Comments and Reply

Valid distinctions between conscious and unconscious perception?

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In this commentary, we discuss the strengths and limitations of Snodgrass, Bernat, and Shevrin's (2004) theory of unconscious perception. Our commentary centers on the value of signal detection theory (SDT) to understanding the unconscious perception controversy, a value that Snodgrass et al. for the most part agree with (i.e., that most approaches to studying unconscious perception are invalid because they have confounded the criterion for detection with the criterion for awareness). However, we believe that their model relies on a somewhat restricted application of SDT. We discuss how SDT can be better applied to provide the necessary tests to validate their model.

Snodgrass, Bernat, and Shevrin (2004) propose a novel and provocative approach to the valid measurement and demonstration of unconscious perception. In this commentary, we consider the strengths and weaknesses of this approach, followed by suggestions for further research. For reasons of space, we focus our commentary mainly on the relationship between detection and identification, primarily given that the psychophysical details have been clearly articulated (Macmillan & Creelman, 1991).

Consideration of the OT/S Model

The measurement of awareness or lack thereof is a persistent problem for investigations into unconscious perception. The objective threshold/strategic (OT/S) model makes the provocative prediction that unconscious perception can occur (in pure form) at the objective detection threshold, where detection $d' = 0$. This contrasts with signal detection theory (Green & Swets, 1966; Macmillan & Creelman, 1991), where it is assumed that target stim-

ulus information should be indiscriminable from noise when detection $d' = 0$ (i.e., null detection sensitivity). When $d' = 0$, the theoretical distributions of noise alone and signal plus noise will be *completely overlapping*. If the OT/S model is supported, target stimulus effects (or processing) should, nonetheless, be present when stimulus detection $d' = 0$. For example, forced-choice target identification is predicted to differ from chance under particular task/observer combinations (e.g., "look" instructions, given look task preference; Snodgrass & Shevrin, 2003). If obtained independently of bias or other reasonable alternative explanations, these results would provide strong support for unconscious perception and, further, might also require slight modifications of SDT in that when detection $d' = 0$, identification d' should also = 0, given certain assumptions such as equally detectable, orthogonal signals (Green, Weber, & Duncan, 1977).

Given that ascertaining null awareness is a primary impediment to unconscious perception research, one strength of Snodgrass et al.'s (2004) proposal lies in arguing that conscious perceptual processes should be absent at detection $d' = 0$ (see Macmillan, 1986, for a similar argument). Although several investigators have identified potential problems with this assumption (Erdelyi, 1986; Reingold & Merikle, 1988), setting null awareness to detection $d' = 0$ is a useful starting point for indicating when conscious awareness of target stimuli may be lacking, because the targets would be indiscriminable from noise. In addition, critics of unconscious perception have argued that many studies have not met this high standard (Holender, 1986). We also believe that another strength of the OT/S model is that it helps rule out what we agree to be weaker approaches that many investigators presently employ in measuring unconscious perception. For example, many of the papers criticized by Snodgrass et al. suggest that unconscious perception occurs only when stimuli are presented at parameters between an objective threshold ($d' = 0$) and a subjective threshold. These stimuli are likely to fall in a range where weakly conscious or partial stimulus information is sufficient to permit identification above chance even though detection confidence is low or below criterion (cf. Haase & Fisk, 2001; Macmillan, 1986; Macmillan & Creelman, 1991).

