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Unconscious perception: A model-based approach to method and evidence

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Unconscious perceptual effects remain controversial because it is hard to rule out alternative conscious perception explanations for them. We present a novel methodological framework, stressing the centrality of specifying the single-process conscious perception model (i.e., the null hypothesis). Various considerations, including those of SDT (Macmillan & Creelman, 1991), suggest that conscious perception functions hierarchically, in such a way that higher level effects (e.g., semantic priming) should not be possible without lower level discrimination (i.e., detection and identification). Relatedly, alternative conscious perception accounts (as well as the exhaustiveness, null sensitivity, and exclusiveness problems—Reingold & Merikle, 1988, 1990) predict positive relationships between direct and indirect measures. Contrariwise, our review suggests that negative and/or nonmonotonic relationships are found, providing strong evidence for unconscious perception and further suggesting that conscious and unconscious perceptual influences are functionally exclusive (cf. Jones, 1987), in such a way that the former typically override the latter when both are present. Consequently, unconscious perceptual effects manifest reliably only when conscious perception is completely absent, which occurs at the objective detection (but *not* identification) threshold.

Despite recent progress in research, the existence and nature of unconscious perceptual effects remains controversial (see, e.g., Draine & Greenwald, 1998, and commentaries—especially Merikle & Reingold, 1998). Concerns about methodological validity are central in this controversy; key questions include how to define conscious and unconscious perception, and relatedly, how to rule out alternative weak conscious perception interpretations of putatively unconscious effects. Answers to these questions determine how existing experimental evidence should be interpreted; conversely, empirical findings inform methodological and theoretical formulations. Currently, there are two major (and incompatible) unconscious perception models, each with its own methodological framework and reading of the experimental evidence. In this article, we propose a novel, third unconscious perception model, discussed fully in Snodgrass (in press; see also Bernat, Shevrin, & Snodgrass, 2001; Snodgrass, 2002). We suggest that the proposed model possesses methodological advantages that allow strong inferences for unconscious perceptual influences, and conversely that the two currently dominant models have not thus far succeeded in this respect.

We will begin by reviewing the relevant experimental and theoretical background, which suggested that the methodological problems in this area were even more serious than originally thought. We will then discuss the two current unconscious perception models, which were developed in response to this apparent state of affairs, highlighting their methodological analyses and experimental paradigms. Briefly, the *subjective threshold* model, proposed by Merikle, Reingold, and associates (e.g., Cheesman & Merikle, 1984, 1986; Merikle, Joordens, & Stolz, 1995; Reingold & Merikle, 1988, 1990), holds that unconscious perceptual effects occur only under stimulus conditions where participants deny awareness but can still perform above chance on perceptual discrimination tasks (i.e., the subjective threshold). This model denies that unconscious perceptual effects occur under more stringent objective threshold conditions, where above chance stimulus discrim-

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ination is impossible. Contrariwise, the *objective threshold/rapid decay* model, proposed by Greenwald and associates (e.g., Abrams & Greenwald, 2000; Draine & Greenwald, 1998; Greenwald, Draine, & Abrams, 1996), holds that objective threshold effects are real but intrinsically very short lived, and that subjective threshold effects are likely weakly conscious perceptual effects.

We will then present our methodological analysis, stressing the necessity of a model comparison approach. Specifically, because all unconscious perception models posit both unconscious and conscious perceptual influences, these dual-process models must show that the simpler, more parsimonious *single-process conscious perception* model cannot account for the target findings (see Dulany, 1997; Holender, 1986). Surprisingly, however, certain central features of the single-process model have received little attention. We argue that scrutiny of these features suggests: (1) which direct measures validly index conscious perception, and (2) what form qualitative differences must take to allow rejection of the single-process model. With this methodological framework in mind, we review the literature and propose the *objective threshold/strategic* model, which holds that objective threshold effects are genuine but not short lived. Moreover, in this model, conscious perceptual influences typically override unconscious ones when both are present. Consequently, unconscious perceptual effects are obtained most reliably only when conscious perception is completely absent.

Experimental and Theoretical Background

As Erdelyi (1985, 1986) made clear, all attempts to demonstrate unconscious influences ultimately rely on some version of the dissociation paradigm. Usually, performance on two tasks is compared; one intended to index conscious perception; the other, unconscious perception. The former is typically a direct discrimination task (e.g., detection), whereas the latter is often an indirect task requiring more complex processing (e.g., semantic priming). In its classic and most common form, the dissociation paradigm seeks to demonstrate positive effects on the unconscious perception index despite null sensitivity on the conscious perception index, thus justifying inferences for unconscious perception.

Difficulties with early subjective threshold methods. In early unconscious perception research, conscious perception indexes were derived from classical psychophysics, and were thus essentially subjective threshold measures. Under these conditions, ostensibly unconscious perceptual effects were easy to obtain (Adams, 1957); these were often in the form of above chance performance on direct tasks despite participants' claims of unawareness. With the advent of signal detection theory (SDT; e.g., Green & Swets, 1966), however, it became widely accepted that subjective thresholds might reflect response criterions applied to a single, conscious process, rather than delimiting the conscious/unconscious boundary. Because this alternative criterion artifact hypothesis is more parsimonious, it was widely viewed (Eriksen, 1960; Goldiamond, 1958) as a general refutation of subjective threshold methods, and it remains a serious hurdle that current unconscious perception models must address.

Difficulties with early objective threshold methods. The modern revival of unconscious perception research utilized objective threshold methods to avoid criterion artifact concerns. Stirring considerable interest, Marcel's (1983a) experiments appeared to demonstrate semantic priming effects under objective threshold conditions; moreover, early replications seemed promising (e.g., Balota, 1983; Carr, McCauley, Sperber, & Parmelee, 1982; Fowler, Wolford, Slade, & Tassinary, 1981). However, when further replications failed, skepticism grew that the initial experiments had actually indexed subjective rather than objective thresholds (Holender, 1986; Merikle, 1982; Nolan & Caramazza, 1982; Purcell, Stewart, & Stanovich, 1983). This skepticism was reinforced by Cheesman and Merikle's (1984) experiments, which seemed to show that semantic priming effects did not occur at carefully determined objective thresholds, but rather only at subjective thresholds.

The Reingold and Merikle critique. Reingold and Merikle (1988, 1990) soon made more fundamental criticisms. Most importantly, they emphasized that inferences for unconscious perception in the classic dissociation paradigm seem to require that the conscious perception index be *exhaustively sensitive* to conscious perception. Otherwise, residual conscious perception could explain indirect effects. Noting, however, that various experiments have used differing direct measures, they suggested that determining which (if any) measures are exhaustive is unclear at best. Moreover, Reingold and Merikle argued that whenever the direct and indirect measures differ (which is usually the case), there is an unacceptable risk that they might tap "different aspects" of conscious perception, and hence that one can never be confident that the direct task is exhaustively sensitive in this situation. If this conclusion is correct, many dissociation paradigm experiments (e.g., Dagenbach, Carr, & Wilhelmsen, 1989) are methodologically invalid.

Reingold and Merikle (1988, 1990) also underscored Macmillan's (1986) observation that demonstrating true *null sensitivity* on the direct measure is very difficult, because inescapable measurement error implies that true discrimination performance might actually exceed zero even when the obtained mean is zero. Finally, Reingold and Merikle suggested that objective threshold dissociation paradigms must assume that direct measures are sensitive only to conscious perception. If, instead, direct measures are also sensitive to unconscious perception, they argued, attaining null sensitivity on direct measures would necessarily eliminate or greatly reduce unconscious influences in general, including on the indirect measure (the *exclusiveness problem*).

As Reingold and Merikle showed, dissociation paradigms must indeed deal with the exhaustiveness and null sensitivity problems. However, the ultimate issue underlying both of these concerns is the possibility that weak conscious perception might account for allegedly unconscious effects. This is a fundamental concern for any version of the dissociation paradigm, not just the classic form—and hence for all unconscious perception paradigms. Similarly, all such paradigms must address how conscious and unconscious perceptual influences mediate direct and indirect performance. Taken together, the difficulties given above stimulated the formulation of the two currently dominant approaches. Merikle and associates (e.g., Merikle et al., 1995) have shifted to a modified subjective threshold approach, whereas Greenwald and associates (e.g., Draine & Greenwald, 1998; Greenwald, Klinger, & Schuh, 1995) have attempted to refine objective threshold methods.

THE SUBJECTIVE THRESHOLD MODEL

Merikle and associates argue that objective threshold effects do not exist (Cheesman & Merikle, 1984), and seek instead to show that subjective threshold effects are indeed unconscious (Cheesman & Merikle, 1986; Merikle et al., 1995). If so, and if one recalls that these effects are obtainable on direct measures, it follows that direct measures must be sensitive to unconscious as well as conscious perceptual influences. If this too is true, the apparent lack of objective threshold findings seems to follow as well (i.e., the exclusiveness problem), whereas subjective threshold approaches appear to avoid this difficulty. Thus, for Merikle and associates, subjective threshold paradigms are the only feasible alternative for both empirical and methodological reasons. On the other hand, as Reingold and Merikle (1990) noted, concerns about exhaustiveness are more troublesome for subjective than for objective threshold approaches. In view of these substantial difficulties, they concluded that neither objective nor subjective threshold paradigms are valid unless significantly modified. To this end, Merikle and associates proposed two remedies: (1) the relative sensitivity paradigm (RSP); and (2) demonstrating qualitative differences between direct and indirect effects.

The Relative Sensitivity Paradigm

The RSP (Reingold & Merikle, 1988) seeks to repair the classic dissociation paradigm's methodological problems while retaining its essential structure (i.e., indirect performance > direct performance). The RSP minimizes exhaustiveness concerns by utilizing the same measure for both the conscious and unconscious perception indexes, varying only direct versus indirect task instructions. If one further assumes that the direct measure is at least as sensitive to conscious perception as the indirect measure, and if moreover an indirect > direct pattern is nonetheless obtained, unconscious perception can be validly inferred because conscious perception cannot account for the higher indirect performance. Furthermore, because only the indirect > direct pattern is central, the RSP seems to avoid the null sensitivity and exclusiveness problems provided that one does not attempt to arrange objective threshold conditions. Notably, the RSP logic does not seem to depend on demonstrating qualitative differences. However, although many accept the RSP logic as methodologically sound (see, e.g., Greenwald et al., 1995), unconscious perception RSP experiments that allow above chance direct measure performance have been unsuccessful to date (Reingold & Merikle, 1988).

The Qualitative Differences Approach

In situations where RSP-like indirect > direct patterns do not occur, Merikle and associates (e.g., Merikle, 1992) argue that convergent validation through the obtaining of qualitative differences is essential. Merikle et al. (1995) further suggested that such differences can be readily obtained with the use of exclusion paradigms to examine subjective threshold effects. In typical exclusion procedures (see Jacoby, 1991), participants are asked to avoid responding with previously presented stimuli. Exclusion paradigm proponents argue that consciously perceived stimuli will be excluded; hence, when exclusion failure occurs, unconscious perception is inferred. Merikle and associates have reliably demonstrated exclusion failure under subjective threshold conditions, whereas exclusion success ensues with clearly visible stimuli (e.g., Merikle & Joordens, 1997a, 1997b; Merikle et al., 1995). This crossed double dissociation is argued to constitute a qualitative difference (Merikle & Daneman, 1998), alleviating concerns about exhaustiveness and thereby demonstrating unconscious perception. Moreover, because both exclusion failure and exclusion success involve deviations from chance, these qualitative differences seem to avoid the null sensitivity problem. Finally, once again, exclusiveness concerns are avoided because objective thresholds are not attempted.

