareness: strategy choice is governed by implicit learning and memory. In *Implicit memory and metacognition* (ed. LM Reder), pp. 45–77. Mahwah, NJ: L. Erlbaum.
46. Maniscalco B, Lau H. 2012 A signal detection theoretic approach for estimating metacognitive sensitivity from confidence ratings. *Conscious. Cogn.* **21**, 422–430. (doi:10.1016/j.concog.2011.09.021)
47. Scott RB, Dienes Z, Barrett AB, Bor D, Seth AK. 2014 Blind insight: metacognitive discrimination despite chance task performance. *Psychol. Sci.* **25**, 2199–2208. (doi:10.1177/0956797614553944)
48. Jachs B, Blanco MJ, Grantham-Hill S, Soto D. 2015 On the independence of visual awareness and metacognition: a signal detection theoretic analysis. *J. Exp. Psychol. Hum. Percept. Perform.* **41**, 269–276. (doi:10.1037/xhp0000026)
49. Sergent C, Wyart V, Babo-Rebelo M, Cohen L, Naccache L, Tallon-Baudry C. 2013 Cueing attention after the stimulus is gone can retrospectively trigger conscious perception. *Curr. Biol.* **23**, 150–155. (doi:10.1016/j.cub.2012.11.047)
50. Ward EJ, Bear A, Scholl BJ. 2016 Can you perceive ensembles without perceiving individuals? The role of statistical perception in determining whether awareness overflows access. *Cognition* **152**, 78–86. (doi:10.1016/j.cognition.2016.01.010)
51. Bronfman Z, Brezis N, Jacobson H, Usher M. 2014 We see more than we can report: 'cost free' color phenomenality outside focal attention. *Psychol. Sci.* **25**, 1394–1403. (doi:10.1177/0956797614532656)
52. Block N. 2014 Rich conscious perception outside focal attention. *Trends Cogn. Sci.* **18**, 445–447. (doi:10.1016/j.tics.2014.05.007)
53. Dretske FI. 2004 Change blindness. *Philos. Stud.* **120**, 1–18. (doi:10.1023/B:PHIL.0000033749.19147.88)
54. Tsuchiya N, Wilke M, Frässle S, Lamme V. 2015 No-report paradigms: extracting the true neural correlates of consciousness. *Trends Cogn. Sci.* **19**, 757–770. (doi:10.1016/j.tics.2015.10.002)

55. Storm JF, Boly M, Casali AG, Massimini M, Olcese U, Pennartz CMA, Wilke M. 2017 Consciousness regained: disentangling mechanisms, brain systems, and behavioral responses. *J. Neurosci.* **37**, 10 882–10 893. (doi:10.1523/JNEUROSCI.1838-17.2017)
56. Fazekas P, Nemeth G. 2018 Dream experiences and the neural correlates of perceptual consciousness and cognitive access. *Phil. Trans. R. Soc. B* **373**, 20170356. (doi:10.1098/rstb.2017.0356)
57. Ivanova MV, Dragoy O, Kuptsova SV, Akinina SY, Petrushevskii AG, Fedina ON, Turken A, Shklovsky VM, Dronkers NF. 2018 Neural mechanisms of two different verbal working memory tasks: a VLSM study. *Neuropsychologia* **115**, 25–41. (doi:10.1016/j.neuropsychologia.2018.03.003)
58. Wilenius-Emet M, Revonsuo A, Ojanen V. 2004 An electrophysiological correlate of human visual awareness. *Neurosci. Lett.* **354**, 38–41. (doi:10.1016/j.neulet.2003.09.060)
59. Koivisto M, Revonsuo A. 2010 Event-related brain potential correlates of visual awareness. *Neurosci. Biobehav. Rev.* **34**, 922–934. (doi:10.1016/j.neubiorev.2009.12.002)
60. Pitts MA, Padwal J, Fennelly D, Martínez A, Hillyard SA. 2014 Gamma band activity and the P3 reflect post-perceptual processes, not visual awareness. *Neuroimage* **101**, 337–350. (doi:10.1016/j.neuroimage.2014.07.024)
61. Frässle S, Sommer J, Jansen A, Naber M, Einhäuser W. 2014 Binocular rivalry: frontal activity relates to introspection and action but not to perception. *J. Neurosci.* **34**, 1738–1747. (doi:10.1523/JNEUROSCI.4403-13.2014)
62. Lumer ED, Friston KJ, Rees G. 1998 Neural correlates of perceptual rivalry in the human brain. *Science* **280**, 1930–1934. (doi:10.1126/science.280.5371.1930)
63. Panagiotaropoulos TI, Deco G, Kapoor V, Logothetis NK. 2012 Neuronal discharges and gamma oscillations explicitly reflect visual consciousness in the lateral prefrontal cortex. *Neuron* **74**, 924–935. (doi:10.1016/j.neuron.2012.04.013)
64. Safavi S, Kapoor V, Logothetis NK, Panagiotaropoulos TI. 2014 Is the frontal lobe involved in conscious perception? *Front. Psychol.* **5**, 1–2. (doi:10.3389/fpsyg.2014.01063)
