

Distinguishing Unconscious From Conscious Cognition—Reasonable Assumptions and Replicable Findings: Reply to Merikle and Reingold (1998) and Doshier (1998)

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S. C. Draine and A. G. Greenwald (1998) demonstrated replicable unconscious semantic priming by combining a *response window procedure*, which increases priming effects by requiring rapid responding, and a *regression analysis* in which the regression intercept is a marker for unconscious cognition. The commentaries by B. A. Doshier (1998) and by P. M. Merikle and E. M. Reingold (1998) raise two questions about conclusions based on these methods: (a) Did Draine and Greenwald (1998) demonstrate an indirect effect (subliminal priming) in the absence of a direct effect (i.e., visibility of the subliminal priming words)? and (b) Did Draine and Greenwald (1998) demonstrate dissociation of conscious from unconscious cognition? The first question has reassuring responses that are reviewed here. The second question is answered by pointing out that although Draine and Greenwald (1998) did not claim to have established such dissociation, they provided data that advance the plausibility of that conclusion.

As recently as the mid-1980s, the word *unconscious* was taboo in many cognitive psychology journals. This taboo status began to unravel when a pair of articles by Marcel (1983a, 1983b) dared to use “unconscious” in their titles. Subsequently, cognitive psychologists have worked toward establishing research models that provide stable empirical grounding for the word *unconscious*. The article by Draine and Greenwald (1998), along with the commentaries on it by Doshier (1998) and Merikle and Reingold (1998), shares this goal. The commentaries nevertheless raise two questions about Draine and Greenwald’s success in moving toward this goal:

1. Did Draine and Greenwald (1998) demonstrate an indirect effect in the absence of a direct effect?¹
2. Did Draine and Greenwald (1998) demonstrate an unconscious effect in the absence of a conscious effect?

Question 1 concerns the appropriateness of basing conclusions on the regression analysis method introduced by Greenwald, Klinger, and Schuh (1995). Doshier (1998) and Merikle and Reingold (1998) expressed several reservations about Draine and Greenwald’s (1998) use of the regression method. After summarizing the reservations, we present responses, most of which have appeared in more detail elsewhere (Draine & Greenwald, 1998; Greenwald & Draine, 1997; Greenwald et al., 1995; Klauer, Draine, & Greenwald,

in press; Klauer, Greenwald, & Draine, 1998). The responses address all of the points raised by Doshier (1998) and Merikle and Reingold (1998).

Question 2 deals with justifications for interpreting empirically observed relationships between direct and indirect effects in terms of theoretical relationships between conscious and unconscious cognition. In stating their objections to Draine and Greenwald’s (1998) conclusions, Merikle and Reingold (1998) take an extreme position on the limits of possible research conclusions about unconscious cognition in subliminal priming research. We question the justification for that extreme position.

Question 1: Did Draine and Greenwald (1998) Find an Indirect Effect Without a Direct Effect?

In the Greenwald et al. (1995) regression method, the occurrence of a statistically significant intercept effect in the regression of an indirect-effect measure of subliminal priming (criterion) on a direct-effect measure of visibility of the prime stimulus (predictor) serves as an indicator that the subliminal priming effect is unconscious. Use of this regression method depends on several assumptions, including rational zero points for both direct and indirect measures,

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¹ A direct effect is the effect of a task stimulus on the instructed response to that stimulus, typically assessed by a measure of accuracy at the instructed task. An indirect effect is an uninstructed effect of the task stimulus on behavior, sometimes assessed by including an irrelevant or distracting component in the task stimulus and measuring influences of that component on the latency or accuracy of the instructed response to it. These concepts have been discussed extensively in Draine and Greenwald (1998) and in the two commentaries that precede this one.

linearity of the regression relationship, and absence of measurement error in the direct-effect predictor measure.

Dosher (1998) and Merikle and Reingold (1998) raised five objections to Draine and Greenwald's (1998) use of the regression method to demonstrate significant intercept effects. In responding to these objections, we show that Draine and Greenwald did effectively use the regression method to demonstrate an indirect effect (measure of subliminal priming) in the absence of a direct effect (measure of visibility of the prime).

Point 1: Did Nonlinearity in the Regression Relationship Produce a Spurious Intercept Effect?