Qualitative differences, however, are difficult to interpret because they may simply indicate an additional conscious process (cf. Dulany, 1997; Erdelyi, 1986; Holender, 1986). To illustrate, exclusion failure may be a criterion artifact. By this account (Snodgrass, 2002), exclusion failure occurs with below-criterion stimuli because participants lack confidence in their perceptions. Conversely, clearly visible stimuli are excluded because they are above criterion (cf. Haase & Fisk, 2001). Accordingly, this pattern could suggest two conscious processes (i.e., conscious perception and metacognitive decision processes), and it does not compel inferences for unconscious perception. Other exclusion-related qualitative differences (standard vs. reverse priming; false recognition—cf. Merikle & Joordens, 1997a, 1997b; Merikle et al., 1995) take the same form and can be similarly interpreted in conscious perceptual terms (see Snodgrass, 2002). Accordingly, the qualitative differences approach requires further elaboration; in particular, it seems necessary to independently demonstrate that the stimuli are not consciously perceivable (Holender, 1986).

THE OBJECTIVE THRESHOLD/RAPID DECAY MODEL

Although Greenwald and associates' initial work (Greenwald, Klinger, & Liu, 1989) produced apparently reliable objective threshold results, a large-sample followup (Greenwald et al., 1995) yielded only mixed results. Rather than concluding that objective threshold effects do not exist, however, Greenwald and associates have recently suggested (e.g., Draine & Greenwald, 1998; Greenwald et al., 1996) that unconscious perceptual effects are intrinsically very short lived. Accordingly, they argue that only very rapid responses can reliably capture such phenomena, and they have consequently adopted "response window" priming procedures that compel 400- to 500-msec response times. Combining this technique with their regression approach (see below), Draine and Greenwald (1998; see also Greenwald et al., 1996; Klinger, Burton, & Pitts, 2000) have suggested that large, reliable objective threshold results are easy to obtain. Further, Abrams and Greenwald (2000) have recently shown that response window effects appear to be driven by part- (rather than whole-) word information, suggesting that unconscious perceptual influences are primitive and analytically unsophisticated. Finally, Greenwald and associates view subjective threshold effects as weakly conscious.

Regarding the exhaustiveness problem, Greenwald and associates disagree with Reingold and Merikle (1988, 1990) that the direct and indirect measures must be identical. Instead, they contend that direct measures that index lower level stimulus attributes (e.g., detection) are likely more sensitive to conscious perception than are typical indirect measures (e.g., semantic priming), which index more complex, higher level stimulus dimensions. In our view, this approach to the exhaustiveness problem has merit, but it is underspecified and requires further elaboration. Regarding the exclusiveness issue, Greenwald et al. (1995) agreed with Reingold and Merikle that direct measure performance may be unconsciously as well as consciously influenced, but they seem to disagree (without explanation) that null sensitivity would therefore eliminate indirect effects.

The Regression Approach to the Null Sensitivity Problem

To deal with this problem, Greenwald et al. (1995) proposed a regression approach in which indirect performance is regressed onto direct performance. Given appropriate scaling, the y-intercept is the point estimate of the indirect effect when direct $d' = 0$. This approach appears to avoid the null sensitivity problem, because such y-intercepts are obtainable even if the direct measure mean and/or individual performance exceeds zero. However, direct performance still contains measurement error, the source of the null sensitivity problem in the first place. In single-predictor situations, measurement error causes systematic underestimation of slope magnitudes. Such slope "flattening" will artifactually elevate the y-intercept when the true underlying slope and direct mean are positive, possibly producing spurious results. Although Klauer, Greenwald, and Draine (1998) have proposed corrective procedures, these modifications may not be sufficient (see Dosher, 1998; and especially Miller, 2000; but see also Klauer & Greenwald, 2000).

More importantly, the validity of the regression approach depends on the reasonableness of using the regression equation for predictive purposes (i.e., to estimate the y-intercept). Doing this is clearly valid when the direct and indirect variables are related (although measurement error is still problematic); when these variables are unrelated, however, it is not clear that such predictions are meaningful. Unfortunately, the direct and indirect measures are generally unrelated in response window experiments (e.g., Draine & Greenwald, 1998); accordingly, the associated y-intercepts may be invalid (cf. Dosher, 1998; Merikle & Reingold, 1998). Although Greenwald and Draine (1998) argued that this pattern could indicate that conscious and unconscious perceptual influences are independent, this conclusion requires strong assumptions. Given the measurement error and predictive validity problems, then, the regression approach requires further elaboration.

THE SINGLE-PROCESS CONSCIOUS PERCEPTION MODEL

Because the single-process conscious perception model plays such a crucial contrastive role, we explore its properties in detail. Three questions are addressed: (1) Which direct measures validly index conscious perception? (the exhaustiveness problem); (2) What are the core features of the conscious perception model? and (3) How can valid inferences for unconscious perception be made? Various lines of evidence will suggest that conscious perception functions on a hierarchical strength/complexity continuum, such that greater stimulus intensity is required in order for more complex effects to occur. This central principle yields three conclusions: (1) Direct measures that index fundamental, lower level stimulus features are exhaustively sensitive with respect to effects that require higher level processing; (2) effects that violate the strength/complexity continuum provide strong evidence for unconscious perception, whereas effects consistent with this continuum do not; and relatedly (3) effects that provide strong evidence moreover overcome the exhaustiveness, null sensitivity, and exclusiveness problems, whereas those that provide weak evidence do not. Before we proceed further, however, two issues require further clarification.

First, the crucial sense of "unconscious perception" concerns whether the relevant stimuli are phenomenally consciousness or not—not whether participants simply deny awareness of these stimuli. For example, the SDT criterion artifact argument holds that ostensibly unconscious stimuli are phenomenally conscious after all, despite subjective reports to the contrary. Conversely, both subjective and objective threshold models assert that the stimuli are phenomenally unconscious, not just below criterion. Further, the key question concerns the stimulus perception itself, *not* the mental processes triggered by these stimuli. Even unconscious perception skeptics (e.g., Dulany, 1997) agree that mental processes (e.g., automatic spreading activation) can be unconscious.

Second, one could object that the models discussed below (e.g., SDT) make no reference to consciousness at all, and hence that it prejudges the issue to assume only conscious perceptual processes. Here, although we agree that these models are officially agnostic, it is still simpler to assume only conscious perceptual processes unless such models can be shown to be insufficient.

Which Measures Validly Index Conscious Perception? (The Exhaustiveness Problem)

As Merikle and Reingold (1990) noted, various measures have been used as conscious perception indexes, including detection (e.g., Dagenbach et al., 1989), forced-choice identification (Cheesman & Merikle, 1984, 1986), and forced-choice position discrimination (e.g., Greenwald et al., 1989; Greenwald et al., 1995). Given this apparent lack of consensus, Reingold and Merikle (1988) argued that no principled basis existed to determine which, if any, of these measures validly indexed conscious perception. However, considerable progress can be made when we consider that the candidate measure need not be sensitive to absolutely all conscious perception, but rather only to *relevant* conscious perception—namely, to the kind(s) of conscious perception that would be necessary, at a minimum, for the effects of interest to occur. Frequently, semantic priming effects obtained with the use of visually presented words are of interest (e.g., Dagenbach et al., 1989). For such effects to occur, the stimulus words' meanings must be extracted. In turn, for semantic priming to occur, at least partial word identification must take place. Here, we mean "word identification" in the SDT forced-choice sense, not in the more difficult and hence less sensitive free response sense sometimes used in the word recognition literature.[1] Hence, any conscious perception index that is exhaustively sensitive to identification-relevant conscious perception is relevantly exhaustive, because null sensitivity on this measure would preclude stimulus-related semantic analysis.

So which direct measures are exhaustively sensitive to identification-relevant conscious perception? One straightforward possibility (cf. Duncan, 1985) is to simply use a forced-choice identification task (Cheesman & Merikle, 1984). But what about other indexes? For example, would a forced-choice semantic classification task (Draine & Greenwald, 1998) suffice? Or how about SDT detection, plausibly the most fundamental and sensitive discrimination of all? Contrary to Reingold and Merikle's (1988, 1990) pessimism, in our view a common set of answers to these questions is suggested by three converging lines of evidence: (1) The structure of word recognition models; (2) the structure and integrative implications of SDT models; and (3) empirical results concerning the relative sensitivities of various direct measures.

The Hierarchical Nature of Word Recognition Models

The idea that semantic activation depends on word identification is consistent with (indeed, is part of) standard models of word recognition (cf. McClelland, 1987; McClelland & Rumelhart, 1981). The initial stage is some kind of feature detection (e.g., letter detection). Output from this stage proceeds to the word identification level, which in turn provides input into subsequent semantic activation. In this way, stimulus processing becomes more complex as it ascends from lower to higher level stages of activation; in addition, higher level processing cannot occur without lower level input. Thus, any stimulus-related semantic activation depends on input from the word identification level, which in turn depends on input from the feature detection level. These inputs can be partial, but they must be nonzero in order for stimulus-related semantic activation to occur at all. Furthermore, although top-down feedback can occur, for this to be perceptually based it too must be derived from the relevant lower level input to begin with.

Importantly, though, word recognition models discuss only the kinds of information activated at various processing levels; they say nothing about consciousness.[2] So where does consciousness fit in? If the single-process conscious perception model is true, semantic priming should not occur unless identification-relevant prime information is phenomenally conscious, which in turn should enable above chance forced-choice identification and detection. Marcel (1983b) called this the *identity assumption*, which holds that conscious percepts reflect the highest level of analysis achieved by the stimuli, as well as the constitutive lower levels. Thus, when higher level effects are obtained despite null sensitivity on lower level discriminations, the identity assumption is violated, supporting inferences for unconscious perception. Indeed, without the identity assumption, Marcel's (1983a) results would not have been surprising in the first place.

These hierarchical considerations suggest a general exhaustiveness principle: Any direct measure that indexes a lower level of analysis than that tapped by the indirect measure is relevantly exhaustive. Thus, if the indirect measure was semantic priming, identification or detection tasks would be exhaustively sensitive. However, if the indirect measure indexed detection, identification might not be exhaustively sensitive because it indexes a higher level of processing. But what about direct measures that index the same level of analysis as that tapped by the indirect measure? In particular, are direct semantic classification tasks (cf. Draine & Greenwald, 1998) exhaustively sensitive with respect to semantic priming? Perhaps surprisingly, priming models suggest otherwise. Specifically, different priming mechanisms (e.g., expectancy vs. spreading activation; see Neely, 1991) seem to require different levels of stimulus information. Whereas the expectancy process apparently requires conscious, explicit knowledge of the prime's semantic category so that the relevant expectancies can be generated, the spreading activation process can operate even when prime–target stimulus onset asynchronies (SOAs) are too brief to allow expectancy process execution (Neely, 1977). Thus, partial identification might suffice to produce spreading activation, even when prime category information is not consciously available. Despite their intuitive plausibility, then, direct semantic classification tasks may not be exhaustively sensitive with respect to spreading activation effects after all, although they would be for expectancy-driven effects. Accordingly, when spreading activation effects are concerned, exhaustive sensitivity is most assured with direct measures that index a lower, rather than the same, level of stimulus analysis than that indexed by the indirect measure.

Implications of SDT

Reingold and Merikle (1988, 1990) argue that different discrimination tasks are radically incommensurable by sheer virtue of being nonidentical. Notably, however, they do not discuss the integrative relevance of SDT, which was formulated in part precisely in order to enable the unified analysis and meaningful comparison of various direct discrimination tasks (cf. Gescheider, 1997; Green & Swets, 1966; Macmillan & Creelman, 1991)—a major problem in classical psychophysics. In our view, SDT models (1) further support the proposed hierarchical exhaustiveness relations, simultaneously suggesting that the major discrimination tasks at issue are meaningfully comparable, and (2) allow the classification of otherwise unclear direct measures.

