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Activation by Marginally Perceptible ("Subliminal") Stimuli: Dissociation of Unconscious From Conscious Cognition

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Introduces a linear regression method for investigating unconscious cognition. For words that were obscured by simultaneous dichoptic masking, indirect effects (semantic priming) and direct effects (perceptual identification) were assessed in 20 experiments (total N = 2,026). When measures of both indirect and direct effects have rational zero points, a statistically significant intercept in the indirect-on-direct-measure regression shows that (a) the indirect effect occurred in the absence of the direct effect, and (b) unconscious cognition is involved. For a position discrimination task, but not for an evaluative decision task, indirect-on-direct regression showed the significant intercept effect. Although small in magnitude, this intercept effect provides the statistically most secure finding yet obtained of a much-sought and controversial data pattern—indirect effect with no direct effect. With one added assumption (which appears plausible for the present data), this pattern indicates that unconscious cognition is dissociated from (i.e., occurs separately from) conscious cognition.

In the last decade there has been a dramatic increase in the acceptability of theoretical interpretations of research findings in terms of unconscious cognition. Part of the shift is linguistic—many psychologists have become willing to use the word *unconscious* in sentences that, until recently, would have been acceptable only with alternative terms such as *unattended, automatic, procedural,* or *implicit.* However, to dismiss this change as just a matter of linguistic style underestimates it greatly. There has also been a conceptual and empirical revolution. An important contribution to this revolution has been the demonstration of replicability for a class of findings that, until recently, were widely regarded with great skepticism—findings of subliminal[1] semantic activation (see Balota, 1983; Bornstein, 1992; Dagenbach, Carr, & Wilhelmsen, 1989; Fowler, Wolford, Slade, & Tassinary, 1981; Greenwald, Klinger, & Liu, 1989; Groeger, 1988; Hardaway, 1990; Marcel, 1983). *Subliminal semantic activation* (SSA) is defined as indirect evidence for analysis of semantic content of word stimuli under conditions that limit or prevent awareness of the presence of these words.

Although SSA is now treated by many experts as a replicable class of phenomena, it continues to be the focus of controversies concerning both its empirical characteristics and its theoretical interpretation (Greenwald, 1992, pp. 768 and 779). Debate over proper description of SSA data is at the center of these controversies. Studies of SSA, involving stimuli presented at the margin of perceptibility, often examine effects of such stimuli on actions the subject is instructed to perform (direct effects) at the same time as observing uninstructed (indirect) effects that can indicate unconscious semantic activation. Holender's (1986) influential review judged the then-available evidence to be unsatisfactory for assessing theoretically crucial details of relationships between direct and indirect effects (see also Merikle, 1982; Purcell, Stewart, & Stanovich, 1983).

Methodological Analysis of Conscious–Unconscious Relations

Alternative Views of Unconscious Cognition

A goal of the present research is to choose among three currently viable views of the nature of unconscious cognition. These are:

Nonexistence. Unconscious cognition does not exist.

Association. Unconscious cognition exists but occurs only in association with (as an adjunct to) conscious cognition.

Dissociation. Unconscious cognition exists dissociated from (independently of) conscious cognition.

In the association view, unconscious cognition occurs at

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[1] The term *subliminal* implies a theory of the perceptual threshold, or limen, that has been largely abandoned as a consequence of the influence of signal detection theory (Green & Swets, 1966). A more theoretically neutral designation of the class of stimuli with which this article is concerned is *marginally perceptible.* This article uses *subliminal* and *marginally perceptible* as interchangeable designations.

the fringes of conscious perception, in response to stimuli that are inadequate to produce distinct conscious percepts. (An example of this view is the position of Cheesman & Merikle, 1984, that unconscious cognition occurs in response to stimuli that fall in a range between "objective" and "subjective" perceptual thresholds; see below.) In terms of the association view, when stimuli produce unconscious effects, they also produce associated but perceptually indistinct conscious effects. On the other hand, if unconscious cognition is dissociated from conscious cognition, then there is no potential path for discovery, via conscious perception, that a potential unconscious influence is occurring. In the concluding *Discussion*, this aspect of the distinction between association and dissociation interpretations of unconscious cognition is noted to have bearing on application, legal, and ethical issues associated with possible effects of marginally perceptible stimuli.

Direct and Indirect Measures

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 *un*instructed 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. As an illustration, a well-known indirect effect is the interference in responding to Stroop's (1935) task of naming the color of a patch of ink, caused by the task-irrelevant stimulus of the ink patch taking the form of the printed name of a different color.

If there is a core of agreement among contemporary researchers on unconscious cognition, it is that theoretical conclusions will come from experiments that obtain both direct and indirect measures of response to experimental tasks. However, the means of using such data to draw conclusions about unconscious cognition remains controversial. A starting point for interpretation of data involving direct and indirect measures is the common informal understanding that the term *unconscious cognition* refers to cognition that occurs without awareness. As others (especially Holender, 1986, and Reingold & Merikle, 1988) have noted, translation of this standard interpretation into research operations depends on assumptions made about the relation of conscious and unconscious cognition to performance on direct and indirect measures. The following discussion of such assumptions draws heavily on and only modestly extends the analysis by Reingold and Merikle (1988).

