Operationalizing Consciousness: Subjective Report and Task Performance[1,2]

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Abstract

There are two distinct but related threads in this paper. The first is methodological and is aimed at exploring the relative merits and faults of different operational definitions of consciousness. The second is conceptual and is aimed at understanding the prior commitments regarding the nature of conscious content that motivate these positions. I consider two distinct operationalizations: one defines consciousness in terms of *dichotomous* subjective reports, the other in terms of *graded* subjective reports. I ultimately argue that both approaches are inadequate, and that a third alternative that involves integration of subjective report and task performance should be adopted

1. Subjective Report, Binarity, and Specificity of Content

1.1 Dissociations between Task Performance and Subjective Report

The determination of a suitable operational definition for consciousness is of paramount importance to the project of unearthing neural correlates of consciousness (NCCs). That project involves correlating patterns of neural activity with particular contents of consciousness.[3] So some behavioral measure for determining those contents of consciousness is essential. There are two obvious candidates: a) successful performance on some task that involves discrimination of that content; or b) subjective report of an experience of that content.

For more than a century, psychophysicists have been studying circumstances in which these two measures seem to come apart—specifically circumstances in which subjects respond differentially to stimuli in spite of an inability to indicate those differences verbally. Broadly, this is the study of 'subliminal' perception. In its basic form, this research provides evidence for dissociation between task performance and subjective report in cases in which perceptual systems are taxed in some way. For instance, in one of the first studies on the subject, Sidis (1898) presented subjects with visual stimuli—a simple letter or number printed on a card—at such distances that subjects complained that they could not make out what was on the card. Sidis then

[3] Chalmers (2000) distinguishes between three types of neural correlates for consciousness: *creature NCC* – the neural correlates that broadly distinguish conscious from non-conscious states; *state NCC* – the neural correlates that distinguish between background states of consciousness, e.g. an attentive state vs. a meditative state; and lastly *content NCC* – the neural representations the contents of which correlate with particular contents of experience. I take the majority of the NCC literature to be directed at content NCCs, and so my discussion is focused on that conception.

introduced a second task—a forced-choice recognition task—in which subjects were forced to guess what was on the card (i.e. either 'letter' or 'number'). On this task, subjects demonstrated better than chance performance, in spite of their insistence that they could not see what was on the card. The conclusion Sidis drew from these results was that subjects were not conscious of the stimuli presented in spite of their abilities to differentially respond to them through the behavioral task.

There are pathological cases that demonstrate similar results. The most prominent of these is a condition that has come to be known as 'blindsight.' Blindsight is defined as residual visual capacity in the absence of consciousness (Weiskrantz et al., 1974; Weiskrantz, 1996). Here, residual visual capacity is measured in terms of successful performance on some task, while absence of consciousness is indicated through subjective reports. The condition is associated with lesions in primary visual cortex (V1). Blindsight subjects are clinically blind (in affected regions of their visual field), and are unable to spontaneously self-prompt to identify stimuli within those regions. It is only when these subjects are exposed to a forced-choice paradigm similar to that developed by Sidis (1898), that they show evidence of preserved abilities of visual discrimination.

Unsurprisingly, blindsight has been of considerable interest to those searching for NCCs.[4] Given that the affected neural region is V1 and that the deficit seems to be directed specifically at consciousness, while leaving some behavioral capacities intact, the natural inference involves identifying V1 as a potential NCC (or at least part of the NCC) for visual consciousness.[5] I revisit blindsight in more detail in proceeding sections; the important observation at this point is that the empirical work related to blindsight assumes an operational definition of consciousness strictly in terms of subjective report. Blindsight patients' abilities to successfully perform some visual task are not taken to indicate any consciousness of the features involved in the discriminations relevant to that performance; rather, their subjective reports of lack of conscious experience are taken at face value.[6] While this interpretation has some intuitive appeal, I argue in what follows that it paints an overly simplistic picture of the relationship between task performance and subjective report that relies on problematic experimental designs for its justification.

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[4] E.g. Crick and Koch (1998); Metzinger (2000), pp. 153-156.

[5] It should be noted that the inference outlined here to localize V1 as the NCC of visual consciousness is not so straightforward. Specifically, it is not clear that V1 satisfies the criterion of *minimal* sufficiency in the definition of NCCs (see Chalmers, 2000). That is, the phenomenon of blindsight does not rule out the (rather likely) possibility that neural activation in V1 is necessary condition for visual consciousness, but that some downstream region that relies on connections from V1 is the minimally sufficient system that would be of primary interest in NCC research. That said, my purpose here is not to settle or even weigh in on this issue; rather, my purpose is to show how blindsight as a phenomenon has contributed to a particular type of operational definition for consciousness that stresses dissociability of task performance and subjective report.