SDT detection is exhaustively sensitive to identification-relevant perception. Counter to Reingold and Merikle's (1988, 1990) incommensurability thesis, SDT models identification (often called "recognition" in SDT) as fundamentally *being* multidimensional detection. Specifically, SDT models two-alternative forced-choice (2AFC) identification in a two-dimensional decision space, rather than the familiar one-dimensional presence/ absence detection decision space (see, e.g., Green & Birdsall, 1978; Haase, Theios, & Jenison, 1999; Macmillan, 1986; Macmillan & Creelman, 1991). As Figure 1A (cf. Macmillan, 1986) indicates, SDT represents identification ($d'_{1,2}$) as the two-dimensional distance between the detectability of stimulus A (d'_1) and Stimulus B (d'_2). The detectability of the A and B stimuli form two legs of a triangle, with stimulus A versus stimulus B identification being the third leg. Crucially, then, the SDT model directly implies that above-chance identification should not be possible when null detection sensitivity holds. Clearly, if both detection "legs" have zero length, identification must be zero as well. Other evidence supports this conclusion; for example, general recognition theory (e.g., Ashby & Townsend, 1986) also models identification in multidimensional detection space (see, e.g., Ashby & Perrin, 1988, pp. 128–129). Indeed, given the usual SDT assumption of multivariate normality, the SDT and general recognition theory identification models are identical.

Thus, SDT detection is exhaustively sensitive to identification-relevant conscious perception, and inferences for unconscious perception are justified if identification-dependent results (e.g., semantic priming) are obtained despite null detection sensitivity. Macmillan (1986, p. 39) concurred: "Above-chance recognition [i.e., identification] performance (or other evidence for activation) when detection $d' = 0$ would be . . . persuasive evidence for subliminal perception."

Furthermore, although the SDT model implies that objective detection and identification thresholds should be the same, the empirical evidence (e.g., Dagenbach et al., 1989; Haase, 1994) suggests instead that detection thresholds are below identification thresholds. To explain this phenomenon, Haase and Fisk (2001) concluded that typical word stimuli reflect highly correlated stimulus dimensions in the context of presence/absence detection, given that overlapping and thus nondiscriminative lower level stimulus information (e.g., flicker or darkness) can support detection but not identification. We agree. Figure 1B depicts this more realistic nonorthogonal situation, where identification exceeds zero only at substantial levels of detection d'.

The importance of distinguishing SDT versus classical detection. The current claim for detection's exhaustiveness applies to SDT but *not* to classical detection. As Figure 2 illustrates (cf. Macmillan, 1986, p. 39), stimuli from the A and B distributions that are below the detection criterion will nonetheless fall on their side of the identification criterion more than on the other side. Thus, above chance identification of below criterion (i.e., classically undetectable) stimuli is to be expected, and it does not support inferences for unconscious perception. The classic SDT texts have sections on "subliminal perception" devoted solely to this point (see, e.g., Green & Swets, 1966, pp. 335–337; Macmillan & Creelman, 1991, pp. 112, 239, 255; see also Haase et al., 1999); indeed, many purported demonstrations of unconscious perception have been dismissed on just those grounds (Cheesman & Merikle, 1984; Goldiamond, 1958; Macmillan, 1986; Merikle, 1984). Contrariwise, null SDT detection sensitivity should prevent above-chance identification.

SDT identification is exhaustively sensitive to classification-relevant perception. SDT also suggests that identification and semantic classification (called "categorization" by SDT) are closely related. In identification, each stimulus is mapped to a unique response; in semantic classification, multiple stimuli are mapped to the same response (Macmillan & Creelman, 1991). Moreover, because classification requires at least partial identification, the latter is relevantly exhaustive with respect to the former. Furthermore, lower level stimulus information (e.g., perceiving a letter or two) might be enough to raise 2AFC identification but not 2AFC classification above chance. Recalling that partial identification might still suffice to produce semantic activation, then, it again appears that semantic classification may not be exhaustively sensitive regarding semantic priming effects.

SDT and discrimination task classification. SDT also aids in the interpretation of various other tasks. For example, several important studies which might appear to have used unrelated, idiosyncratic conscious perception indexes in fact used standard two-interval forced-choice (2IFC) detection. In such tasks (see, e.g., Macmillan & Creelman, 1991), both the signal and noise stimuli are presented on each trial in two or more distinct intervals, either temporal (e.g., separated briefly in time) or spatial (e.g., presented either to the left or right of center). With this in mind, it becomes clear that Groeger (1988) used 2IFC temporal detection, and that Greenwald et al.'s (1989; see

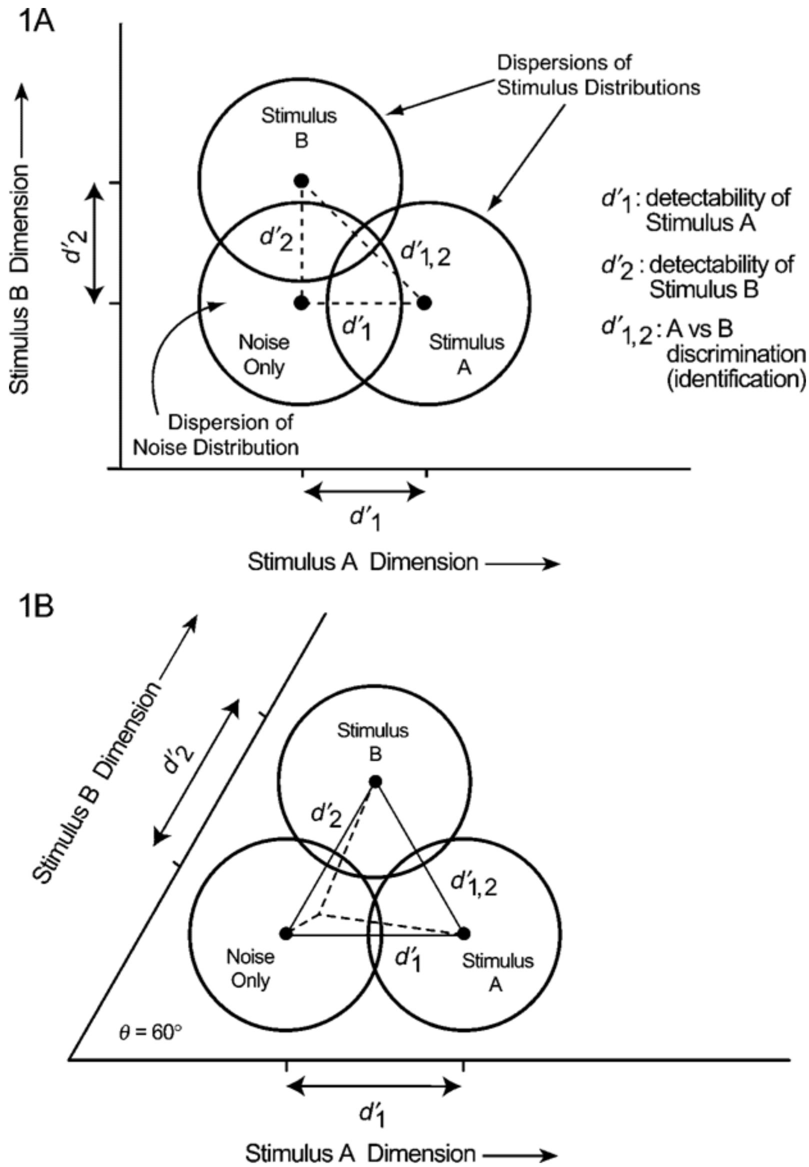

Figure 1. (A) SDT two-dimensional representation of identification discriminations, illustrating identification's dependence on and derivation from detection. The three circles represent the two-dimensional distributions of the noise only, *A*, and *B* stimuli. Each circle is one *SD* away from the mean of that distribution. Identification d' ($d'_{1,2}$) is the distance between the detectability of stimulus *A* (d'_1) and *B* (d'_2). This distance depends on both the magnitudes of d'_1 and d'_2 and the correlation between the stimulus *A* and *B* dimensions. An idealized case is depicted here, wherein d'_1 and d'_2 are equal and the stimulus A and B dimensions are orthogonal. (B) Here, a more realistic depiction of the relationship between detection and identification is given, reflecting the highly correlated (i.e., nonorthogonal) nature of typical word stimuli. Consequently, identification d' is smaller than detection d'. Moreover, at low levels of detection the stimulus *A* and *B* dimensions overlap completely. The internal dotted lines depict this situation, where identification d' exceeds zero only at substantial levels of detection d'.

also Greenwald et al., 1995) position discrimination task was 2IFC spatial detection.

What about forced-choice lexical decision, also sometimes used as a conscious perception index (e.g., Klinger et al., 2000)? Given the above, it becomes clear that lexical decision is a basic semantic classification task. Less clear is Draine and Greenwald's (1998) "word versus XG" task, which seems to be a hybrid of identification and lex-

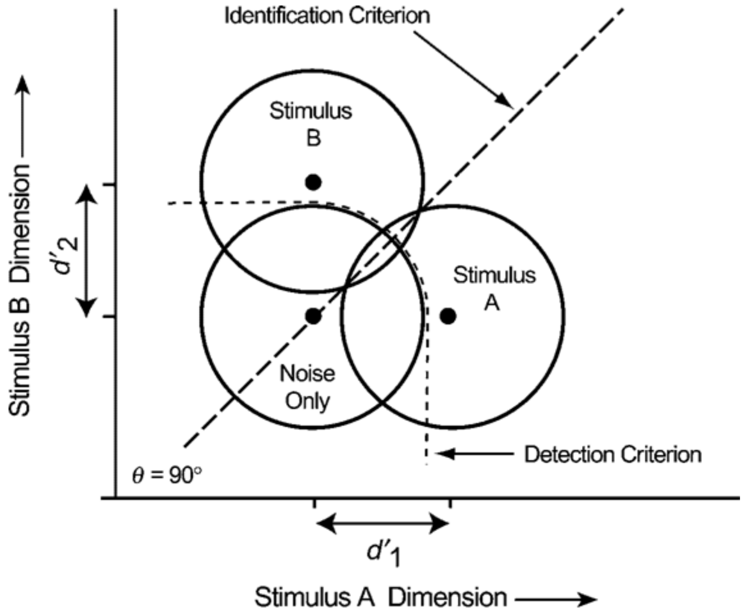

Figure 2. SDT representation of how above chance identification is expected even with stimuli that are below the detection criterion, but without implying unconscious perception (cf. Macmillan, 1986). Some of the *A* stimuli will be below the detection criterion; these stimuli will more often be on the "*A* side" of the identification criterion than on the *B* side. The analogous situation holds for the stimulus *B* distribution.

ical decision. In this task, if the stimulus is a word, it can be any word (similar to regular lexical decision); if not, it is always an irregular string of Xs and Gs (similar to identification). Given that the word versus XG task is at least partly classification, however, it may not be exhaustively sensitive to semantic priming effects.