Holender (1986). Figure 1 (left panel) shows the assumptions that were made by Holender (1986, as analyzed by Reingold & Merikle, 1988) in arriving at a skeptical conclusion about the existence of unconscious cognition. Holender assumed that, in order to draw conclusions, direct measures must be sensitive to all conscious effects of task stimuli and must reflect only conscious effects. With these assumptions (labeled *exhaustiveness* and *exclusiveness*, respectively, by Reingold and Merikle), evidence for unconscious effects of stimuli is obtained by demonstrating the occurrence of an indirect effect in the absence of a direct effect.

With the exhaustiveness and exclusiveness assumptions, an indirect-without-direct-effect finding provides evidence not only for the existence of unconscious cognition, but also for dissociation. (This is because the unconscious effect—detected by the indirect measure—is unaccompanied by any conscious effects.) Holender's analysis provides no means of evaluating the association interpretation of unconscious cognition, because data consistent with association must include effects on both direct and indirect measures, and, with the exhaustiveness and exclusiveness assumptions, any data including both direct and indirect effects can be interpreted entirely in terms of conscious cognition, needing no appeal to unconscious cognition.

Holender (1986) reviewed empirical work on subliminal activation, giving detailed consideration to studies that claimed to have found the highly sought indirect-without-direct-effect pattern (especially Balota, 1983; Fowler et al., 1981; and Marcel, 1983). Holender concluded that, because of limited evidence from performance on direct measures and/or questionably exhaustive direct measures, these studies were inadequate to support claims of having established the absence of any conscious effects when indirect effects occurred. Since Holender's review, several further claims for SSA by visual word stimuli have been reported (e.g., Avant & Thieman, 1985; Dagenbach et al., 1989; Doyle & Leach, 1988; Greenwald et al., 1989; Groeger, 1988; Hirshman & Durante, 1992; Kostandov, 1985; Shevrin, 1988). Although some of these studies reported the indirect-without-direct-effect pattern, their collective weight appears to have remained insufficient to counterbalance the skeptical position stated in Holender's (1986) review.

Cheesman and Merikle (1984). Several commentators on Holender's review (Latto & Campion, 1986; Merikle & Cheesman, 1986; Morton, 1986; Navon, 1986; Paap, 1986) observed that requiring indirect effects in the complete absence of direct effects may be too stringent a requirement for demonstrations of SSA. An alternative favored by several of these authors was one proposed by Cheesman and Merikle (1984), based on their distinction between objective and subjective thresholds.

Although modern perceptual theory does not treat the concept of *threshold* as theoretically well defined, still the position of Cheesman and Merikle can be understood satisfactorily in terms of operational definitions of its threshold constructs. An objective threshold is the highest level of stimulus presentation (i.e., duration, energy, or signal-to-noise ratio) at which forced-choice responding indicates that the stimulus is undetectable (i.e., performance is at chance on a direct measure of detection). In contrast, a subjective threshold is the highest level of stimulus presentation at which subjects report phenomenal lack of awareness. The subjective threshold, which should be associated with greater stimulus energy than the objective threshold, is expected to be associated also with above-chance performance on direct measures. In this view, SSA was defined as