[6] E.g. Weiskrantz (1996)

1.2 Binarity and Level of Specificity of Conscious Content

The empirical paradigms cited above in connection with both subliminal perception and blindsight share a common structure. Specifically, they use the same basic dual task protocol involving a forced-choice recognition task and a dichotomous (i.e. all-or-none response: "seen-or-unseen") subjective report task. This use of dichotomous measures is grounded in two implicit assumptions:

a) Consciousness is a binary property; and
b) Conscious content is specified at a particular level of abstraction that is captured by the properties and objects subjects are asked to identify in standard subjective report tasks.

The connection between the use of dichotomous measures and the commitment to consciousness as a binary property is straightforward. If the phenomenon under investigation is a binary property, then an appropriately chosen dichotomous measure can exhaustively reflect the presence or absence of that property.

The second claim requires some unpacking. Within this literature, there is some regularity, which is difficult to capture succinctly, in the types of objects and properties subjects are asked to identify in subjective report tasks. Typically subjects are asked to identify simple stimuli—e.g. letters, number, simple geometrical shapes, etc.—or simple features of stimuli—e.g. color, orientation, direction of motion, etc. The relevant assumption is that consciousness bottoms out at this level—i.e. that representations of these types of external stimuli/features are *perceptual simples*. For contrast, note that it would seem strange, in this context, to ask a dichotomous question of a relatively complex stimulus, say, a yellow shoe. If a subject reports that they have failed to see a yellow shoe, we do not simply stop there; there are more fine-grained ways the experience could be characterized. In §*III*, I argue that these presumed perceptual simples may be similarly broken down into more fine-grained content. This has significant consequences for methodology in the study of NCCs.

2. Graded Measures of Subjective Report

2.1 Empirical Considerations: Graded Subjective Report Tasks

Prima facie, it is intuitive enough to think that for any given perceptual property—say, e.g., a visual experience of redness—it is simply a matter of fact (and not, e.g., degree) whether one has an experience of that property. However, pressing on this intuition a bit, it becomes clear that there's not much behind it. Suppose a ball were thrown at your head. It's easy to imagine that you could successfully dodge the ball without explicit conscious awareness *that it is a ball*. Suddenly looming objects in peripheral vision reliably elicit dodging behavior. Of course, such behavior need not be predicated on object recognition; after all, peripheral vision is quite limited. These considerations make it plausible to think that dodging behavior can be dissociated from consciousness of the ball *as a ball*. However, the considerations do not support an intuition that dodging behavior can be dissociated from consciousness *of anything at all.* It may be that having some vague experience of "something coming" (for lack of a better characterization at this point) is necessary for successful dodging. That is, there is no intuition in this case that consciousness should be all-or-none—i.e. with binary content specified at the level of *ball*.

However, suppose I were to assume that consciousness in this case *is* all-or-none in this sense. Suppose further that I were to construct an experiment, similar in design to those explicated in the previous section, in which I forced you to dichotomously indicate whether (or not) you saw the ball. It is reasonable to expect that there would be a sufficient number of successful dodgings coupled with "unseen" responses on the dichotomous report task to *generate* a result suggesting that there is no predictive relationship between consciousness and dodging behavior. In other words, if I were to construct dichotomous forced-choice protocol around this particular example, it is easy to see how I could generate a result demonstrating that consciousness is not necessary for dodging behavior. Of course, such a result would be dubious, as it would pretty clearly be an experimental artifact rather than a valid indicator of any interesting fact about consciousness.

Overgaard et al. (2006; 2008; Ramsoy and Overgaard, 2004) provide compelling reason to think that this sort of situation may be precisely what is happening in many standard psychophysical (dichotomous report) forced-choice paradigms. As an alternative to dichotomous measures, Ramsoy and Overgaard (2004) developed a four-point perceptual awareness scale (PAS). This scale was generated by probing normal, healthy subjects to scale the clarity of their visual experiences of a stimulus array presented for random durations ranging from 16ms to 192ms. Judgments of perceptual clarity for the subjects naturally clustered—i.e. without any intervention from the experimenters—into four distinct categories: "clear image" (CI), "almost clear image" (ACI), "weak glimpse" (WG), and "not seen" (NS).

Overgaard et al. (2008) applied the PAS to a forced-choice paradigm with blindsight patient, GR. In the experiment, GR was presented with stimuli in her blind field and then forced to identify those stimuli, just as in normal force-choice tasks. In the first set of trials, she was additionally asked to report her perceptual awareness using a dichotomous subjective report task; in the second set, she was asked to do the same instead using the PAS. The results are striking (see *table 1* below).