Empirical Evidence Regarding Thresholds and Relative Sensitivities

Experiments comparing objective thresholds support the proposed exhaustiveness hierarchy. For example, Dagenbach et al. (1989) repeatedly found that detection thresholds were below 2AFC identification thresholds, as did Price (1990, Experiment 1). Similarly, Haase (1994) found that detection exceeded chance under conditions when 2AFC identification did not, and Greenwald et al. (1989, Appendix) found that 2IFC and presence/absence detection were more sensitive than word and single-letter identification tasks. In turn, Stenberg, Lindgren, Johansson, Olsson, and Rosen (2000, p. 984) found that 2AFC identification was more sensitive than semantic classification. Interestingly, lexical decision is more sensitive than most semantic classification tasks (e.g., pleasant vs. unpleasant; see Draine & Greenwald, 1998, Experiment 4; Klinger et al., 2000), probably because the former requires less information than the latter. Collectively, these findings confirm that detection is the most sensitive task, followed by identification, and finally semantic classification. Indeed, even if one thought that these tasks were completely unrelated (cf. Reingold & Merikle, 1988, 1990), these findings would still support the proposed exhaustiveness relations, because achieving null sensitivity on the relevant lower order task (which requires more stringent exposure conditions) should suffice to prevent conscious, higher order perceptual effects.

Core Features of the Conscious Perception Model

The foregoing suggests further that conscious perception occurs on a strength/complexity continuum, with only weak perception being necessary for lower level analysis and discrimination (e.g., detection), but requiring stronger perception for higher level analysis and discrimination (e.g., semantic priming). This central feature is embodied in two experimental manipulations widely believed to affect conscious perception: (1) stimulus intensity, and (2) direct versus indirect instructions. In turn, these manipulations illustrate the core prediction of the conscious perception model: Only effects compatible with the strength/complexity hierarchy should be possible.

Stimulus Intensity

This is the most fundamental manipulation; everyone agrees that conscious perception is positively related to stimulus strength. As stimulus duration is reduced and/or the heaviness of masking is increased, conscious perception diminishes. Eventually, subjective thresholds are reached; with still shorter durations, objective thresholds are finally attained. This pattern suggests a core prediction:

If an effect is driven by conscious perception, it should correlate positively with suitable conscious perception indexes. Thus, putatively unconscious effects that show this positive relationship are suspect, whereas those that do not are more compelling. Marcel (1983a), for example, emphasized that his subliminal and supraliminal priming effects were of the same size; conversely, Holender (1986) took care to rebut this claim. Similarly, Cheesman and Merikle (1984) stressed that they found a strong positive relationship ($r = .71$) between direct identification and indirect semantic priming, with null effects at the objective identification threshold.

Complexity of processing. Relatedly, it is widely held that the complexity of stimulus analysis is positively related to the degree of conscious perception. This leads naturally to the heart of the dissociation paradigm logic: Higher level effects (e.g., semantic priming) should not be possible without above chance performance on lower level tasks. Accordingly, semantic priming should not occur at the objective identification (or detection) thresholds; this is why Cheesman and Merikle's (1984) negative results were so compelling. Conversely, if such effects can be reliably obtained, considerable warrant for inferring unconscious perception obtains.

Strategic control over response. The utilization of metacognitive response strategies reflects complex, higher level conscious processing. Accordingly, strategically mediated effects should correlate positively with the degree of phenomenally conscious perception. A particularly popular version of this hypothesis holds that strategic control over responding is possible only with consciously (but not unconsciously) perceived stimuli, and infers unconscious perceptual influences when participants show effects but cannot voluntarily control them (cf. Jacoby's, 1991, process-dissociation paradigm; see, e.g., Merikle & Joordens, 1997a, 1997b; Merikle et al., 1995).

Direct Versus Indirect Instructions

In direct versus indirect manipulations, stimulus strength is held constant. Here, the fundamental idea is that direct instructions maximize conscious perceptual influences because they ask participants to utilize the relevant conscious perceptions, whereas indirect instructions do not. In relative sensitivity-type situations (i.e., when the same measure is used, varying only direct vs. indirect instructions), then, if conscious influences alone are at work, a direct $\geq$ indirect pattern is expected. This amounts to the hypothesis that conscious perception should correlate positively with direct (vs. indirect) instructions. Conversely, if an indirect $>$ direct pattern is obtained, inferences for unconscious influences are warranted.

A Generalized Qualitative Differences Approach to Inferences for Unconscious Perception

All unconscious perception paradigms centrally involve attempting to show that the single-process conscious perception model cannot account for the target effects, and in this sense always involve qualitative differences. But how can qualitative differences be evaluated? When do they suggest an additional unconscious perceptual process, as opposed to a second conscious process? Considerable progress can be made by examining the direction of the relationship between the qualitative difference and the conscious perception index or manipulation. In *weak* qualitative differences, this relationship is positive, and claims for unconscious perception are questionable because positive relationships are consistent with the conscious perception model. In particular, ostensibly unconscious effects may instead be weakly conscious. Unfortunately, many intuitively appealing qualitative differences suffer from this difficulty—specifically, those that demonstrate stronger, more complex, or more controlled effects with strong than with weak stimuli. For example, Abrams and Greenwald's (2000) finding that weak stimuli receive only fragmentary, partial analysis suggests a positive relationship, weakening their claim that these effects are unconscious. Similarly, Cheesman and Merikle's (1986) findings of relatedness proportion effects with clearly visible but not weak stimuli are inconclusive for just this reason (cf. Holender, 1986). As these examples show, weak qualitative differences remain vulnerable to the exhaustiveness and null sensitivity problems, exactly the difficulties they were intended to overcome.

In *strong* qualitative differences, on the other hand, this relationship is negative, allowing strong inferences for a second, unconscious perceptual process because it contradicts core features of the conscious perception model. In particular, it is difficult to interpret putatively unconscious effects as weakly conscious. For example, Groeger (1988) found more complex semantic effects with objectively undetectable stimuli, but only less complex structural effects with stronger stimuli, suggesting a negative relationship. Similarly, the relative sensitivity logic is appealing precisely because an indirect $>$ direct pattern implies a negative relationship. Furthermore, in typical dissociation paradigm experiments (e.g., Greenwald et al., 1989) the indirect task requires more complex processing than does the direct task, rendering an indirect $>$ direct pattern even more impressive.

However, for negative relationships to carry the desired inferential force, several conditions must be met. First, the qualitative differences must correspond to independently determined objective or subjective thresholds (cf. Holender, 1986); otherwise, multiple conscious perceptual processes could be indicated. Second, it must be clear that conscious perception would produce monotonically increasing positive effects; otherwise, negative relationships do not contradict the conscious perception model. Third, the negative direction must be unambiguous (cf. Dunn & Kirsner, 1989). For example, Merikle and associates (e.g., Merikle et al., 1995) have presented various qualitative differences that appear to exhibit negative relationships. However, exclusion can be alternatively viewed as a criterion-based strategic process that becomes stronger as stimulus intensity increases, suggesting that the true underlying relationship may be positive.

The present analysis has been strongly influenced by Dunn and Kirsner's (1988, 1989), methodological analysis of dissociations in the implicit memory literature. The relevance of their analysis becomes clear when we realize that qualitative differences are simply another name for dissociations. For example, showing that conscious control is possible with consciously but not unconsciously perceived stimuli is equivalent to demonstrating a single dissociation. Furthermore, Dunn and Kirsner showed that the strongest qualitative difference of all obtains when a *nonmonotonic* relationship—in which the direction changes across levels of performance—occurs, because this pattern fundamentally contradicts single process accounts. Applied to the present framework, we suggest that a particular U-shaped nonmontonic relationship—negative subthreshold, positive suprathreshold—provides strong evidence for a second, unconscious perceptual process.

Application to the Exhaustiveness, Null Sensitivity, and Exclusiveness Problems

Moreover, negative and/or nonmonotonic relationships between the conscious and unconscious perception indexes greatly ameliorate the exhaustiveness, null sensitivity, and exclusiveness problems, because all three predict a nonnegative relationship. For example, the fundamental concern underlying the exhaustiveness and null sensitivity problems is that weak conscious perception is actually responsible for putatively unconscious effects. If this is true, a positive, or at worst zero, relationship should hold. Analogously, the exclusiveness problem assumes that reducing direct measure performance will also reduce indirect measure effects, and hence also predicts a positive relationship. Finding negative or nonmonotonic relationships, then, provides direct evidence that nonexhaustiveness or measurement error is not responsible for unconscious perception index findings, and allays exclusiveness concerns as well.

THE OBJECTIVE THRESHOLD/ STRATEGIC MODEL

The subjective threshold and objective threshold/rapid decay models were developed in response to a shared conclusion: Objective threshold results were unreliable and weak. The former model concluded that objective threshold results did not exist; the latter concluded that objective threshold results were genuine but very short-lived. Our review of the evidence suggests a third explanation: Conscious and unconscious perceptual influences are *functionally exclusive* (cf. Jones's, 1987, typology), and the former override the latter when (1) both are present, and (2) participants regard their conscious perceptions as relevant given the task context. The latter occurs by definition with direct tasks and may occur frequently even with ostensibly indirect tasks.

From this perspective, reliable unconscious perceptual influences are most easily obtained at the objective detection threshold (ODT; detection $d' = 0$), where no stimulus-related conscious perception occurs. However, at the longer, objective identification threshold (OIT), stimuli are consciously detectable even though they are not yet identifiable. Whenever participants regard their conscious perception as relevant, then, unconscious perceptual influences should be maximal at the ODT and *decline*, not increase, as stimulus intensity increases to the OIT, because the overriding low-level conscious perception is not yet sufficient to support higher level effects. Accordingly, it is essential to distinguish between the ODT and OIT, because erroneous conclusions can result when they are conflated. For example, Cheesman and Merikle's (1984) influential null findings were actually obtained under OIT, not ODT, conditions. Finally, as stimulus intensity surpasses the OIT, higher level effects also increase, now driven exclusively by conscious perceptual inputs.

The objective threshold/strategic model thus predicts a methodologically powerful nonmonotonic relationship (initially negative, becoming positive) between the direct and indirect measures when data are obtained in the appropriate stimulus intensity regions. (See Figure 3A.) In contrast, the single-process conscious perception model predicts a monotonic relationship in which indirect performance remains flat and does not exceed zero until the OIT, then becoming positive. (See Figure 3B.) Notably, the subjective threshold model makes the same prediction. (See Figure 3C.) Finally, the objective threshold/rapid decay model predicts a monotonic relationship in which indirect performance exceeds zero but remains flat, given very rapid responses. (See Figure 3D.) If responding is relatively slow, this model predicts only conscious perceptual effects (cf. Figure 3B).

Strategic Factors Mediate Unconscious Perceptual Influences

Before surveying the literature, it is useful to explain the role of two strategic effects that arise when participants attempt to consciously identify weakly perceivable primes. The most important such mechanism—conscious perception override—has just been described, and it produces the crucial negative or nonmonotonic relationship. Lest this override hypothesis seem overly post hoc, consider that semantic priming is also eliminated even with clearly visible primes if participants focus on the primes' nonsemantic properties (e.g., perform a letter search task—cf. Smith, Theodor, & Franklin, 1983; see Maxfield, 1997, for a recent review). To illustrate this strategic process with weakly perceivable primes, consider Dagenbach et al.'s (1989) experiments. In the threshold-setting phase, all participants began with SDT detection; some then additionally performed 2AFC identification, whereas others performed 2AFC semantic classification. In the subsequent semantic priming task, ODT but not OIT priming was obtained.