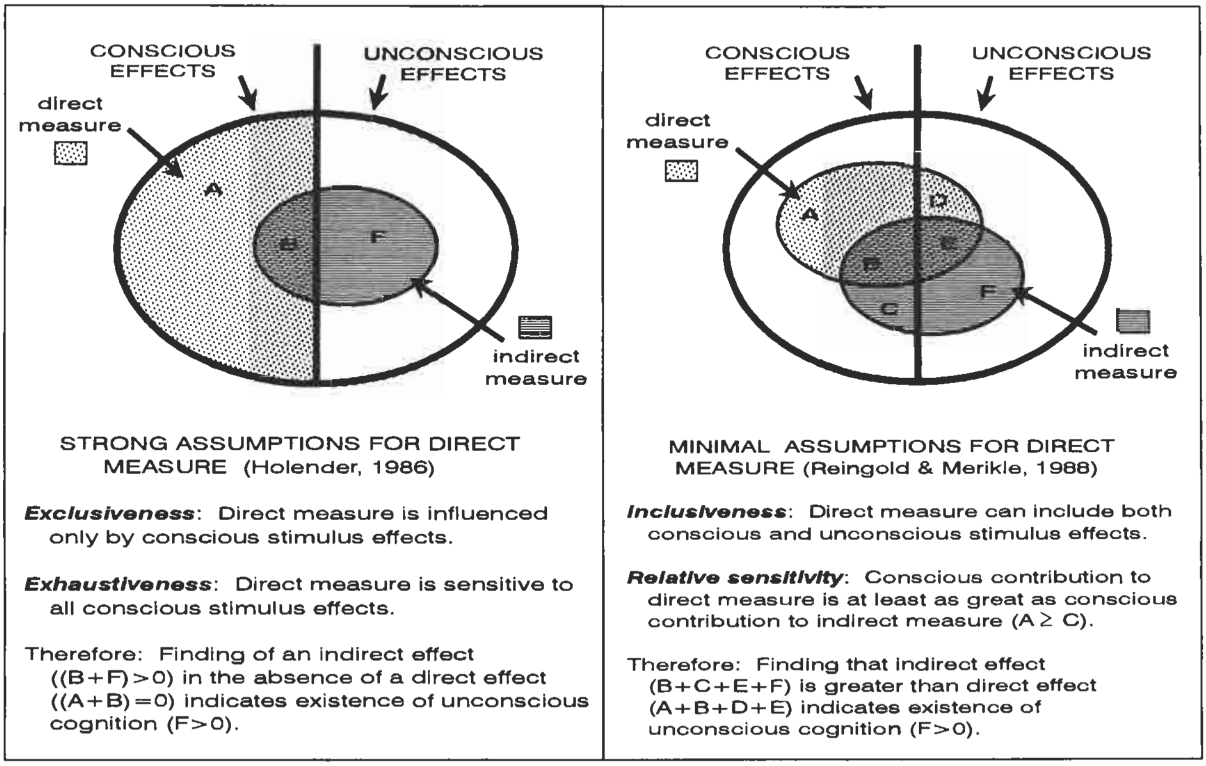

Figure 1. Alternative assumptions about use of direct and indirect measures as indicators of conscious and unconscious cognition. In addition to the assumptions shown, both panels also use an inclusiveness assumption for the indirect measure, that is, the indirect measure can be sensitive to both conscious and unconscious stimulus effects. For the right panel, the conclusion of unconscious cognition ($F > 0$) follows also from an indirect-without-direct-effect finding, as follows: Because the direct effect ($A + B + D + E$) is zero, A, B, and E must be zero; $C = 0$ follows from the relative sensitivity assumption ($A \geqq C$); and $F > 0$ then follows from the indirect effect ($B + C + E + F$) being greater than zero when B, C, and E are 0. (Areas represent magnitude of stimulus effects on direct and indirect measures.)

occurrence of indirect effects of stimuli that fall in the range between objective and subjective thresholds.

Reingold and Merikle (1988). Motivated perhaps to avoid reliance on the theoretically ill-defined threshold concept, Reingold and Merikle (1988) offered a further methodological analysis. They suggested, first, a relaxation of Holender's assumptions about direct measures. In particular, they considered it implausible that unconscious stimulus effects should be excluded from contributing to performance on direct measures, and unrealistic to expect that direct measures could be sensitive to all conscious stimulus effects. Accordingly, Reingold and Merikle instead based their analysis on the assumption that direct measures (like indirect measures) might include both conscious and unconscious contributions (see also Jacoby, Lindsay, & Toth, 1992) and, further, that direct measures need not be sensitive to all conscious stimulus effects.

Replacing Holender's exclusiveness assumption with the inclusiveness assumption shown in Figure 1 (right panel) had the undesired side effect of making it impossible to interpret any patterns of data from direct and indirect measures in terms of unconscious cognition. Reingold and Merikle immediately repaired this situation by introducing what they described as a minimal assumption to enable conclusions about unconscious cognition. Their additional assumption was that direct measures were at least as sensitive to conscious stimulus effects as were comparable indirect measures. In the right panel of Figure 1, this *relative sensitivity* assumption is interpreted as assuming that the region labeled A is at least as large as that labeled C.

As was the case for Holender's analysis, Reingold and Merikle's analysis interprets the indirect-without-direct-effect data pattern as providing evidence for unconscious cognition. At the same time, Reingold and Merikle (see also Joordens & Merikle, 1993) discouraged searches for the indirect-without-direct-effect pattern on two grounds. One was statistical: To demonstrate the pattern, it is necessary to accept a null hypothesis (i.e., the hypothesis of no direct effect), and this is statistically problematic. Their second consideration was that, with elimination of the exhaustiveness assumption, part of the significance of the indirect-without-direct-effect pattern was lost. (This point is given further attention in considering the dissociation interpretation in the concluding *Discussion.*) For these reasons, Reingold and Merikle instead advocated the search for a different data pattern, the finding of an indirect effect that was statistically stronger than a direct effect when the two effects were comparable, that is, both of these effects were described on the same measurement scale and both were obtained in response to the same task stimuli. It can be seen in the right panel of Figure 1 that this indirect-greater-than-direct finding obliges the conclusion that unconscious stimulus effects exist.

By avoiding any need to demonstrate a null indirect effect, Reingold and Merikle's analysis appeared to have made it easier to develop convincing evidence for unconscious cognition. After several years, however, it is apparent that finding such evidence is not at all easy. The indirect-greater-than-direct pattern has appeared replicably only in research using memory-based measures, that is, research in which direct and indirect effects are measured at a substantial delay after stimulus presentations (see Merikle & Reingold, 1991). Findings of indirect-greater-than-direct-effect patterns are well established only in studies of *subliminal mere exposure* (e.g., Bonanno & Stillings, 1986; Bornstein & D'Agostino, 1992; Kunst-Wilson & Zajonc, 1980; Mandler, Nakamura, & Van Zandt, 1987; Seamon, Marsh, & Brody, 1984).

Regression Strategy for Testing the Indirect-Without-Direct-Effect Pattern

Merikle and Reingold (1992) discouraged further searches for the indirect-without-direct pattern, observing that "the study of unconscious processes has . . . been impeded by a preoccupation on the part of many researchers with proving either the existence or the nonexistence of unconscious influences" (p. 77). Despite being in agreement with much of the argument on which Merikle and Reingold's critique of existing literature was based, the present authors believed that a continued search for the indirect-without-direct pattern was warranted because of both (a) the already-noted theoretical and practical significance of that pattern and (b) the previously unrecognized possibility of using a regression analysis to identify the pattern.