	Intact Field		Injured Field	
	Correct	Incorrect	Correct	Incorrect
Seen	27	0	6	1
Not Seen	2	4	12	14
	Intact Field		Injured Field	
	Correct	Incorrect	Correct	Incorrect
CI	21	0	7	0
ACI	8	1	8	3
WG	1	2	3	9
NS	0	0	0	3
	Intact Field		Injured Field	
	Correct	Incorrect	Correct	Incorrect
CI-ACI	29	1	15	3
WG-NS	1	2	3	12

Table 1: Results from Overgaard et al. (2008). The first two rows of data replicate standard blindsight results using a binary measure of subjective experience. Here there is no predictive relationship between accuracy and conscious awareness. The second set of rows (labeled CI- Clear Image, ACI- Almost Clear Image, WG- Weak Glimpse, and NS- Not Seen) show the data when the PAS was substituted for the binary measure of subjective report. In these circumstances, awareness is predictive of accuracy.

The results on the dichotomous report trials match standard blindsight results. That is, there is no predictive relationship between awareness and accuracy when the dichotomous measure is used. However, when the PAS is substituted for the dichotomous measure, a predictive relationship emerges. This can clearly be seen in the second set of rows, which report the PAS data. As is shown in the bottom rows of *table 1*, GR's accuracy in her blind field is remarkably high on trials accompanied by either a "clear image" or "almost clear image" response on the PAS evaluation, just as it is in her intact field. Her overall accuracy is decreased on stimuli presented in her blind field, but the vast majority of the inaccurate responses are coupled with either "weak glimpse" or "not seen" responses on the PAS evaluation.

Upon closer inspection, another quite interesting feature of these data stand out. Within the injured field, accuracy of responses on trials with "clear image" (CI) PAS reports match accuracy of responses with "seen" dichotomous reports (respectively- 6 correct, 1 incorrect; 7 correct, 0 incorrect). And accuracy of responses on trials with "almost clear image" (ACI), "weak glimpse" (WG) and "not seen" (NS) PAS reports match accuracy of responses with 'not seen' dichotomous reports (respectively, 11 correct, 15 incorrect; and 12 correct, 14 incorrect). See *table 2* for reference.

	Intact Field			Injured Field	
	Correct	Incorrect		Correct	Incorrect
Seen	27	0	Seen	6	1
Not Seen	2	4	Not Seen	12	14
	Intact Field			Injured Field	
	Correct	Incorrect		Correct	Incorrect
CI-ACI	29	1	CI	7	0
WG-NS	1	2	ACI-WG-NS	11	15

Table 2: Results suggest that in the injured field "almost clear image" PAS responses get grouped into "unseen" dichotomous reports, whereas in the intact field "ACI" PAS responses get grouped into "seen" dichotomous responses.

However, in the intact field, it is accuracy of trials with "CI" and "ACI" PAS reports that match accuracy of responses with "seen" dichotomous responses (respectively- 29 correct, 1 incorrect; 27 correct, 0 incorrect); while accuracy on trials with "WG" and "NS" PAS reports matches accuracy of trials with "unseen" dichotomous reports (respectively- 1 correct, 2 incorrect; 2 correct, 4 incorrect). Curiously, this is not a result that Overgaard et al. take much interest in pointing out, but what it suggests is that there is a criterion shift between fields when using dichotomous measures. That is, the dichotomous task *is not measuring the same thing* in the intact and injured fields, respectively. This raises serious concerns against the validity of dichotomous measures in blindsight experimental designs. There is no reason to suppose that these concerns should not generalize to cause problems for other binary report forced-choice tasks such as those standardly used in studies of subliminal perception.

In the initial study in which they developed the PAS, Ramsoy and Overgaard (2004) speculated about the implications of the PAS for the study of subliminal perception more generally. In that study, subjects were asked to identify aspects of simple stimuli in an array, when those stimuli were presented for brief intervals (between 16-193ms). For all stimulus dimensions—i.e. shape, color, and position—Ramsoy and Overgaard found predictive relationships between awareness and accuracy of identification. That is, as subjects' (reported) awareness of these aspects of the stimulus array increased, so did their accuracy in discriminating those aspects. This may seem like a trivial result, but it threatens wide-ranging consequences for much of the literature on subliminal perception (which utilizes dichotomous subjective report tasks).