As explained and illustrated in Dosher's (1998) commentary, various nonlinear relationships can produce a spurious significant-intercept finding from a linear regression analysis. As Dosher noted, Greenwald et al. (1995), Draine and Greenwald (1998), Greenwald, Draine, and Abrams (1996), and Greenwald and Draine (1997) each considered and addressed this possibility in their uses of the regression method. In order to allow for nonlinearity, Greenwald et al. (1996) fitted curvilinear (cubic) regression functions to their data sets, whereas Draine and Greenwald (1998) employed a more general *lowess regression-smoothing procedure* (Chambers, Cleveland, Kleiner, & Tukey, 1983) that allows for arbitrary nonlinear patterns. Both of these procedures affirmed significant-intercept effects that were indistinguishable in magnitude from those obtained in linear regression tests. Further, inspection of the numerous regression scatterplots displayed by Draine and Greenwald (see also Greenwald et al., 1996) reveals many above-zero values for the indirect measure in the vicinity of the direct measure's zero value. This last circumstance, which did not characterize Dosher's (1998) hypothetical scatterplots, indicates that significant intercept effects are expected when these data are analyzed by any of a wide variety of nonlinear regression procedures.

Point 2: Did Measurement Error in the Direct Measure Produce Spurious Intercept Effects?

This question was recognized and treated by Greenwald et al. (1995), Draine and Greenwald (1998), Greenwald et al. (1996), and in more detail by Greenwald and Draine (1997). These previous treatments made Dosher's (1998) identical point that it is indeed possible for measurement error in a regression predictor variable to produce a spurious regression intercept effect. The previous treatments also observed that the conditions that could create such a spurious intercept (namely, positive slope of the regression function and predictor mean substantially above zero) were not characteristic of the data sets in any of these four articles.

As Dosher (1998) noted, the measurement error concern has been addressed even more extensively by Klauer et al. (in press), using a method that is briefly summarized in this issue by Klauer et al. (1998). The Klauer approach employs an *errors-in-variables method* that estimates regression parameters (slope and intercept) in a fashion that is freed of

the effects of measurement error in the predictor. Klauer et al. (in press) applied the errors-in-variables method to 18 regression-intercept tests reported by Draine and Greenwald (1998). For these 18 tests, Draine and Greenwald had originally reported intercept effects that averaged $d' = +.194$ ($SE = .030$). Application of the Klauer method changed this value only slightly to mean $d' = +.189$ ($SE = .031$). This outcome, coupled with the conclusion that Draine and Greenwald's findings were robust across linear and nonlinear analyses (see Point 1), again affirms Draine and Greenwald's significant-intercept findings.

Point 3: Is the Regression Method Appropriate When Direct and Indirect Measures Are Uncorrelated?

Both Dosher (1998) and Merikle and Reingold (1998) asserted that Greenwald et al.'s (1995) regression method is questionable or inappropriate when the indirect-on-direct regression slope is approximately flat. However, neither Dosher nor Merikle and Reingold provided a rationale for this assertion, and we have not yet been able to discover one. To argue by example, consider a hypothetical *blindsight study*.² Assume that this study obtains both a direct measure of vision (e.g., responses to requests to describe objects present in the visual field) and an indirect measure of blindsight (e.g., accuracy of reaching and grasping actions toward ostensibly unseen objects). Because subjects might reveal weak and variable sensitivity on the direct measure, an indirect-on-direct regression test is feasible. We pose the question, Should an intercept effect estimated from this regression test be considered as a valid indicator of blindsight only if there is a clear positive correlation between the direct and indirect measures? In the event that anatomically independent pathways govern the two performances (a plausible hypothesis for the blindsight phenomenon), a valid theoretical expectation is that the slope can be flat, meaning that the two measures could be uncorrelated. At the same time, residual vision that is assessed by the direct measure may be of some help in reaching and grasping such that there could also be a positive correlation. We can find no reason for concluding that suitability of the regression intercept test should depend on whether or not this correlation is found. Similarly, we cannot discover a compelling rationale for Dosher (1998) and Merikle and Reingold's (1998) asserted need for a positive regression slope as a precondition for using Greenwald et al.'s (1995) regression method in the subliminal priming domain.