Although the OT/S model has advantages over other approaches, several challenges remain. First is the difficulty of demonstrating true null sensitivity when observed mean detection $d' = 0$. According to Miller (2000, Table 1), if the true d' were in the range from 0 to 0.2, the probability that observed $d' \leq 0$ would range from

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0.54 to 0.24, based on 100 trials. Thus, some observers with observed $d' = 0$ might actually have some discriminative capability. Increasing the number of trials above 100 would reduce the chances of observed $d' = 0$ when true d' was some small, positive value. The studies cited by Snodgrass et al. (2004) in support of unconscious perception used about 100 or fewer detection trials (with the exception of Van Selst and Merikle, 1993). To counter the preceding argument, Snodgrass et al. state that their nonmonotonic model solves the “null awareness” problem, in that a negative relationship between detection and identification (or priming) is obtained in the region between the objective detection threshold and the objective identification threshold. However, one potential problem with this approach is that there may be significant differences in how observers carry out detection tasks as opposed to identification tasks when detection d' is near zero. These differences are important and deserve further investigation in their own right. As the authors indicate, such a (detection) task may appear “nonsensical” to the observer (cf. Marcel, 1983).

One possibility that should be explored further is that the nonmonotonic model might be based on a mixture of subjects who displayed varied perceptual processing characteristics. This mixture could consist of (1) random responding; (2) incorrect, but discriminative responding (i.e., negative d'); and (3) very low-level correct discrimination. To illustrate, it is very possible that across several blocks of trials, observers could see the targets some of the time, leading to correct detection. However, if they were unbiased, they might have illusory perceptions of the target, leading to a high false-alarm rate and near zero (and/or negative) d' (especially if targets were correlated with the noise). Another similar and seldom discussed problem is the often observed negative d' values in such studies. For example, the nonmonotonic relationship in Greenwald, Klinger, and Schuh (1995, Figure 4, p. 32) is based on a -0.4 value of d' . What is one to make of such a value? Is it possibly due to measurement error, or possibly due to discriminative performance in which the observers mistake the noise for the signal (and vice versa) on some proportion of the trials? Despite zero, or especially with negative, d' , the observer might successfully discriminate one target stimulus from another on a *separately blocked* identification task by selecting the target that most closely matched the trial display (cf. Duncan, 1985). Thus, at near zero values of d' , observers could perform separately blocked detection and identification trials using *different strategies* in that there would be no noise-alone trials on the identification task. Until a more thorough analysis of detection performance in the research cited by Snodgrass et al. (2004) in support of the nonmonotonic model is undertaken (e.g., computing confidence intervals for detection to determine whether or not they are outside the value of $d' = 0$, providing observers with training and feedback, etc.), it remains uncertain whether SDT can or

cannot account for a “dissociation” between detection d' and identification d' (or some other measure such as semantic priming).

A final research issue concerns practice effects on detection. That is, most of the experiments that Snodgrass et al. (2004) cite involve placing an observer in a very difficult and unconstrained situation for detecting target stimuli, as we have just mentioned above, without providing practice or feedback on the task. Many reports show that detection on difficult tasks can improve dramatically with practice (Dagenbach, Carr, & Wilhelmsen, 1989; Espinoza-Varas & Watson, 1989), so it would be informative to determine whether the stimuli are in principle undetectable (when observed $d' = 0$), or temporarily undetectable due to unique stimulus–observer situations. The preceding methodological issues represent avenues for future psychophysical work that could provide validity tests of the OT/S model and provide more thorough psychophysical evidence to convince more skeptical readers.

Implications for Theories of Conscious/Unconscious Processing

If supported, the OT/S model could potentially rule out other models of conscious/unconscious processing. For example, both Libet (1985) and Velmans (1991) have argued that conscious processes are insufficient to explain performance in psychological tasks. They concluded that consciousness is epiphenomenal, merely providing the results of processing that has already been carried out to the highest causal levels. If, on the contrary, conscious processes are capable of overriding unconscious influences until the point where $d' = 0$, then consciousness appears to have a strong causal role (Dulany, 1997; Perruchet & Vinter, 2002), one that is perhaps stronger than presently recognized. That is, conscious processes are operating below the subjective threshold (cf. Debner & Jacoby, 1994; Merikle, Joordens, & Stoltz, 1995). Similarly, many approaches used today to measure unconscious perceptual influences could be invalid for the same reason.