Further, Dagenbach et al. (1989) found that strategically driven attempts to extract specifically semantic prime information can produce a second type of inhibiting influence on semantic activation. Specifically, although participants who underwent only nonsemantic threshold-

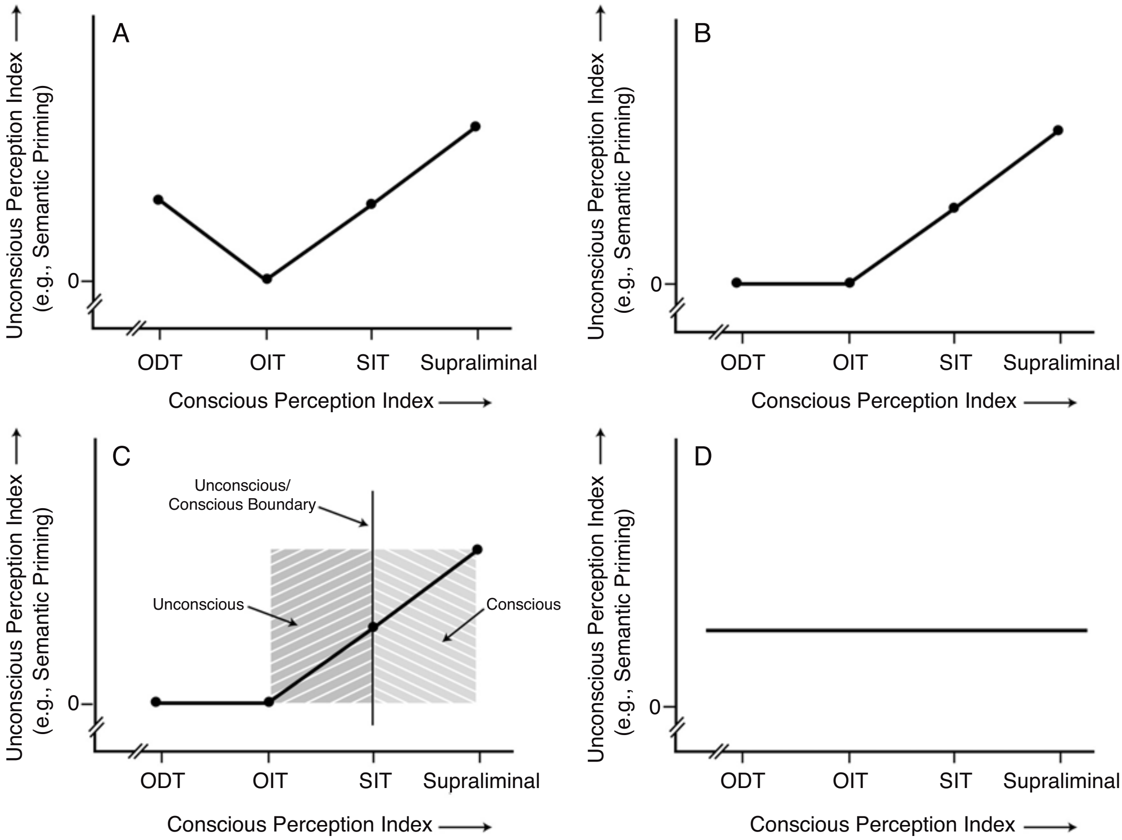

Figure 3. (A) The objective threshold/strategic model's nonmonotonic prediction for the relationship between direct and indirect performance. This relationship is negative as stimulus intensity increases from the objective detection threshold (ODT) to the objective identification threshold (OIT), reaching zero at the OIT. Beyond the OIT, the relationship becomes positive. (B) The single-process conscious perception model's monotonic prediction for the direct/indirect relationship. Indirect performance remains flat and does not exceed zero until the OIT is surpassed; then, the relationship becomes positive. (C) The subjective threshold model's monotonic prediction for the direct/indirect relationship. Although identical to the single-process conscious perception model's prediction, the subjective threshold model holds that stimuli below the subjective identification threshold (SIT) are unconscious, whereas stimuli above this threshold are conscious. (D) The objective threshold/rapid decay model's monotonic prediction for the direct/indirect relationship. Here, indirect performance exceeds zero but remains flat throughout the entire stimulus intensity range, provided that very rapid responses are obtained.

setting tasks (i.e., detection and identification) exhibited the usual positive ODT effects, those whose second direct task was semantic classification exhibited negative (i.e., related > unrelated RTs) ODT effects. Dagenbach et al. (1989) proposed that an attentional center–surround (C–S) mechanism was responsible: When attempts are made to extract semantic meaning from unidentifiable primes, the prime (the center) receives additional activation, whereas the prime's semantic associates (the surround) are inhibited to reduce the possibility that they will be erroneously retrieved. Carr and Dagenbach (1990) replicated the positive and negative ODT priming effects, again showing that the preceding threshold-setting task mediated their direction. They further found, as predicted by the C–S account, that repetition priming was unaffected (see also Dagenbach & Carr, 1994).

When are these strategic mechanisms invoked? Conscious perception override likely occurs whenever participants believe the primes are relevant, whereas the C–S mechanism requires further, additional attempts to extract semantic information. Importantly, unconscious perception experiments often contain features likely to invoke one or both of these strategic mechanisms. For example, they often begin with lengthy threshold-setting and/or practice phases, in which stimulus intensity is gradually reduced (see, e.g., Cheesman & Merikle, 1984; Dagenbach et al., 1989). Such procedures highlight the presence and relevance of weakly perceivable primes. Once invoked, these mechanisms are apparently carried over into the priming phase, perhaps automatically.

Even without such initial tasks, these mechanisms may be invoked whenever prime–target semantic relationships are salient. For example, Smith, Besner, and Miyoshi (1994) found that short and long-duration primes produced equivalent priming when presented between participants, but that intermixing prime duration eliminated short-duration priming. Stolz and Besner (1997) suggested that prime–target semantic relationships were salient with long-duration primes, and thus that intermixing prime durations perhaps encouraged attempts to extract semantic information from short-duration primes as well, invoking C–S inhibition. On the other hand, prime–target relationships would not be salient with short-duration primes presented alone, so C–S inhibition should not occur. Accordingly, Stoltz and Besner manipulated the relatedness proportion, conjecturing that a low relatedness proportion would render prime–target relationships nonsalient, thus obviating C–S mechanisms. As predicted, with low relatedness proportion, both long- and short-duration primes produced equivalent priming even when intermixed. With high relatedness proportion, however, the intermixed condition eliminated short-duration priming.[3]

Negative priming and inferences for unconscious perception. Under certain conditions, weakly conscious perception can produce negative priming, which can produce misleading negative and/or nonmonotonic relationships. For example, Durante and Hirshman (1994, Experiment 1) found positive priming with 33-msec primes, negative priming with 66-msec primes, and positive priming once more with clearly visible primes. The negative priming with 66-msec primes was apparently due to C–S inhibition (or retrospective prime clarification; see Kahan, 2000); moreover, free identification with these primes was approximately 45%, suggesting that they were far above the OIT and hence partially conscious. Thus, negative relationships provide strong evidence against conscious perceptual explanations only when it is clear that conscious perception would produce monotonically increasing positive effects. Accordingly, we focus on standard semantic priming and forced-choice discrimination tasks, and largely avoid negative priming paradigms.

Evidence for Reliable ODT Results and the Objective Threshold/Strategic Model

In our view, the two strategic processes, along with distinguishing between ODT and OIT conditions, can explain extant unconscious perception findings. Conscious perception override explains the negative and/or nonmonotonic relationships often found between the conscious and unconscious perception indexes, whereas the C–S mechanism explains certain otherwise puzzling results. Both of these mechanisms can interfere with unconscious perceptual influences, obscuring their presence. With all this in mind, the objective threshold/strategic model predicts that ODT results should be easily obtainable (barring C–S inhibition), and that null findings should usually occur at the OIT. For reasons of space, the present review is not exhaustive, but it does cover most research conducted after Holender's (1986) review. We emphasize research that has used clearly valid conscious perception indexes (i.e., SDT detection or identification). Accordingly, we do not discuss response window experiments (e.g., Abrams & Greenwald, 2000; Draine & Greenwald, 1998; Klinger et al., 2000), which have used semantic classification tasks and variants thereof.

Direct Versus Indirect Investigations

These studies attempt to obtain more complex (usually semantic priming) indirect effects while simultaneously demonstrating null sensitivity on a less complex direct measure.

Dagenbach et al. (1989); Carr and Dagenbach (1990). SDT detection tasks verified that the threshold-setting procedures were successful: Dagenbach et al. (1989, Experiment 4) reported 50.5% correct (80 trials; Experiments 1–3 used 40 trials), whereas Carr and Dagenbach (1990, Experiment 1) obtained 49.8% correct (80 trials). When only nonsemantic threshold-setting tasks were used, positive ODT and null OIT findings were found in the priming phase; when semantic discrimination threshold-setting tasks were used, reverse ODT and null OIT findings were obtained. Overall, five positive ODT priming effects (Carr & Dagenbach, Experiment 1; Dagenbach et al., Experiments 1–4) and two null OIT priming effects (Dagenbach et al., Experiments 1 and 4) were found, thus demonstrating a negative relationship between stimulus intensity and semantic priming in the crucial ODT–OIT region. Positive supraliminal priming was also found, producing the full nonmonotonic pattern.

Klinger and Greenwald (1995). These investigators also used SDT presence/absence detection as the conscious perception index, along with an indirect semantic priming task. In each of two experiments (Experiments 1 and 3), they divided participants into two equally sized groups: low d' (mean detection $d' = 0.05$ and -0.01, respectively) and high d' (mean $d' = 1.42$ and 1.13). The low d' group thus met the ODT, whereas the high d' group approximated the OIT (cf. Haase, 1994; Experiment 3b). In both experiments, the low d' group showed priming effects; the high d' group did not. Klinger and Greenwald thus obtained two further replications of the negative relationship between stimulus intensity and semantic priming in the ODT–OIT region. Moreover, positive supraliminal priming was also found, again producing the entire nonmonotonic pattern.

Groeger (1988). Using auditory primes, Groeger first estimated 2IFC (temporal interval) detection thresholds. An indirect sentence completion task was then performed in which a word was missing; a tone filled the gap. The control group received only the tone, the "subawareness" (ODT) group received an undetectable prime word along with the tone, and the "subrecognition" group (a subjective threshold variant) received a detectable but not freely identifiable prime along with the tone. Following presentation of the sentence, participants selected which of two clearly audible targets best completed it. One target word was either semantically or phonologically related to the prime; the other was unrelated. The control group showed no effects, ruling out item bias. The ODT group showed only semantic priming effects, whereas the subjective threshold group showed only phonological effects. Thus, the quieter ODT produced higher level effects, whereas louder, subjective threshold conditions produced only lower level effects, again demonstrating a negative relationship between stimulus intensity and effect complexity. A subsequent 120-trial 2IFC detection check confirmed null sensitivity (50.4%) for the ODT group, and near perfect detection sensitivity for the subjective threshold group.

Greenwald et al. (1989). Here, the conscious perception index was 2IFC position interval detection. The primary indirect measure was an evaluative decision priming task; prime–target pairs were either congruent or incongruent regarding positive or negative emotional connotations. Only ODT stimulus conditions were examined, so these experiments did not address the negative and/or nonmonotonic relationship issue. Importantly, however, all three experiments yielded positive ODT semantic priming effects.[4] Furthermore, Greenwald et al. (1989) introduced an additional, novel indirect measure derived from the 2IFC detection task itself. Using the words *left* and *right* as stimuli, they orthogonally manipulated word meaning and spatial position, thus allowing independent derivation of (1) the influence of the word's specific meaning on detection response selection (the indirect index), and (2) the effect of actual word position (the direct index). Despite null detection sensitivity, participants' detection responses were influenced by word meaning congruence (significant in Experiments 1 and 3), thus demonstrating unconscious priming.[5]

Greenwald et al. (1995). This large-scale replication of Greenwald et al. (1989) used the same two indirect measures. Exposure conditions allowed mean 2IFC detection to exceed chance ($d' = .40$); evidence for ODT effects thus required use of the regression approach. Strikingly, null evaluative priming and only weak position congruence effects were obtained. These findings appear to powerfully nonreplicate Greenwald et al. (1989), and apparently motivated Greenwald and associates to shift to the response window paradigm (cf. Draine & Greenwald, 1998).