Point 4: Were Draine and Greenwald's (1998) Direct and Indirect Measures Comparable?

Reingold and Merikle (1988) stressed the importance of using comparable direct and indirect measures. Direct and indirect measures are comparable to the extent that they

² Blindsight (see Weiskrantz, 1986) is a brain-damage-associated condition that is characterized by the patient's denying having visual experience despite being capable of some appropriate responding to objects in the visual field.

share stimuli, procedures, and response metric. Comparability is desirable because it will typically help in assuring validity of Reingold and Merikle's (1988) *relative sensitivity assumption*: the assumption that the direct measure has at least as much sensitivity to conscious stimulus effects as does the indirect measure. As described by Reingold and Merikle (1988), complete comparability of direct and indirect measures requires that the two measures use the same stimulus-presentation procedures and the same response metric, differing only in instructions and response characteristics that are measured. Achieving complete comparability is generally quite difficult. Merikle and Reingold (1998) criticized Draine and Greenwald (1998) for undermining comparability of direct and indirect measures by not using the indirect measure's response window procedure (which obliged very rapid responding) also for direct measures. However, Draine and Greenwald had deliberately dropped the response window procedure after establishing that its time pressure reduced the sensitivity of the resulting direct measure. In Reingold and Merikle's (1988) analysis, comparability is not an end in itself. Rather, these authors urge comparability specifically in order to provide conditions that should satisfy the relative sensitivity assumption. Draine and Greenwald's elimination of the response window from their direct measure was for the purpose of increasing their direct measure's sensitivity in order to help to satisfy the relative sensitivity assumption. Consequently, Draine and Greenwald's procedure was actually more consistent with the aims of Reingold and Merikle's (1988) analysis than was Merikle and Reingold's (1998) recommended alternative of retaining the response window procedure for the direct measure.³

Point 5: Can the Regression Method Demonstrate an Indirect Effect in the Absence of a Direct Effect?

With the regression method, a statistically significant intercept indicates that a greater-than-zero indirect effect is associated specifically with the value of zero on the direct effect measure. As Greenwald et al. (1995) explained in introducing the regression method, this result (a) achieves Reingold and Merikle's (1988) indirect-*greater-than*-direct-effect criterion for demonstrating unconscious cognition, while (b) simultaneously providing an indirect-*without*-direct-effect pattern. The multiple successful uses of the regression method by Greenwald et al. (1995), Draine and Greenwald (1998), Greenwald and Draine (1997), and Greenwald et al. (1996) make clear that the regression method not only can demonstrate an indirect effect in the absence of a direct effect, but has repeatedly done so.

Question 2: Did Draine and Greenwald (1998) Demonstrate Unconscious Cognition in the Absence of Conscious Cognition?

This is a question about theoretical interpretation of Draine and Greenwald's (1998) multiple indirect-without-direct-effect findings. Do these findings warrant interpretation as demonstrating a dissociation between conscious and unconscious cognition? That is, did they indicate uncon-

scious cognition of a stimulus source in the absence of *any* conscious cognition of it? Any attempt to address this question necessarily starts with the elegant methodological analysis of Reingold and Merikle (1988), which formed the basis not only for the Merikle and Reingold (1998) comment, but also for the original development of the regression method by Greenwald et al. (1995). A major value of Reingold and Merikle's (1988) contribution was to make entirely clear the distinction between the conscious-unconscious dissociation question and the previous question about demonstrating an indirect effect in the absence of a direct effect.

Dissociation Conclusion Depends on "Exhaustiveness" Assumption

Draine and Greenwald (1998) did not actually state a firm conclusion about dissociation. Rather, they concluded—consistent with Reingold and Merikle's (1988) analysis—that a dissociation conclusion was acceptable "if it is assumed that direct measures were sensitive to *all* consciously mediated processing of the semantic category of the primes" (p. 301, emphasis added). The "if" clause in this quote is Reingold and Merikle's (1988) *exhaustiveness assumption*. In an important review article, Holender (1986) had remarked on the tacit, but unfounded, assumption of exhaustiveness that characterized much subliminal cognition research. Reingold and Merikle (1988) strongly reinforced Holender's point that the exhaustiveness assumption could not and should not routinely be treated as an acceptable assumption in subliminal cognition research. Agreeing with that point, Greenwald et al. (1995) (a) carefully avoided making the exhaustiveness assumption in their development and use of the regression method, and (b) concluded that "the validity of the exhaustiveness assumption is difficult to address empirically. Thus, both the association and dissociation views remain viable" (cf. Greenwald et al., 1995, p. 37).