65. Weilnhammer VA, Ludwig K, Hesselmann G, Sterzer P. 2013 Frontoparietal cortex mediates perceptual transitions in bistable perception. *J. Neurosci.* **33**, 16 009–16 015. (doi:10.1523/JNEUROSCI.1418-13.2013)
66. Brascamp JW, Brascamp J, Blake R, Knapen T. 2015 Negligible fronto-parietal BOLD activity accompanying unreportable switches in bistable perception. *Nat. Neurosci.* **18**, 1672–1678. (doi:10.1038/nn.4130)
67. Overgaard M, Fazekas P. 2016 Can no-report paradigms extract true correlates of consciousness? *Trends Cogn. Sci.* **20**, 241–242. (doi:10.1016/j.tics.2016.01.004)
68. Brascamp J, Sterzer P, Blake R, Knapen T. 2018 Multistable perception and the role of the frontoparietal cortex in perceptual inference. *Annu. Rev. Psychol.* **69**, 77–103. (doi:10.1146/annurev-psych-010417-085944)
69. Zou J, He S, Zhang P. 2016 Binocular rivalry from invisible patterns. *Proc. Natl Acad. Sci. USA* **113**, 8408–8413. (doi:10.1073/pnas.1604816113)
70. Shoemaker S. 1981 Some varieties of functionalism. *Philos. Top.* **12**, 93–119. (doi:10.5840/philtopics198112145)
71. Naber M, Brascamp J. 2015 Commentary: is the frontal lobe involved in conscious perception? *Front. Psychol.* **6**, 1–3. (doi:10.3389/fpsyg.2015.01736)
72. Jack AI, Shallice T. 2001 Introspective physicalism as an approach to the science of consciousness. *Cognition* **79**, 161–196. (doi:10.1016/S0010-0277(00)00128-1)
73. Dennett DC. 1991 *Consciousness explained*. London, UK: Penguin.
74. Blake R, Brascamp J, Heeger DJ. 2014 Can binocular rivalry reveal neural correlates of consciousness? *Phil. Trans. R. Soc. B* **369**, 1–9. (doi:10.1098/rstb.2013.0211)
75. Giles N, Lau H, Odegaard B. 2016 What type of awareness does binocular rivalry assess? *Trends Cogn. Sci.* **20**, 719–720. (doi:10.1016/j.tics.2016.08.010)
76. Debner JA, Jacoby LL. 1994 Unconscious perception: attention, awareness, and control. *J. Exp. Psychol.* **20**, 304–317. (doi:10.1037/0278-7393.20.2.304)
77. Clark RE, Manns JR, Squire LR. 2001 Trace and delay eyeblink conditioning: contrasting phenomena of declarative and nondeclarative memory. *Psychol. Sci.* **12**, 304–308. (doi:10.1111/1467-9280.00356)
78. Crick F, Koch C. 1990 Towards a neurobiological theory of consciousness. *Semin. Neurosci.* **2**, 263–275. (doi:10.1016/B978-0-12-185254-2.50021-8)
79. Marcel AJ. 1988 Phenomenal experience and functionalism. In *Consciousness in contemporary science* (eds AJ Marcel, E Bisiach), pp. 121–158. Oxford, UK: Clarendon Press.
80. Weiskrantz L. 1997 *Consciousness lost and found*. Oxford, UK: Oxford University Press.
81. Naccache L. 2006 Is she conscious? *Science* **313**, 1395–1396. (doi:10.1126/science.1132881)
82. Eriksen CW. 1960 Discrimination and learning without awareness: a methodological survey and evaluation. *Psychol. Rev.* **67**, 279–300. (doi:10.1037/h0041622)
83. Holender D. 1986 Semantic activation without conscious identification in dichotic listening, parafoveal vision, and visual masking: a survey and appraisal. *Behav. Brain Sci.* **9**, 1–66. (doi:10.1017/S0140525X00021269)
84. Snodgrass M, Kalaida N, Winer ES. 2009 Access is mainly a second-order process: SDT models whether phenomenally (first-order) conscious states are accessed by reflectively (second-order) conscious processes. *Conscious. Cogn.* **18**, 561–564. (doi:10.1016/j.concog.2009.01.003)
85. Green DM, Swets JA. 1966 *Signal detection theory and psychophysics*. New York, NY: Wiley.
86. Snodgrass M. 2002 Disambiguating conscious and unconscious influences: do exclusion paradigms demonstrate unconscious perception? *Am. J. Psychol.* **115**, 545–579. (doi:10.2307/1423527)
87. Lovibond PF, Shanks DR. 2002 The role of awareness in Pavlovian conditioning: empirical evidence and theoretical implications. *J. Exp. Psychol. Anim. Behav. Process.* **28**, 3–26. (doi:10.1037/0097-7403.28.1.3)
88. Dennett DC. 2001 Are we explaining consciousness yet? *Cognition* **79**, 221–237. (doi:10.1016/S0010-0277(00)00130-X)