In contrast to previous strategies of attempting to establish chance performance levels on direct measures for all subjects, the present studies deliberately established conditions that allowed a substantial proportion of subjects to perform above chance on direct measures. Because these procedures also resulted in considerable between-subject variation in performance on direct measures, it was possible to examine the shape of the function relating performance on direct and indirect measures.

Importantly, Reingold and Merikle's (1988) analysis did not logically exclude the possibility of finding or interpreting the indirect-without-direct-effect pattern. Examination of their assumptions, as shown in the right panel of Figure 1, reveals that the indirect-without-direct-effect data pattern, like the indirect-greater-than-direct-effect pattern, yields the conclusion that unconscious cognition is demonstrated (i.e., region F > 0; see caption of Figure 1). Reingold and Merikle dropped the search for the indirect-without-direct-effect pattern primarily because of statistical considerations, specifically, the difficulty of arguing for acceptance of a null hypothesis (of no direct effect) in order to find that pattern. The regression strategy used in the present research overcomes this statistical problem. The use of regression analysis in the present research is explained in Figure 2.

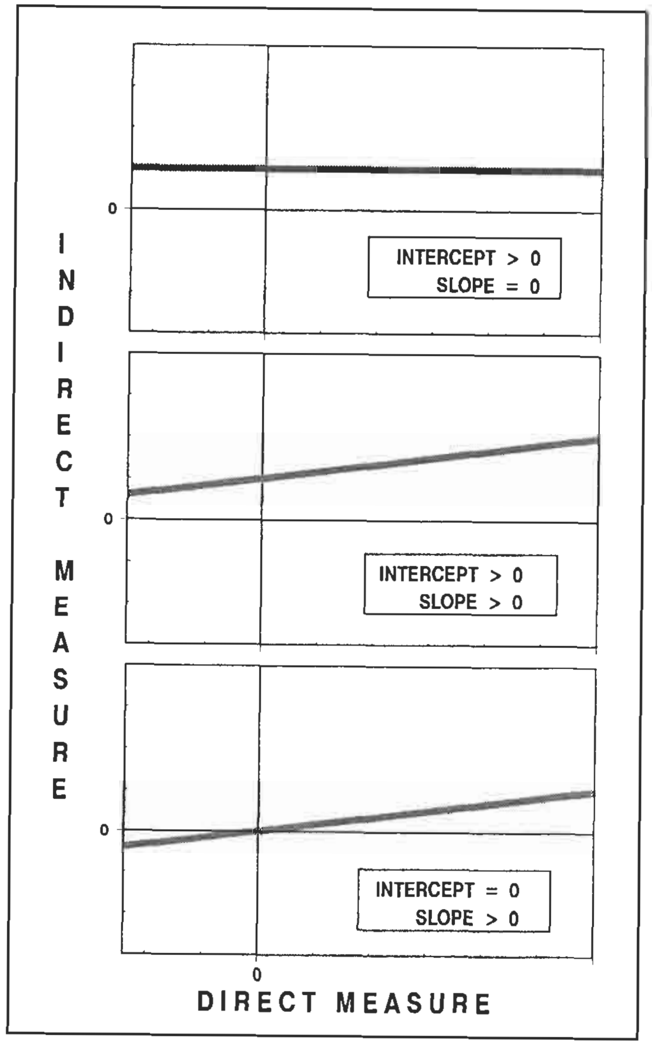

Figure 2. Some interpretable data patterns for linear regression of an indirect measure on a direct measure. The linear regression function in the top panel of Figure 2 shows an indirect effect in the absence of any direct effect (intercept > 0), as well as independence of the indirect effect from the direct effect (slope = 0). The pattern in the middle panel also shows an indirect effect in the absence of a direct effect (intercept > 0), while also demonstrating some degree of relation between direct and indirect effects (slope > 0). The function in the bottom panel reveals evidence for an indirect effect but one that occurs only to the extent that a direct effect occurs (slope > 0, intercept = 0).

Measurement Assumptions for Use of the Regression Method

Interpretation of the regression patterns shown in Figure 2 requires measurement assumptions in addition to the operationalization assumptions explained in Figure 1. The chief measurement assumption is that both direct and indirect measures have rational zero points. The direct measure must have a rational zero point in order to ensure that its zero value can be interpreted as the absence of direct effects of marginally perceptible stimuli. The similar requirement for the indirect measure ensures that its nonzero value indicates the presence of an indirect effect. In addition, any use of regression analysis assumes that measures of participating variables are related linearly or can be transformed into measures that are related linearly. It is not necessary for the direct and indirect measures to have interval scale properties. Indeed, interval scaling of measures does not guarantee linearity of their interrelationship. At the same time, the possibility of finding linear relations between (possibly transformed) measures is substantial only if the measures have ordinal scale properties.

With the present operationalization and measurement assumptions, the finding of a significant regression intercept effect (i.e., a nonzero indirect effect associated with a zero direct effect) indicates an unconscious contribution to the indirect measure. This interpretation corresponds to the situation in which Regions A–E in the right panel of Figure 1 all are assumed to be equal to zero, and only Region F is nonzero. The significant intercept finding also is consistent with dissociation (absence of conscious effects when unconscious effects occur), because Regions A–C (representing conscious stimulus effects) all must be zero. One of the most useful features of the regression method is that with it evidence for the indirect-without-direct-effect pattern occurs in the form of a null hypothesis rejection (the significant intercept effect), rather than the null hypothesis acceptance that characterized previous methods.