Ramsoy and Overgaard speculated that, if a dichotomous subjective report task were imposed on top of the results from the PAS findings, "CI" and "ACI" responses would correspond to affirmative dichomotous reports, while "WG" and "NS" PAS responses would correspond to negative dichotomous reports.[7] When they analyzed their results in accord with this hypothesis, they found that their results would replicate standard subliminal perception results. That is, in spite of the fact that subjects were at chance in the discrimination task when they gave "NS" PAS responses, they were sufficiently above chance on trials with "WG" responses that, when the two categories are collapsed together, the data seem to demonstrate subliminal perception—i.e. better than chance task performance in the absence of "conscious awareness," as measured by dichotomous subjective report. So, as above, this raises the concern that dichotomous measures are not a valid indicator of conscious awareness. Again, dichotomous measures seem to risk manufacturing or at least exaggerating data that demonstrate the influence of "unconscious" processing by collapsing a range of discriminated content into two broad categories.

3. Conscious Content and Levels of Specificity

3.1 Consciousness: Graded or Compositionally Determinate

The arguments in the preceding section demonstrate that operationalizing consciousness in terms of dichotomous subjective reports is problematic. In §*I*, I showed that the use of dichotomous measures was motivated by two claims: (a) that consciousness is a binary property, and (b) that conscious content is specified at the level of simple stimuli/features of the environment. Naturally enough, proponents of graded measures of consciousness tend to reject the first of these claims, instead maintaining that consciousness is a graded property.[8] However, the methodological preference for graded measures over dichotomous measures does not, in itself, force such a commitment. A distinct possibility is that consciousness may be a binary property of contents which are not specified at the level of assumed perceptual simples. In other words, consciousness of seemingly simple external stimuli/features may itself be *composed* of determinate (conscious) contents specified at a finer grain—call this the view of consciousness as *compositionally determinate*.

The following may be useful in drawing out the contrast between these views. I introduced §*II* asking that you imagine dodging a ball thrown at your head. The idea with that example was that, while consciousness of the ball *as a ball* is not necessary for dodging behavior, it does not follow that consciousness of *anything at all* is not necessary

[7] It should be noted that subsequent studies have found direct comparisons between graded and dichotomous measures to be elusive (Overgaard et al., 2006). So the hypothesis that CI/ACI and WG/NS would correspond respectively to "seen" and "not seen" dichotomous reports, while intuitive, is likely an oversimplification. Nonetheless, the fact remains that there is a predictive relation between awareness and accuracy when the graded measures were used; and that predictive relation seems to be masked when dichotomous measures are used.
[8] See, e.g., Overgaard et al. (2006); Sandberg et al. (2010).

for dodging behavior. The difference between the graded view and the view that consciousness is compositionally determinate turns on how best to characterize the *anything at all* of which subjects may be conscious in such cases. The graded view, quite simply, characterizes that gray area of conscious content in terms of gradations of awareness *of the ball*. In other words, similar to the view supporting the use of dichotomous measures, the graded view takes for granted a characterization of conscious content in terms of the relevant external stimulus/features, but allows for gradations of that content. By contrast, the view I am proposing maintains that there may be fully determinate (i.e. non-graded) contents of conscious experience that nonetheless underdetermine an explicit judgment *that the stimulus is a ball*. For instance, instead of characterizing the experience in terms of the ball, suppose we characterize it along the lines of "*accelerating motion in peripheral visual field*." This can constitute fully determinate conscious content, with the apparent gradation in the subjects' experience only coming into play when you force a judgment about the external stimulus—i.e. when you force them to judge whether (or not) what they saw was a ball.

Another way of setting up this view is to say that seemingly simple judgments of external stimuli/features can be underlain by multiple, distinct processes and subsystems, and there is no reason to think that we cannot have conscious access to the outputs of those more specific processes. In other words, the idea is that conscious experiences of external stimuli/features are actually composed of finer-grained conscious content resulting from the specific processes supporting that experience. So when a subject's report of a feature of a stimulus seems to indicate partial awareness, we should have an interest in which processes and subsystems are functioning, in order to better understand the content of that subject's experience. This is in contrast to the graded view, which simply characterizes partial awareness as attenuated consciousness of the relevant stimuli/features of the environment. In effect, the concern is that this characterization of conscious content conflates the content of experience with the content of the judgment demanded by the task in the forced-choice protocol. The alternative view involves seeking a deeper understanding of the specific content processed by whatever subsystems are still functioning. The methodological burden thus shifts from taking content of experience for granted and trying to figure out the best way to measure that content toward seeking a better understanding of content of experience itself.