In their commentary on Draine and Greenwald (1998), Merikle and Reingold (1998) went beyond Reingold and Merikle's (1988) cautions about the exhaustiveness assump-

³ A greater level of comparability than that described by Reingold and Merikle (1988) is possible when direct and indirect measures are obtained from exactly the same task. The only instance of such completely comparable direct and indirect measures of which we are aware was in the position-discrimination task introduced by Greenwald, Klinger, and Liu (1989), and used also by Greenwald et al. (1995) and by Greenwald and Draine (1997). In the position-discrimination task, subjects are asked to judge whether word stimuli are positioned to the left or right of a central fixation point. In the version of this task used by Greenwald et al. (1995), the word stimuli were *RIGH* or *LEFT* on a subset of trials, with each stimulus appearing equally often in the right-of-center and left-of-center positions. (Greenwald et al., 1995, used *RIGH* rather than *RIGHT*, in order to keep stimulus width constant.) The direct measure was agreement of response with stimulus position, whereas the indirect measure was agreement of the response with stimulus verbal content. Greenwald et al. (1995) and Greenwald and Draine (1997) both reported analyses of this measure using the regression method, and both reported significant intercept effects.

tion to imply that the exhaustiveness assumption should generally be avoided in subliminal priming research and that, therefore, a dissociation conclusion from subliminal priming research was beyond empirical reach. We here suggest the reasonableness of a more moderate position on the dissociation interpretation. To do so, we (a) review the reasons stated by Draine and Greenwald for believing that the exhaustiveness assumption was plausible for at least a portion of their data, and (b) consider the wisdom of treating the exhaustiveness assumption as possibly acceptable, rather than as necessarily unacceptable.

Appraisal of the Exhaustiveness Assumption in Draine and Greenwald's (1998) Research

In Draine and Greenwald's (1998) research, exhaustiveness translates to the assumption that their direct measures were sensitive to all conscious effects of their visually masked priming stimuli. One cannot conclusively establish the validity of this exhaustiveness assumption by empirical means, because of the inescapable possibility that a conscious stimulus effect may remain undetected by available direct measures. Recognizing this, both Draine and Greenwald (1998) and Greenwald et al. (1995) attempted to maximize the plausibility of exhaustiveness by (a) using the most sensitive direct measures that were at their disposal, and (b) using multiple direct measures in regression analyses. Draine and Greenwald showed that their word-detection measure (the one they called *word vs. XG-string discrimination*) was more sensitive to visually masked stimuli than was their semantic classification direct measure (Draine & Greenwald, 1998, p. 297). Further, in order to maximize sensitivity of direct measures in their regression analyses, Draine and Greenwald employed these two direct measures simultaneously as regression predictors (Experiment 4). This multiple regression generalization of the regression method yielded statistically significant intercept effects for both 17-ms and 33-ms prime durations (Draine & Greenwald, 1998, p. 297). Even with these findings in favor of dissociation in hand, Draine and Greenwald limited their conclusion about dissociation to saying that it was an acceptable interpretation of their findings *only* to the extent that the exhaustiveness assumption could be judged acceptable (p. 301).

It may be instructive to consider exhaustiveness in the context of the related setting of the blindsight phenomenon (see Footnote 2). There, too, drawing a conclusion in favor of dissociation of conscious from unconscious vision requires an exhaustiveness assumption, that is, the assumption that a blindsight patient totally lacks consciousness of vision. The possibility of demonstrating dissociation is precisely what makes blindsight so compellingly interesting a phenomenon. (Further, there is no lack of plausible theories about independence of pathways for conscious and nonconscious visual information that might be dissociated by the focused brain damage of the blindsight syndrome.) The more general point is that exhaustiveness is only an assumption: one that may be either valid or invalid. Merikle and Reingold's (1998) position, of supposing that the only

proper stance regarding exhaustiveness is to treat it as invalid, seems clearly too restrictive for the blindsight setting. Similarly, exhaustiveness should not be treated as being beyond consideration in the subliminal priming domain.