Method

Overview

The findings reported in this article were obtained between October 1989 and July 1992. The aim of research at the start of this period was to develop computerized dichoptically masked stimulus presentations for more extensive research on SSA than was possible with the electromechanical tachistoscope used by Greenwald et al. (1989). In the first year, the research conformed to the strategy that was used widely in previous research of (a) establishing conditions that would cause most subjects to perform at or near chance on direct measures and (b) excluding from analyses subjects whose performance on direct measures was above chance. Initial results were disappointing. Several of the early experiments effectively reduced performance on direct measures to chance levels but produced no consistent findings that indicated SSA on indirect measures.

After 1 year, enough data had been collected to permit a substantial increase of statistical power of analyses by combining results from different studies that had used similar procedures. Also at about that time, when it began to appear that the dissociation hypothesis that had guided the initial studies might be in error, analyses using the regression strategy described above were first conducted. These analyses included subjects whose data had previously been dropped for being above chance on direct tests. In 1991, a brief report of results from about two-thirds of the total data set included in this report was presented informally (Greenwald, 1991). The additional data in the present article were obtained partly from new studies and partly by using measures that permitted inclusion of subjects who had been dropped from previously reported analyses because observations were lacking in one or more cells of a stimulus X response contingency table. The present conclusions supersede those of the brief 1991 report.

Subjects

Two thousand twenty-six undergraduate students from lower-level psychology courses at the University of Washington volunteered to participate in exchange for a modest course credit. This total does not include a small number who terminated the experiment prematurely either because of vision problems that prevented them from seeing the displays properly or because of eye discomfort that might have been caused by improper adjustment of the apparatus, nor does it include 30 subjects whose data were unusable because of equipment malfunction or program error. Data for 75 of the 2,026 who completed the experiment without equipment error were discarded before hypothesis tests were conducted either because they showed severe asymmetry of visual performance (suggesting either poor vision in one eye or possible deliberate closing of one eye during portions of the experiment) or because they volunteered to the experimenter at the conclusion of the experiment that they had deliberately closed one eye at some time (even if only for one trial) during the experiment. The reason for the concern about eye closing is that dichoptic masking is effective only when both eyes view the stimuli.

Apparatus

Up to 3 subjects participated concurrently, each in a small (1.5 × 2.5 m) room containing a table on which were placed a 13-in. (33-cm, diagonal) color monitor and keyboard controlled by IBM/AT-type (80286 processor) computers. Subjects viewed a color (Enhanced Graphics Adapter [EGA]) display through a viewing apparatus that presented the images from the left and right halves of the display screen to the left and right eyes, respectively. (Similar apparatus was used previously by Cheesman & Merikle, 1986, and Greenwald & Klinger, 1990.) The apparatus obliged subjects to view the display from a distance of 65 cm through rotary prisms that were adjusted to superimpose the left-eye and right-eye images. Stimuli (such as instructions) that were presented simultaneously to both halves of the screen were easily viewed with binocular fusion. The placement of the keyboard, on the table that supported the viewing apparatus, allowed the subject to press the A key with left forefinger and the 5 key (on the keyboard's numeric keypad) with right forefinger; these keys were marked with green adhesive dot labels. All responses to the major experimental tasks were made with just these two keys.

General Procedure

Initial instructions on the display screen guided the subject in adjusting seat height, chin rest, forehead rest, and rotary prisms. There followed a brief description of the general nature of tasks to be encountered, followed by a computer-administered consent procedure in which subjects were given the opportunity to excuse themselves, without loss of the customary course credit, by pressing a key to terminate the session (no subjects did so terminate).

In all experiments, the first experimental task (presence-absence detection in Experiments 1–3, and position discrimination in Experiments 4–20—see further descriptions below) included practice at 100 or more trials of masked displays and permitted adjustment of masking conditions (usually by making them more difficult) contingent on the subject's performance on a direct measure. In Experiments 4–20, the initial practice phase also served to assess the subject's eye dominance (as described in more detail below). Next came practice and two blocks of trials of the experiment's second task, which was position discrimination in Experiments 1–3 and judgment of the evaluative meaning of words in Experiments 4–20. Two more blocks of trials at the initial task were followed by two more of the second task and, finally, two more of the initial task. All stimulus parameters that could vary across trials within any block of trials (especially, the side to which the mask was presented and stimulus identity) were varied by an on-line randomization routine that resulted in a unique sequence of trials for each subject.

The procedure involved 400–600 trials divided between the two tasks, and lasted, for most subjects, between 45 and 75 min. The variation in session duration was due to allowing subjects both to self-initiate trials and to rest ad lib during and between blocks of trials. Subjects going at the most rapid rate possible could initiate new trials about 1 s after their response to the prior one.