Suggestions for Future Research

We have previously shown (Haase & Fisk, 2001; Haase, Theios, & Jenison, 1999) that stimulus identification can be accurately predicted from detection performance, and we have done so under conditions similar to those in many published reports claiming unconscious perception (e.g., Debner & Jacoby, 1994; Merikle & Reingold, 1990). Furthermore, our results were predicted by an SDT model that has received support in several areas of basic psychophysical inquiry (Benzschawel & Cohn, 1985; Green et al., 1977; Starr, Metz, Lusted, & Goodenough, 1975; Swenson & Judy, 1981). These experiments were conducted using concurrent rating scale detection and identification. That is, on each trial, the observers rated their confidence in stimulus detection and then attempted to identify the target from a small set. We believe that such a task would be well suited in further

“strong inference” testing of the OT/S model, especially since the evidence from identification tasks (Snodgrass, Shevrin, & Kopka, 1993; Van Selst & Merikle, 1993) has been obtained when detection and identification were assessed in separate blocks of trials. In traditional psychophysical work, it has often been found that identification performance is higher than that predicted by theory (Macmillan & Creelman, 1991), when the two tasks are compared on separate runs. We also believe that the rating scale task provides a better tool for assessing awareness in difficult detection tasks compared to a yes/no task, given that awareness is likely to be a graded construct (as opposed to representing a simple dichotomy). Relatedly, one could argue that strict reliance on $d' = 0$ as a measure of null awareness provides only a global indicator of performance on a task and does not assess subjective states (i.e., d' assesses discriminability of targets and or targets from noise, but may not inform us about the observers’ trial-to-trial subjective states). Our own intuitions and visual perceptions from conducting research in this domain is that very subtle conscious processes can explain the observed pattern of data from “unconscious perception” experiments, though it is true that from a scientific standpoint, the objective methods employed in these studies may be incapable of identifying internal processing states unambiguously (Uttal, 1990, 1999).

A Concluding Caveat

As many have noted, unconscious perception has been beset by problems for many years (Holender, 1986). Given the continual ebb and flow of evidence for and against unconscious perception, one may question whether conclusive results will ever be possible. A very similar controversy has played out in the literature regarding unconscious learning (Dulany, 1997; Perruchet & Vinter, 2002; Shanks & St. John, 1994). Part of the problem may result from the attempt to specify the nature of internal processing from behavioral data (especially for very subtle, complex distinctions, and especially from global indicators such as d'). A similar argument has been eloquently made by Uttal (1990, 1999):

The conclusion to which we are directed by these considerations is that there may very well be a vast difference between the real psychobiological mechanisms and the inferences about mechanisms drawn from formal models. In addition, there may be no way to measure or evaluate those differences. My assertion is that computational, mathematical, or neural net models can, in principle, say nothing rigorous about internal mechanical reality in a reductionistic sense—they are neutral in practice and principle—regardless of how perfectly they describe function or process. They may be elegant and fully descriptive, but they can never be explanatory in the reductive manner suggested by some contemporary theoreticians. (Uttal, 1990, p. 199)

Thus, in contrast to many cognitive approaches, psychophysical models such as SDT are process neutral and

do not take a stand as to the psychological status of such processes:

Subliminal perception results seem surprising to the degree that an inappropriate, threshold model guides theorizing and experimentation: Failure to detect is understood as a drop below threshold, rather than below criterion. This interpretation meshes well with the idea that the threshold is the dividing line between consciousness and its absence. Detection theory, however, has no construct corresponding to consciousness. It is true that instructions of which subjects presumably are conscious can lead to criterion changes, but the converse implication need not hold (Macmillan & Creelman, 1991, p. 255).

The statements above are not meant to deny the reality of consciousness, rather that many, if not most, of the models and methods used in the attempt to characterize conscious and/or unconscious states may be inherently ambiguous.

In conclusion, we believe that more detailed application of psychophysics, along the lines that we have suggested above, may not only be helpful in providing another way to understand “objective threshold unconscious perception,” but, if Snodgrass et al. (2004) are correct, may also provide better tests of SDT itself.

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