Conclusion

Greenwald et al. (1995), in presenting evidence that they cautiously interpreted as consistent with a dissociation interpretation, observed:

The present findings should prompt further tests using the regression method, accompanied by further attempts to disconfirm the exhaustiveness assumption. To the extent that future data sets show significant intercept effects without disconfirming exhaustiveness, the dissociation interpretation should become increasingly acceptable. (pp. 37–38)

Draine and Greenwald (1998) have added to the number and variety of subliminal priming procedures that have yielded significant intercept effects and, thereby, have increased the plausibility of the dissociation interpretation.

As findings consistent with dissociation continue to accumulate, the burden of appraising the exhaustiveness assumption should shift toward those who regard it as implausible. If the exhaustiveness assumption is indeed incorrect for Draine and Greenwald's (1998) research, then that incorrectness should eventually demonstrate itself empirically. In particular, if there is no dissociation, then replications with improved direct measures—that is, replications with direct measures that have increased sensitivity to conscious stimulus effects—should eventually yield *nonsignificant* intercept effects. On the other hand, so long as significant intercept findings continue to accumulate, the exhaustiveness assumption, and the dissociation conclusion that depends on it, remain plausible and become increasingly so.

References

- Chambers, J. M., Cleveland, W. S., Kleiner, B., & Tukey, P. A. (1983). *Graphical methods for data analysis*. Boston: Duxbury Press.
- Doshier, B. A. (1998). The response-window method—Some problematic assumptions: Comment on Draine and Greenwald (1998). *Journal of Experimental Psychology: General*, *127*, 311–317.
- Draine, S. C., & Greenwald, A. G. (1998). Replicable unconscious semantic priming. *Journal of Experimental Psychology: General*, *127*, 286–303.
- Greenwald, A. G., & Draine, S. C. (1997). Do subliminal stimuli enter the mind unnoticed? Tests with a new method. In J. Cohen & J. Schooler (Eds.), *Scientific approaches to consciousness* (pp. 83–108). Mahwah, NJ: Erlbaum.
- Greenwald, A. G., Draine, S. C., & Abrams, R. L. (1996, September). Three cognitive markers of unconscious semantic activation. *Science*, *273*, 1699–1702.
- Greenwald, A. G., Klinger, M. R., & Liu, T. J. (1989). Unconscious processing of dichoptically masked words. *Memory & Cognition*, *17*, 35–47.
- Greenwald, A. G., Klinger, M. R., & Schuh, E. S. (1995). Activation by marginally perceptible ("subliminal") stimuli:

- Dissociation of unconscious from conscious cognition. *Journal of Experimental Psychology: General*, 124, 22–42.
- Holender, D. (1986). Semantic activation without conscious identification in dichotic listening, parafoveal vision, and visual masking: A survey and appraisal. *Behavioral and Brain Sciences*, 9, 1–23.
- Klauer, K. C., Draine, S. C., & Greenwald, S. C. (in press). An unbiased errors-in-variables approach to detecting unconscious cognition. *British Journal of Mathematical and Statistical Psychology*.
- Klauer, K. C., Greenwald, A. G., & Draine, S. C. (1998). Correcting for measurement error in detecting unconscious cognition: Comment on Draine and Greenwald (1998). *Journal of Experimental Psychology: General*, 127, 318–319.
- Marcel, A. J. (1983a). Conscious and unconscious perception: An approach to the relation between phenomenal experience and perceptual processes. *Cognitive Psychology*, 15, 238–300.
- Marcel, A. J. (1983b). Conscious and unconscious perception: Experiments on visual masking and word recognition. *Cognitive Psychology*, 15, 197–237.
- Merikle, P. M., & Reingold, E. M. (1998). On demonstrating unconscious perception: Comment on Draine and Greenwald (1998). *Journal of Experimental Psychology: General*, 127, 304–310.
- Reingold, E. M., & Merikle, P. M. (1988). Using direct and indirect measures to study perception without awareness. *Perception & Psychophysics*, 44, 563–575.
- Weiskrantz, L. (1986). *Blindsight*. New York: Oxford University Press.

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