Over the course of 20 experiments, many procedural details varied. In order for the exposition not to be made tedious with these details, the description here gives—in addition to general characteristics of procedures that were maintained across experiments—the variations for which analyses indicated possible effects on performance and for which separate analyses of experiments were therefore justified. Additionally, some minor variations across experiments are described by indicating the range of values (e.g., of numbers of trials per block) that were used in different experiments.[2]

Display and Mask Characteristics

Previous experiments reported by Greenwald and Klinger (1989) established characteristics of simultaneous dichoptic masks that effectively obscured visually presented words for a majority of subjects. Masks were constructed using items in a software-fabricated "character set." Each item in the software character set was composed by blackening selected pixels in the 8 (horizontal) × 14 (vertical) pixel array that constitutes a character space for the EGA-interface display. These fabricated characters were constructed so that, with appropriate side-by-side and top-to-bottom juxtapositions, regularly spaced gratings oriented vertically, horizontally, or in either diagonal direction could be constructed. Rather than using regular gratinglike masks, however, masks were constructed on each trial by selecting randomly, and with replacement for each position in a 3-row × 15-column rectangular array, elements corresponding to a selected thickness. The line thickness (or textural coarseness) of the mask elements was randomly 5 or 6 pixels on each trial in Experiments 1–3 and was started at 6 pixels in the remaining experiments (but could be adjusted to lower values in some of the later experiments contingent on performance). Sample masks are shown in Figure 3.

Preliminary Trials

Initial practice. For the first task (word detection in Experiments 1–3 or word position discrimination in Experiments 4–20), an initial set of 10 practice trials was conducted with no mask, allowing word stimuli to be easily visible (and easily discriminable from blank trials for the detection task). The next 10 practice trials were presented with a relatively ineffective mask (made up of elements with 1-pixel line thickness). Thereafter, the masks being used in the experiment were introduced for another 100–110 trials divided into blocks of 20 (or 30), 40, and 40 trials. Immediate feedback (the word ERROR displayed immediately after errors) was provided throughout these trials. In all experiments, these initial blocks of trials allowed subjects' performances with masked presentations to stabilize, a procedure developed from previous observation that subjects often showed improvements in performance during the first 50–100 trials. The initial task was used also to adjust mask characteristics to bring performance to a level below 75% correct. In Experiments 1–15, mask effectiveness was increased after any of the first three blocks for which block performance exceeded 75% correct. In Experiments 16–20, mask effectiveness could also be reduced if performance was below 55% correct on an early trial block.[3]

Eye dominance determination. In Experiments 1–3, one ("majority") eye was arbitrarily assigned, for each subject, to receive the mask on *critical* trials—the trials that obtained indirect measures. In Experiments 4–20, eye dominance was established on the first trial block of the initial

[2] A considerably more detailed record of procedures has been prepared and is available from the first author on request.

[3] Mask effectiveness was increased in Experiments 1–15 by increase the size of a bright white framing field on the EGA display, resulting in reduced apparent contrast in the field containing the target word stimulus. In Experiments 16–20, mask effectiveness was additionally adjustable by varying the textural coarseness of the mask, based on the findings of Greenwald and Klinger (1989).

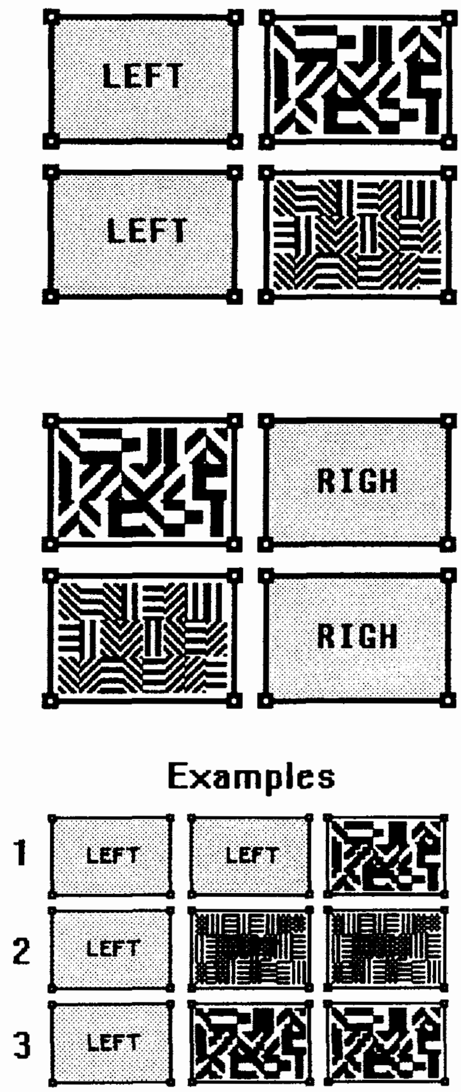

Figure 3. Examples of mask patterns and letter strings used in experiments. These masks are not as wide as those used, and frames have been added around them to facilitate the reader's simulating the effect of dichoptic masking by free fusion. By deconverging eyes (as if focusing on a more distant object) while looking at a mask + word pair from about 8 in., the reader should be able to superimpose the two, subjectively seeing three rectangles side by side (as simulated in Examples 1–3 at the bottom). If two of these three rectangles contain a word, as in Example 1, the eye it names is (at least at the moment) dominant. Example 3 shows the subjective appearance if the right eye is dominant when looking at the topmost mask + word pair. An apparent mixture of the two images in the middle rectangle (as in Example 2) also may occur and simulates the experience of some subjects in the present research. The topmost mask is made of mask elements 5 pixels thick, and the one below it is of elements 2 pixels thick. The reader will likely find (consistent with findings of Greenwald & Klinger, 1989) that the mask with 5-thick elements obscures the word more effectively than does the mask with 2-thick elements, when mask and word are superimposed.