3.2 Blindsight Revisited

Resituating these issues through some further consideration of blindsight may help to add an amount of clarity and practicality to the distinction. The literature on blindsight is smattered with odd reports of subjects' experiences during forced-choice trials.[9] For instance, Zeki and Ffytche (1998) report several descriptions of the visual experience of blindsight patient, GY, in a psychophysical task involving identification of direction of motion of target stimuli on a screen. In an earlier study, Barbur et al. (1980), GY had demonstrated evidence of blindsight with respect to perception of direction of motion in his blind hemifield. In a post-trial interview, GY described his experience as "that of a normal person when, with eyes shut, he looks out a window and moves his hand in front of his eyes." Subsequently, he described the experience to Zeki and Ffytche as a "black shadow moving on a black background."[10] It is not immediately obvious how to parse such reports. One thing that seems reasonably clear is that it would be extremely misleading to characterize GY's task performance as resulting from "unconscious" visual processing (as is suggested by the standard blindsight protocol with a dichotomous subjective report task).

The view of consciousness as a graded property characterizes the experiences of blindsight subjects as drastically degraded experience of the aspects of the visual scene relevant to the forced-choice task.[11] In other words, the idea would seem to be that the content of visual experience for blindsight patients is the same as that of normal perceivers with respect to the relevant stimulus/feature being identified in the forced choice task; the difference lies in the *degree to which* those subjects are conscious of that content. Thus, if the forced-choice task involves identification of a particular stimulus, the graded view would maintain that the subject has a degraded visual experience *of that stimulus*. So, specifically with respect to GY's reports, the graded view would characterize GY's descriptions as indicating degraded experience *of visual motion*.

However, it is not as though there is a single way in which visual motion is either processed or experienced. Quite to the contrary, there is a wide body of evidence suggesting that there are specialized subsystems dedicated to processing different kinds of motion that exhibit their own particular psychophysical characteristics (e.g., biological, rigid, acceleration, constant, expansion, etc.).[12] This is precisely the type of feature of perceptual systems that motivates the view of consciousness as compositionally determinate. The criticism this view offers of the graded view in this particular case is that it is a potentially misleading oversimplification to characterize GY's experience as degraded experience *of visual motion*, because to do so stops well short of the more

[9] See, e.g., Weiskrantz et al.'s (1974) and Persaud and Lau (2008) for other examples of these sorts of reports.
[10] Zeki and Ffytche (1998), pp. 29-30.
[11] E.g., Overgaard et al. (2008) characterize GR's responses on the PAS as indicating "degraded vision" of the stimuli identified in the forced choice task.
[12] See, e.g., Johannson (1973), Perotti et al. (1996), Schmerler (1976)

interesting questions regarding the type(s) of visual motion GY is still able to process and/or experience.

3.3 An Integrative Operationalization of Consciousness

A more precise characterization of the content of GY's experience requires elaborated psychophysical tasks designed to test specific hypotheses about the particular visual capacities that remain intact (such as those mentioned in connection with perception of visual motion). These hypotheses should both inform and be informed by GY's open reports about the content of his experience. For instance, in order to make sense of GY's claim that he experiences something like "a black shadow moving on a black background," different psychophysical tasks should be investigated with a mind to the sorts of residual processes this description might indicate. For example, this might involve pursuing such questions as: Is GY capable of discriminating figure from ground without motion? Are there relevant differences in GY's discrimination of accelerating stimuli as opposed to stimuli moving at a constant velocity? Is GY capable of discriminating biological motion from rigid motion? Etc. In all such cases, the methodology will involve finding correlations between aspects of GY's subjective reports and his performance on various psychophysical tasks.

In this way, this view prescribes a methodology in which subjective report tasks function in unison with psychophysical tasks, rather than seeking dissociations between them. The idea would be to seek measures that maximize correlations between subjective reports and task performance, the justification being that such measures are more likely to be informative with respect to the particular subsystems underlying preserved perceptual capacities. The reason that standard approaches have been led astray is simple: the easiest and most common way to describe the content of experience comes at the course-grained level of external stimuli/features of those stimuli. If it is right that experience is actually composed of content discriminated at a finer-grain, then more sensitive subjective report tasks will be necessary in order to capture that content.

In sum, the methodological considerations at issue in this section cast doubt on the idea that subjective report alone provides a sufficient basis for determining conscious content. Rather, what is needed is an integrative approach that facilitates determinations of conscious content through an interplay between information gathered in subjective reports and performance on various psychophysical tasks. Thus, rather than taking the content of our experiences for granted, this project opens the possibility that we may learn *more* about the content of our experience as we learn more about the ways in which both we and our neural systems interact with our perceptual environments.

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