However, although all these experiments (except Greenwald et al., 1989, Experiment 1) used simultaneous dichoptic masking, Greenwald et al.'s (1995) procedures differed from their earlier work in one crucial respect. In Greenwald et al. (1989; Experiments 2 and 3) and Klinger and Greenwald (1995), all primes were presented only to the nondominant eye. In Greenwald et al. (1995), however, experimental (nondominant eye) trials were intermixed with filler (dominant eye) trials. Because simultaneous dichoptic masking is much less effective with dominant eye trials, this procedure produced a within-subjects mixture of hard-to-see trials with easier-to-see trials. This situation seems to invoke C–S interference (cf. Smith et al., 1994; Stenberg et al., 2000, p. 977; Stolz & Besner, 1997), reducing or eliminating priming effects from the weaker stimuli; similar suppressive mechanisms may have also greatly reduced the position congruence effects.

Double Direct Measure Investigations

These studies seek more complex effects on one direct measure while simultaneously demonstrating null sensitivity on a less complex direct measure (cf. Marcel, 1983a, Experiments 1 and 2).

Snodgrass, Shevrin, and Kopka (1993), replicated by Van Selst and Merikle (1993) and Snodgrass and Shevrin (2002). Here, the unconscious perception index was 4AFC identification; the conscious perception index was SDT detection. Identification was performed using two strategies (within subjects): "Look" instructions urged reliance on any available conscious perception, whereas "pop" instructions asked participants to respond with the first word that came to mind. Participants also indicated their strategy preference, yielding an individual difference variable. Overall, identification performance was obtained in seven experiments; because their designs were so similar, the results are ideally suited to meta-analytic cumulation.

The primary result was a preference $\times$ strategy interaction [$F(1,242) = 36.23, p = 6.45 \times 10^{-9}$], wherein performance was below chance in the nonpreferred strategy and above chance in the preferred strategy, especially for look preference participants. Strikingly, only interactive effects were obtained; the grand performance mean was right at chance (25%). Snodgrass and Shevrin (2002) interpreted this interaction in terms of unconscious attribution; participants might expect to do worse in their nonpreferred strategy, but better in their preferred strategy.

In earlier studies, null detection sensitivity was obtained in separate experiments (e.g., Snodgrass et al., 1993, Experiment 3). Van Selst and Merikle (1993, Experiment 3) were particularly thorough: Detection conditions exactly matched those used for the identification task, and many trials (240/participant) were obtained. Null detection sensitivity (49.3%; chance = 50%) ensued; furthermore, neither preference nor strategy mediated performance. Van Selst and Merikle concluded (p. 201), "This complete absence of any effects indicates that subjects are unable to utilize any of the information in the displays when making detection decisions." More recently (Snodgrass & Shevrin, 2002, Experiment 3), participants completed both identification and detection task phases; again, null detection sensitivity held ($d' = .05$). Overall, null detection sensitivity seems well established; when all detection trials are combined (7,248 across three experiments), detection was 49.9%.

Price (1990, 2001). Here, participants made 2AFC semantic category and SDT detection discriminations across a wide range of prime–mask SOAs. In two experiments, as SOAs became more stringent, first semantic discrimination fell to chance. At still shorter SOAs, detection fell to chance. At the ODT, however, semantic discriminations now deviated from chance, but only in terms of increased *variance*. Price's results are consistent with Snodgrass and associates', in that no overall mean effects occurred. Furthermore, because Price did not have (for example) preference and strategy information, inhibitors and facilitators were mixed, yielding only variance effects.

Do Reliable ODT Unconscious Perception Effects Exist?

The present review suggests that experiments using carefully determined ODT conditions yield reliable evidence for unconscious perception. These positive results were obtained in 20 experiments from nine investigations (Carr & Dagenbach, 1990—1; Dagenbach et al., 1989—4; Greenwald et al., 1989—3; Groeger, 1988—1; Klinger & Greenwald, 1995—2; Price, 1990, 2001—2; Snodgrass & Shevrin, 2002—3; Snodgrass et al., 1993—2; Van Selst & Merikle, 1993—2). These more rigorous studies have provided stronger and more consistent evidence for ODT effects than did the earlier studies criticized by Holender (1986), Reingold and Merikle (1988, 1990), and others. Moreover, negative and/or nonmonotonic relationships were found whenever the appropriate comparison could be made. These positive results were obtained in 7 experiments from four investigations (Dagenbach et al., 1989—2; Groeger, 1988—1; Klinger & Greenwald, 1995—2; Price, 1990, 2001—2). Cheesman and Merikle's (1984, Experiments 1 and 2) results also fit the hypothesized pattern: null OIT findings, but now a positive rather than a negative relationship (being on the other side of the OIT).

But what about effect size? Although some ODT findings may appear small in raw units, their effect sizes are reasonable. For example, the average effect size (Cohen's d) for the five ODT studies in Dagenbach et al. (1989) and Carr and Dagenbach (1990) is .52; similarly, the average Cohen's d for the preference × strategy effect for the seven ODT studies in Snodgrass et al. (1993), Snodgrass and Shevrin (2002), and Van Selst and Merikle (1993) is .77. By comparison, consider that many standard cognitive effects appear small in raw units as well (e.g., 30–50 msec priming effects) but also possess moderate effect sizes. Furthermore, it is unlikely that unpublished null findings would substantially affect the present conclusions. For example, Rosenthal's fail-safe N for the overall preference × strategy effect alone is 83, meaning that 83 samples (with about 35 participants each) with null findings would have to exist to render this effect nonsignificant.

But what about task comparability issues? Reingold and Merikle (e.g., 1988) argued that direct and indirect task differences are problematic, particularly with respect to (1) the stimulus states being discriminated, (2) SDT sensitivity versus response bias, (3) task metric, and (4) retrieval environment. As with the exhaustiveness and null sensitivity problems, the underlying concern is that task differences may render the direct task less sensitive to relevant conscious perception than the indirect task, producing artifactual results. There is little reason, however, to believe that such differences were problematic in the studies just reviewed. First, differences in the stimulus states being discriminated (i.e., task differences per se) are nonproblematic provided that the proposed exhaustiveness hierarchy is observed. Second, the measures used were materially bias free: The conscious perception index was SDT detection, and the unconscious perception index was either suitably controlled priming tasks or forced-choice identification or classification, in which bias, if any, reduces rather than increases performance. Third, although task metric did sometimes differ (e.g., detection vs. priming), this is only problematic if one seeks to compare the magnitude of point estimates of the direct and indirect effects (i.e., relative sensitivity style), and even then procedures are available to equate the metrics (see Klotz & Neumann, 1999, p. 988). In any event, differing task metrics are nonproblematic when the focus is on the relationship between the conscious and unconscious perception indexes, rather than on comparing their means.

Finally, task retrieval environment differences require close consideration. For example, Purcell et al. (1983) and Holender (1986) showed that failing to equate effective luminance levels for the direct and indirect tasks likely produced spurious results in certain earlier studies (e.g., McCauley, Parmelee, Sperber, & Carr, 1980). Unfortunately, this was likely also a problem in Kemp-Wheeler and Hill's (1988, 1992) experiments, which led us to omit them from our review. In the other recent studies just discussed, however, luminance levels were always equated.

However, in some of the experiments above (Carr & Dagenbach, 1990; Dagenbach et al., 1989; Greenwald et al., 1989; Klinger & Greenwald, 1995, Experiment 1), another potential problem occurred. In these studies, primes were presented alone during the threshold-setting phase, but along with targets during the priming phase. Accordingly, Dark (1988; see also Bernstein, Bissonnette, Vyas, & Barclay, 1989; Dark & Benson, 1991; VanVoorhis & Dark, 1995) suggested that retroactive priming—in which prime identifiability increases when followed by a related target—might explain ostensibly unconscious priming effects. Under more stringent ODT conditions, however, Klinger and Greenwald (1995, Experiment 2) found no retroactive priming. Furthermore, Durante and Hirshman (1994; see also Hirshman & Durante, 1992, p. 262) manipulated retroactive priming and found that it was negatively, not positively, related to masked priming effects. Thus, retroactive priming does not seem to explain masked priming effects, let alone ODT effects. Along these lines, Dark and Benson (1991, p. 74) acknowledged that retroactive priming may not occur under ODT conditions.

Furthermore, Klinger and Greenwald (1995, Experiment 3) equated the conscious and unconscious perception index retrieval environments completely, suggesting that their other, nonequated priming results were valid. Van Selst & Merikle (1993; Experiment 3) did the same for the two tasks in our paradigm (cf. Snodgrass & Shevrin, 2002; Snodgrass et al., 1993), yielding similar convergent validation. Finally, the Groeger (1988) and Price (1990, 2001) task environments were completely equated, as were Greenwald et al.'s (1989; Greenwald et al., 1995) position response measures.

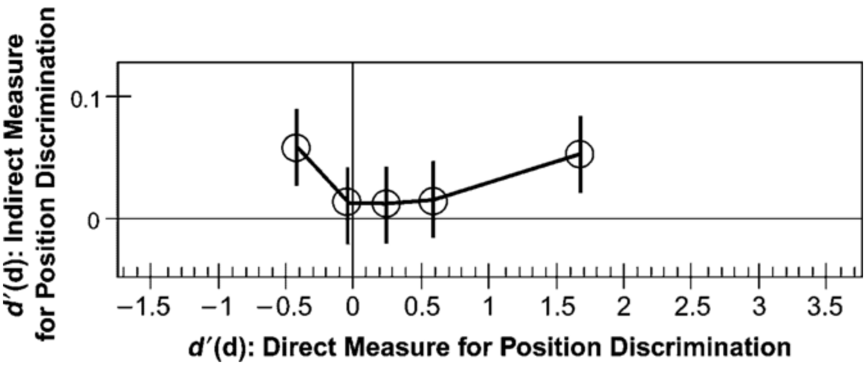

Figure 4. Regression data from Greenwald et al. (1995), showing a curvilinear relationship between the direct and indirect measures. On the horizontal axis is d'_d, a direct measure which indexed participants' ability to discriminate the masked stimulus words' actual spatial position when the words' semantic meaning had no bearing on detection response selection. On the vertical axis is d'_i, an indirect measure reflecting the effect of masked word meaning (the word "left" or "righ," shortened from *right* to keep length constant) on detection task response selection (irrespective of the word's actual spatial position). This figure is a descriptive summary, categorized into pentiles of scores on d'_d and showing 95% confidence intervals of d'_i for each pentile, plotted as a function of the pentile mean on d'_d ($N = 1{,}431$). Notice that the bottom pentile reflects below zero values of d'_d; these presumably occur because of measurement error. At the same time, such below zero d'_d scores are more likely to reflect true underlying $d'_d = 0$ than obtained values closer to zero (see Greenwald et al., pp. 39–40). Adapted from Figure 4 of "Activation by Marginally Perceptible ("Subliminal") Stimuli: Dissociation of Unconscious From Conscious Cognition" by A. G. Greenwald, M. R. Klinger, and E. S. Schuh, 1995, *Journal of Experimental Psychology: General, 124*, p. 32. Copyright 1995 by the American Psychological Association. Adapted with permission.