(position discrimination) task for which the subject's overall performance dropped below 80% correct. If performance with mask to left eye was worse than that with mask to right eye, the left eye was considered dominant; otherwise, the right eye (which is dominant in this task for about two-thirds of subjects) was considered dominant. After assignment of the majority eye or identification of the dominant eye, the distribution of trials shifted from 50% with mask to each eye to 67% with mask to the majority or dominant eye. All critical trials (for indirect measures) were presented with mask to the majority or dominant eye. Direct measures of detection or position discrimination were based only on *non*critical trials with mask to the majority or dominant eye. The main purpose of the additional trials with mask to the minority or nondominant eye was to discourage the strategy of closing one eye while performing the tasks.

Position Discrimination Task

A position discrimination task was used in all 20 experiments. The sole instruction for this task was to judge whether the (masked) word stimulus that was presented on each trial was displaced to the left or right of a centered fixation point. At the start of each trial, the word `READY` appeared both left and right of the central fixation point of the display. This word signaled the subject to start the trial by pressing either response key. The ready signal then disappeared for 150 ms, after which a four-letter word was presented for 200 ms in the field of one eye, just right of center or just left of center, and the mask was presented simultaneously to the other eye. Subjects indicated their position judgments by pressing the left or right key. After the initial warm-up blocks of this task, immediate feedback was discontinued, but percentage correct was reported to the subject after each block of 50–56 trials. The following are members of the sample of 75 four-letter words used for this task: also, beef, city, damp, easy, fast, girl, hand, itch, king, lake, mean, nail, ooze, pain, rake, salt, tack, view, want.

As mentioned, masking was initially a random 50% to each eye but shifted to 67% to the majority or dominant eye thereafter. On a random 67% of just those position discrimination trials that (a) took place after establishment of the majority or dominant eye and (b) were presented with mask to that eye, the four-letter word stimulus was either `LEFT` or `RIGH`. (The string `RIGH` was used, rather than `RIGHT`, to keep stimulus width constant at four characters on all trials.) This 67% of the trials with mask to the majority or dominant eye that used `LEFT` or `RIGH` as stimulus were identified as *critical trials.* The remaining 33% of trials with mask to the majority or dominant eye, which used a randomly selected (with replacement) one of the 75 other four-letter words as stimuli, were designated *noncritical* trials. (Trials with mask to the minority or nondominant eye also used the 75 other four-letter words as stimuli.)

Direct measure. The direct measure of position discrimination performance, $d'_{(d)}$, was a variant of the signal detection measure, d' (sensitivity; Green & Swets, 1966), which is ordinarily computed from hit and false alarm rates in a detection experiment. To compute $d'_{(d)}$, left- and right-position stimuli were treated, respectively, as noise and signal trials. The hit rate was therefore computed as the proportion of right-position noncritical trials on which the right response key was pressed; the false alarm rate was the proportion of left-position noncritical trials on which the right key was pressed. This direct-effect measure has a rational zero point corresponding to chance performance.

Indirect measure. An important secondary purpose of the position discrimination task was to assess indirect effects of the word stimuli, seeking to replicate the finding of Greenwald et al. (1989) that position choices were influenced by presentation of the words LEFT and RIGHT, independently of the position in which those words occurred. Based on critical trials only, the indirect measure, $d'_{(i)}$, was also computed as a signal-detection sensitivity measure. To compute $d'_{(i)}$, LEFT and RIGH stimuli (regardless of their position) were treated as noise and signal, respectively.[4]

Versions 1–4. The position discrimination task was used in four versions. Three of these versions, used in Experiments 1–17, were very similar, with variations only in the level of difficulty for the critical trials (those using LEFT or RIGH as stimuli). In Experiments 1–7 (Version 1), all four-letter words used for the position discrimination task, including critical trials, were presented in character positions −4 to −1 or +1 to +4 (with negative positions starting just to the left and positive positions starting just to the right of a single-asterisk fixation point, considered to be at position 0). Left- and right-position stimuli thus were centered, respectively, 2.5 character positions left and 2.5 positions right of the center of the fixation point, corresponding to an angular separation of their centers of 1.33°. In Experiments 8–15 (Version 2), task difficulty for noncritical trials was increased slightly by presenting word stimuli either in positions −3 to 0 (left) or 0 to +3 (right); difficulty for critical trials was increased even more by presenting the stimuli LEFT or RIGH either in positions −2 to +1 (left position) or −1 to +2 (right position), corresponding to an angular separation of centers of only 0.27°. In Experiments 16–17 (Version 3), the discrimination for both noncritical and critical trials was made slightly easier by widening the centered fixation point to two character positions (a double asterisk) and therefore increasing the separations of left- and right-position words by one character width, to 1.60° and 0.53°, respectively, for noncritical and critical trials. For Experiments 18–20 (Version 4), the stimuli for all trials of the position discrimination task were changed, making the task considerably more difficult. The new stimuli for the task were four-letter words that were spelled properly either to the left or to the right of the fixation point, and reverse-spelled on the other side. The task was to respond with the left key if the forward spelling was left of center, and the right key if the forward spelling was right of center. In effect, this combined the two tasks of lexical (word–nonword) discrimination and position discrimination. As an example, the stimulus HALF FLAH would be correctly responded to by pressing the left key, whereas the correct response for FLAH HALF was the right key. Critical trials presented one of the stimuli, LEFT TFEL, TFEL LEFT, RIGH HGIR, or HGIR RIGH. (Note that there was no correct response on RIGH HGIR or HGIR RIGH trials, because neither four-letter string was a word. However, because, for virtually all subjects, these stimuli were not clearly visible, this procedural anomaly did not produce confusion; no subject raised a question about it.) For Version 4, hit and false alarm rates used to compute $d'_{(i)}$ were, respectively, the proportion of right key responses to stimuli containing RIGH, and the proportion of right key responses to stimuli containing LEFT.