Finally, as with the exhaustiveness and null sensitivity problems, skeptical task comparability hypotheses predict positive (or at least nonnegative) relationships between the direct and indirect indexes—which is contradicted by the negative relationships found above (including in Dagenbach et al., 1989; Klinger & Greenwald, 1995). Negative relationships also suggest that direct/indirect differences in time of administration are not problematic. If fatigue or some other time-related factor underestimated prime perceivability, nonnegative relationships should occur.

Further Evidence for the Objective Threshold/Strategic Model

Additional retrospective evidence. The extensive detection check by Van Selst and Merikle (1993; see also Snodgrass & Shevrin, 2002; Snodgrass et al., 1993) retroactively suggests that certain earlier work by the second author conducted under identical exposure conditions also attained null detection sensitivity (Shevrin & Fritzler, 1968a, 1968b; Shevrin & Rennick, 1967; Shevrin, Smith, & Fritzler, 1969, 1970, 1971), yielding six further positive ODT results.

Regression approach evidence. Negative slopes in the ODT–OIT region ameliorate regression approach validity concerns because (1) predictor measurement error now underestimates y-intercepts in the very situations in which positive slopes overestimate them (i.e., when the direct measure mean is positive), and (2) the presence of a relationship allows the meaningful derivation of y-intercepts. With this in mind, consider again Greenwald et al.'s (1995, p. 36) position discrimination congruence results. As Figure 4 shows, a U-shaped nonmonotonic relationship was obtained. Given the negative slope in the ODT region, the y-intercept is underestimated, not overestimated. These data therefore allow valid use of the regression approach and moreover replicate Greenwald et al.'s (1989) position discrimination findings, yielding further ODT effects.

Prospective evidence. Since developing this theory, we have made prospective predictions in two experiments. First, Bernat et al. (2001) investigated unconscious P300 effects in a classical visual oddball paradigm (e.g., Pritchard, 1981). P300 oddball effects (i.e., greater amplitude to the rare stimulus) are a classic psychophysiological effect with supraliminal stimuli; here, we used ODT stimuli ($d' = .10$). Brain waves were the indirect measure, and significant P300 oddball effects were obtained. Because participants were told to attend closely to the stimulus display, and hence were alerted to the stimuli's presence and relevance, we predicted a negative relationship. As Figure 5 shows, the oddball effect was indeed negatively related to detection d' ($r = -.44, p < .05$). Second, Snodgrass and Shevrin (2002) predicted that conscious perception override would operate more under look than under pop instructions, because the former urge reliance on conscious perception whereas the latter do not, and that this would occur especially for look preference participants, who were particularly inclined to rely on conscious perception. As Figure 6 shows, look performance was indeed negatively correlated with detection d' ($r = -.31$, $p < .06$), whereas pop performance was not ($r = .05$, n.s.).

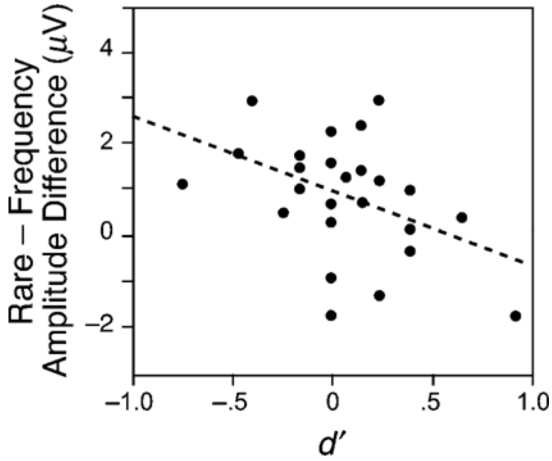

Figure 5. Regression of P300 oddball effect (rare minus frequent peak amplitude difference, 400–760 msec window, averaged across the Fz, Cz, and Pz electrodes) on detection *d′*. Adapted from Figure 5 of "Subliminal Visual Oddball Stimuli Evoke a P300 Component" by E. Bernat, H. Shevrin, and M. Snodgrass, 2001, *Journal of Clinical Neurophysiology, 112,* p. 168. Adapted with permission.

Conscious Perception Override May Be Optional or Delayed

Whereas C–S interference is strategy-dependent, the negative ODT–OIT relationship seems ubiquitous, suggesting that conscious perception may intrinsically override unconscious perceptual influences. There is, however, some evidence for positive OIT effects, which suggests that conscious perception override may also be optional. For example, Hines, Czerwinski, Sawyer, & Dwyer, (1986, Experiment 4) apparently obtained OIT semantic priming effects. However, Hines (1993) obtained above-chance identification under similar conditions, suggesting that Hines et al. (1986) perhaps underestimated identification sensitivity. However, contrary to conscious perception predictions, Hines's priming effects were uncorrelated with identification, and OIT subgroups still showed priming effects (see Hines, 1992, 1993; Hines et al., 1986). If reliable, an important task difference may account for these results: The pronunciation task was used throughout. Unlike lexical decision, noticing the presence or absence of prime–target relationships does not clearly aid pronunciation performance, making the primes less relevant and thus possibly obviating conscious perception override.[6]

Conscious perception override may also be bypassed or delayed when indirect task performance is so fast that there is insufficient time for conscious perception to develop and/or the override process to occur. This might account for the flat regression slopes obtained in Greenwald and associates' (e.g., Abrams & Greenwald, 2000; Draine & Greenwald, 1998; Klinger et al., 2000) response window paradigm, which produces very brief RTs (c. 400 msec). Similarly, motor activation paradigms also produce very brief RTs, which could explain Eimer and Schlaghecken's (1998; Eimer, 1999) apparently reliable priming effects obtained under what appear to be OIT conditions. Strikingly, Klapp and Hinkley (2002; see also Eimer & Schlaghecken, 2002) have recently reported that negative motor activation effects diminish rapidly just above the OIT; furthermore, when primes are fully visible, positive priming results. They argued that this pattern constituted a negative relationship between prime visibility and negative priming, justifying inferences for unconscious perception. However, although these data could indeed reflect delayed conscious perception override, the negative relationship logic is less compelling when both negative and positive priming effects are involved, because one could alternatively argue that weakly conscious primes produce negative priming whereas more visible primes produce positive

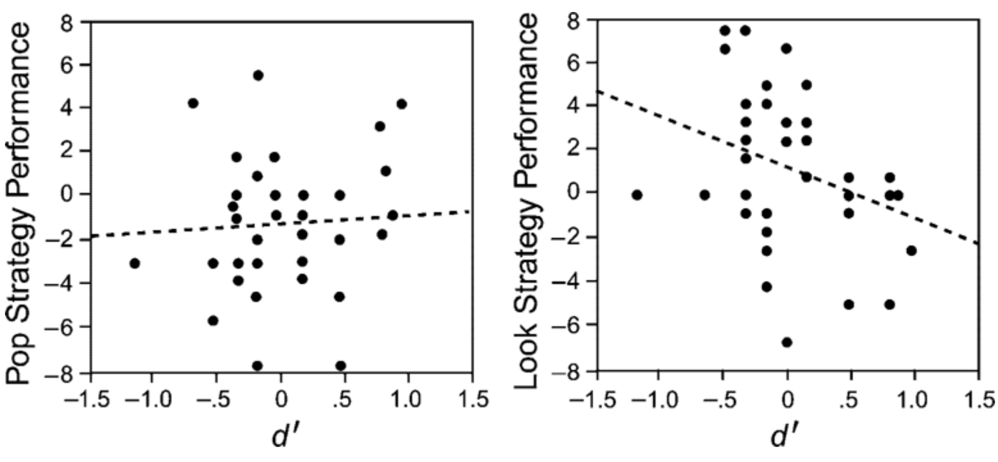

Figure 6. Regression of identification performance on detection *d′* for look preference participants. A negative slope occurs under look instructions, which encourage reliance on conscious perception, but not under pop instructions, which do not. Identification performance is plotted such that chance (25%) is zero on the *y*-axis. Data from M. Snodgrass and H. Shevrin (2002), *Unconscious Inhibition and Facilitation at the Objective Detection Threshold: Replicable and Qualitatively Different Unconscious Perceptual Effects.* Manuscript submitted for publication.

priming. Accordingly, we suggest that the strongest evidence that these effects are driven by unconscious perception is their OIT status, not the negative relationship between prime visibility and negative priming.

DISCUSSION

If our literature review is accurate, the available evidence suggests a nonmonotonic U-shaped relationship between the conscious and unconscious perception indexes. This pattern constitutes a strong qualitative difference inconsistent with the single-process conscious perception model, thus allowing strong inferences for unconscious perception. In particular, the conscious perception model holds that genuine ODT effects are impossible, and that any apparent ODT findings are actually weakly conscious (cf. the exhaustiveness and null sensitivity problems). However, the initial, negative-going (ODT–OIT) portion of the nonmonotonic relationship allays these concerns, because they predict nonnegative relationships at all times. The negative portion also ameliorates exclusiveness concerns, which similarly predict positive relationships.

Moreover, the nonmonotonic relationship is consistent with the objective threshold/strategic model but inconsistent with the alternative unconscious perception models. For example, like the conscious perception model, the subjective threshold model also predicts that genuine ODT effects are impossible, and hence that putative ODT findings must actually be weak subjective threshold effects (see, e.g., Merikle & Daneman, 2000; Merikle, Smilek, & Eastwood, 2001). Here again, the negative ODT–OIT portion of the curve contradicts this interpretation, instead suggesting that ODT effects reflect unconscious perceptual influences distinct from subjective threshold phenomena. Furthermore, the objective threshold/rapid decay model holds that reliable ODT effects should occur only under highly speeded conditions, which was not the case in the evidence reviewed herein. Finally, the later, positive-going (OIT on up) portion is indistinguishable from the conscious perception model, suggesting that subjective threshold and objective threshold/rapid decay effects, which are obtained in this region, may in fact be weakly conscious.

The available evidence also suggests that direct ODT effects qualitatively differ from indirect ODT effects in a striking manner. Moreover, this qualitative difference turns out to have substantive implications for the exclusiveness problem and the conscious control issue as well.

We will now discuss (1) implications of the nonmonotonic relationship for how conscious and unconscious perception jointly determine performance; (2) implications of the qualitatively different direct and indirect ODT effects; and (3) the objective threshold/strategic interpretation of subjective threshold and objective threshold/rapid decay effects.

How Do Conscious and Unconscious Perceptual Influences Jointly Determine Performance?

The general issue of how to model the joint contribution of two processes to performance has received considerable attention in the memory literature. Jones's (1987) influential typology posits three prototypical alternatives: (1) *redundancy*, in which, for example, process *B*'s influence depends on the successful execution of process *A* (here, *B*'s influence completely overlaps with *A*'s, but not vice versa); (2) *independence*, in which process *A* and *B*'s influences are independent, and their overlap is the product of their individual probabilities; and (3) *exclusivity*, where process A and B's influences are mutually exclusive, resulting in no overlap. As Jones noted, these models imply a positive, zero, or negative correlation between the *A* and *B* processes, respectively.

So which alternative fits the observed U-shaped function best? In our view, the data are most consistent with a modified exclusivity model, in such a way that conscious perceptual influences typically override unconscious ones when both are present. At the ODT, conscious perception is completely absent, allowing higher level unconscious perceptual influences to manifest freely. In the ODT–OIT region, these slightly stronger stimuli are consciously detectable although not yet identifiable. This lower level conscious perception nonetheless overrides higher level unconscious perceptual influences, producing the negative portion of the curve. Beyond the OIT, conscious perception is strong enough by itself to drive higher level effects, and the curve becomes positive.

In suggesting that conscious and unconscious perceptual *influences* are functionally exclusive, however, we do not mean to imply that the underlying *processes* are exclusive. Indeed, the data suggest that although unconscious perception can occur alone (i.e., at the ODT), conscious perception occurs only along with unconscious perception—suggesting a redundancy model on the process level. Rather, the posited functional exclusiveness relationship holds when both processes are operative and thus overlap. Merikle et al. (1995, p. 436) made a similar distinction, noting that the process dissociation paradigm posits process independence but functional exclusiveness with exclusion tasks (i.e., consciously perceived items are excluded, even if also unconsciously perceived). Alternatively, the data may be consistent with an exclusivity relationship on the process level, implying no process overlap. This formulation, however, predicts that OIT effects should never occur, and thus it cannot accommodate Hines's (e.g., 1992, 1993) and Eimer's (e.g., 1999) apparently reliable OIT findings. In contrast, in pure redundancy or independence models where exclusivity plays no role, negative relationships cannot occur. In the ODT–OIT region, for example, unhelpful lower level conscious perception would simply have no effect, because unconscious perception could continue to support higher level performance unopposed.

Implications for the exclusiveness problem. Reingold and Merikle (1988, 1990) argued that achieving direct measure null sensitivity would eliminate not only conscious but unconscious perceptual influences as well, including on the indirect measure. Thus, the exclusiveness problem predicts a positive relationship between the direct and indirect indexes. The negative ODT–OIT portion of the curve, however, contradicts this prediction. This can be explained by realizing that the exclusiveness problem does not inevitably arise whenever direct measures are sensitive to both conscious and unconscious perceptual influences, but rather only when pure redundancy or independence models hold. In these situations, attaining null sensitivity would indeed eliminate unconscious perceptual influences. Conversely, if some form of exclusivity holds, approaching null sensitivity would actually potentiate rather than eliminate unconscious perceptual influences, dissolving the exclusiveness problem. Thus, the exclusiveness problem is a contingent hypothesis, rather than a model-free methodological concern such as the exhaustiveness and null sensitivity problems.

Direct and Indirect Unconscious Perceptual Effects Are Qualitatively Different

With indirect tasks, overall ODT priming effects are readily apparent, barring the presence of inhibitory C–S effects. With direct tasks, however, an offsetting mixture of facilitation and inhibition occurs at the ODT, such that overall performance means seem to indicate only chance performance. To observe these underlying effects, one must examine either (1) the underlying interactions involving individual differences that mediate whether facilitation or inhibition occurs, or (2) overall variance. Thus, direct instructions, which encourage attempts to retrieve unconscious perceptions, produce complex, interactive effects. Conversely, indirect instructions do not seem to invoke these additional mechanisms (e.g., unconscious attributional processes), producing less complex and more obvious effects. Although more work must be done to explain this qualitative difference, one possibility is that the frustrating and peculiar nature of direct ODT tasks (i.e., trying to respond to stimuli that one cannot see; cf. Marcel, 1983a) may render participants' attitudes particularly relevant. On the other hand, most indirect tasks are not problematic in this way.

Implications for the exclusiveness problem. Notably, *overall* direct measure performance does not exhibit the nonmonotonic relationship, but rather declines monotonically to chance and remains flat as stimulus intensity is reduced. This creates the impression that both conscious and unconscious influences must have been eliminated, thus raising the exclusiveness problem. Moreover, given this pattern, it is easy to see why pure redundancy or independence models have heretofore been implicitly assumed. Without further information, then, it might seem that genuine indirect ODT effects could only occur if direct measures were exclusively sensitive to conscious perception, just as Reingold and Merikle (1988, 1990) suggested.

As we have seen, however, unconscious perceptual influences do manifest at the ODT, but not on overall direct performance means. Moreover, just as with indirect ODT effects, there is evidence that higher level direct ODT effects are negatively related to detection d' when conscious perception is relevant (cf. Figure 6, Snodgrass & Shevrin, 2002). Similarly, Price's (1990, 2001) higher level increased variance effects occurred at the ODT, but declined as detectability increased. Taken together, these findings suggest that direct measure effects, when assessed appropriately, do exhibit the U-shaped nonmonotonic relationship, and hence that a functional exclusivity model best explains direct performance as well. Accordingly, attaining null sensitivity potentiates rather than eliminates direct ODT effects as well, dissolving the exclusiveness problem once more.

Implications for the conscious control postulate. The bidirectional nature of direct ODT effects moreover supports the popular hypothesis that truly unconscious influences cannot be consciously controlled. If they could be, below chance performance would never occur on higher level direct tasks because participants would be able to facilitate at will, and overall above chance performance would result. In turn, this would produce nonmonotonic patterns on overall direct performance. For example, 2AFC identification would fall to chance at the OIT and then rise above chance at the ODT as overriding conscious perception disappeared. This, however, does not happen; instead, overall direct performance declines monotonically to chance and remains flat.

Interpretation of Subjective Threshold and Objective Threshold/Rapid Decay Effects

Because these effects are obtained with supra-OIT stimuli, thus allowing useful conscious perception to occur, they may be driven by weakly conscious perception.

Subjective threshold effects. These effects are vulnerable to skeptical concerns, because they increase monotonically with stimulus intensity in a manner consistent with the conscious perception model. Furthermore, although exclusion-related qualitative differences (e.g., Merikle et al., 1995) suggest that subjective threshold stimuli may be unconscious, they may alternatively reflect potentially controllable criterion artifacts (Snodgrass, 2002; cf. Haase & Fisk, 2001). Consistent with this interpretation, Visser and Merikle (1999) found that monetary incentives eliminated exclusion failure, perhaps because such incentives encouraged more lenient exclusion criterions.[7]

At the same time, we suggest elsewhere that subjective threshold approaches nonetheless do index a second, distinct aspect of consciousness—namely, higher order reflective awareness (Snodgrass, 2002, in press; Snodgrass & Shevrin, 2002). Although we cannot pursue this here, from this perspective there are two substantive senses, not just one, in which perception can be conscious: (1) *phenomenal consciousness*, which refers to experiential (e.g., perceptual) contents and qualia per se, and (2) *reflective consciousness*, which is a higher order metacognitive process involving reflecting upon and evaluating various phenomenal contents. This framework resembles Block's (1995, and especially 2001) distinction between phenomenal and certain forms of *access* consciousness. In the present framework, subjective thresholds reflect one important mechanism that determines whether or not phenomenally conscious perceptions are accessed by higher order metacognitive processing such as reasoning, planning, and the initiation of voluntary action (cf. Shallice's, 1988, *supervisory system*; see also Jack & Shallice, 2001). Accordingly, although we argue that objective threshold approaches best index phenomenal awareness, in our view subjective threshold methods index a distinct form of consciousness of broad ecological importance.

Objective threshold/rapid decay effects. Because these effects are uncorrelated with direct performance, they are less obviously compatible with the conscious perception model. However, their flat slopes may be a procedural artifact. In the response window paradigm, although indirect measures are highly speeded, direct measures are not. If conscious perception develops slowly (Baars, 1997), greater response time will increase both its degree and variance, thus overestimating the conscious perception actually present at the time of indirect task response execution. Indeed, direct performance declines when speeded (Draine & Greenwald, 1998, p. 290). If the true conscious perception variance is small, an underlying restriction of range could artifactually flatten observed regression slopes. In agreement with this explanation, these slopes are usually weakly positive; furthermore, prime exposure duration is positively related to response window effect size (Draine & Greenwald, 1988, p. 301). Collectively, these considerations suggest that response window effects may indeed be driven by weakly conscious perception. Consistent with this suspicion, these effects appear to be driven only by part-word information (Abrams & Greenwald, 2000).

On the other hand, systematic overestimation of conscious perception in response window paradigms may mean that some of these effects actually meet the OIT or better, and hence really are valid objective threshold phenomena. If so, however, their primitive, fragmentary nature might not be an intrinsic property of unconscious perceptual effects, but rather could simply mean that more complex stimulus analysis, whether conscious or unconscious, takes longer to complete than such highly speeded tasks allow. In any event, to more clearly determine the objective versus subjective threshold status of response window phenomena requires that (1) direct measures be obtained under comparably speeded conditions (cf. Merikle & Reingold, 1998); and (2) clearly exhaustive direct measures (e.g., SDT identification or detection, but not classification) be used.

Summary and Conclusions

This paper has proposed a model-based approach to the methodological difficulties that have beset unconscious perception research. Various considerations suggested a hierarchical strength/complexity model of conscious perception, which in turn suggested that SDT detection and identification, but not category discrimination, are exhaustively sensitive for typical indirect tasks. Furthermore, if the conscious perception model is true, only effects consistent with the strength/complexity hierarchy should be possible (barring negative priming), and thus only nonnegative direct/indirect relationships should occur. Similarly, the exhaustiveness, null sensitivity, and exclusiveness problems also predict only nonnegative relationships. Contrariwise, the literature review suggested that ODT effects are reliably obtainable and moreover that negative and/or nonmonotonic relationships are typically found, supporting the objective threshold/strategic model and providing strong evidence against alternative conscious perception interpretations. Moreover, the U-shaped pattern suggests that conscious and unconscious perceptual influences are functionally exclusive, perhaps dissolving the exclusiveness problem. In contrast, approaches that allow positive (the subjective threshold model) or zero (the objective threshold/rapid decay model) relationships provide weaker evidence, because they may be compatible with the conscious perception model. Finally, direct and indirect ODT effects are qualitatively different. In particular, direct ODT effects are bidirectional; accordingly, their existence is easy to overlook. Moreover, their bidirectional nature provides strong evidence that they cannot be consciously controlled.

In closing, we wish to acknowledge the large debt that the objective threshold/strategic model owes to similar ideas proposed previously by Dagenbach et al. (1989) and pre-response-window Greenwald and associates (see especially Greenwald et al., 1995; Klinger & Greenwald, 1995); other influences include Marcel (1983b), Besner and associates (e.g., Stolz & Besner, 1997), Mandler (1994), and earlier work reviewed by Dixon (1981).

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NOTES

1. We thank Lori Buchanan for helpful clarification of this important point.

2. We thank Daniel Holender for helpful comments on this issue.

3. As Stolz and Besner (1997) noted, the short-duration primes were in fact largely identifiable, but their identification likely required some effort. This suggests that C–S mechanisms can occur whenever prime identification requires effort, not just when it fails outright.

4. It is important to distinguish the ODT conditions used in Greenwald et al.'s (1989) main experiments (see pp. 37, 40, and 41) from the more lenient conditions used in supplementary experiments (see their Appendix). In the latter work, they intentionally allowed above chance performance to facilitate comparing the sensitivity of various different direct tasks (p. 45).

5. However, Doyle (1990) argued that Greenwald et al.'s (1989) results were not obtained under ODT conditions. Doyle suggested that semantic meaning in general (i.e., being a word vs. nonword) should aid detectability (cf. Doyle & Leach, 1988), and that it was only because Greenwald et al. arranged matters so that the unconscious semantic influence "canceled itself out" (with half congruent and half incongruent trials) that null detection sensitivity appeared to occur. This argument, however, confuses general and specific semantic influences on detectability. Although Greenwald et al.'s (1989) overall detection performance indeed canceled out specific semantic effects (i.e., of left vs. right), any general semantic influence should still have been apparent.

6. At the same time, strategic expectancy processes are sometimes invoked in pronunciation tasks (e.g., with high RP; see Neely, 1991). However, Hines (1992, p. 162) noted that his prime–target pairs were not highly associated, essentially instantiating a low RP situation.

7. On the other hand, it may be that increased motivation and attention were responsible for eliminating exclusion failure, as Visser and Merikle (1999) suggested. However, they did not consider SDT-based alternative explanations such as shifting exclusion criteria.

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