Word Detection Task

Used only in Experiments 1–3, the word detection task produced direct and indirect measures from subjects' judgments of the presence or absence of a word stimulus on each trial. Subjects were instructed that word stimuli would be presented on approximately one-half of the trials and that they should press the right key to indicate presence and the left key to indicate absence. Events on each detection trial were similar to those on position discrimination trials except that words (which were positioned left or right of center as in Version 1 of the position discrimination task) were presented on only a random 60% of trials. When presented, words were always four letters long, subtending 1.07° in width and 0.62° in height. The detection task was introduced with practice trials using no mask, so that blank trials were easily discriminable from word trials. Immediate feedback (the word ERROR after each miss or false alarm) was discontinued after practice, but subjects did receive feedback indicating percentage correct for the just-completed block at the end of each of the four postpractice blocks of 56 trials.

As with the position discrimination task, masking was 50% to each eye before introduction of critical trials, and thereafter was 67% to one arbitrarily assigned (majority) eye. The *direct measure* of detection performance was the standard signal detection sensitivity measure (d'), with the false alarm rate computed in the usual fashion as proportion of right-key (present) responses on trials with no word stimulus. An *indirect measure* of SSA was incorporated into the detection task by using, as critical trials, the stimuli LEFT and RIGH on 67% of word-present trials that had mask to the majority eye. This indirect measure was computed in the same fashion as for the position discrimination task. Although one analysis presented below uses the direct measure for the word detection task, no regression analyses involving the indirect measure for the detection task are

[4] All analyses reported in this article also were conducted using measures of the various direct and indirect effects expressed in the form of gamma coefficients, which have a variety of desirable properties as measures of association between dichotomized stimulus and response variables (see Nelson, 1986), and in the form of hit rates minus false alarm rates (the measure reported previously by Greenwald & Klinger, 1989, 1990). The results of these alternative analyses uniformly agreed with conclusions based on the analyses of the signal-detection sensitivity measures that are described in the text.

reported. The reason is that, because of inadequate statistical power, these analyses were inconclusive regarding the regression-effect pattern. Accordingly, these results have been reserved for report in combination with data from later experiments.[5]

Evaluative Decision Task

Experiments 4–20 used an evaluative decision task that was similar to the one used by Greenwald et al. (1989). On each trial, subjects were asked to judge whether a clearly visible lower-case word meant "something pleasant" or "something unpleasant." The left key indicated "bad" or "unpleasant" and the right key "good" or "pleasant." On critical trials, evaluative priming words, in capital letters, were presented to the nondominant eye. In Experiments 4, 6, and 11–20, the evaluative priming word on critical trials was accompanied by a simultaneous dichoptic mask to the dominant eye. In Experiments 5 and 7–10, however, the priming word on critical trials was clearly visible (not masked). Initial practice trials, done without masking in any experiment, never included priming words. When primes were introduced, subjects in experiments with visible priming were instructed to treat upper-case (prime) words as distractors that were to be ignored and to respond only to the lower-case (target) words.

Feedback. Subjects received immediate (ERROR after mistaken classifications) only on initial practice trials at this task. After practice, feedback on percentage correct was given only at the end of blocks of 25–56 trials. Subjects were instructed to respond rapidly to the target. End-of-block messages advised subjects to respond more rapidly if the end-of-block report showed they were making no errors. In Experiments 16–20, the end-of-block feedback message also advised subjects to respond more slowly if their score was lower than 85% correct (Experiments 16–17) or 90% correct (Experiments 18–20).

Subjects were encouraged to exit their cubicles and address questions to the experimenter whenever they were unsure about instructions. In experiments with dichoptic masking of primes, the primes were not visible to most subjects and instructions made no mention of them. However, occasional subjects for whom masking was ineffective were understandably confused by the appearance of priming words in the evaluative decision task and asked the experimenter how to respond to them. These subjects were instructed to treat the capitalized words as distractors by ignoring them and responding only to the (target) words that appeared in lower case.

SOAs and other task variations. There were four types of variations in procedures of the evaluative decision task. First, as already mentioned, evaluative priming was done without masking in Experiments 5 and 7–10. Second, stimulus onset asynchrony (SOA: interval between start of prime and start of clearly visible target) was most often either 250 ms (Experiments 4, 5, 8, 9, 13, 15, and 16) or 300 ms (Experiments 17–20). Other values used were 500 ms (Experiments 10 and 11), 1,000 ms (Experiments 6 and 7), 0 ms (prime and target simultaneous in Experiment 14), and −200 ms (prime *after* target in Experiment 12). Third, the set of priming stimuli included *repetition* primes (same word for prime and target) in Experiments 4–9 and 15–20, but it included only nonidentical evaluatively polarized words (*semantic* primes) in Experiments 10–14. Lastly, the total number of evaluative decision trials was 224 (56 per block in Experiment 4–7), 120 (30 per block in Experiment 8), or 100 (25 per block in Experiments 9–20). Related to this reduction in numbers of trials, procedures of Experiments 8–20 assured that each possible target (evaluative word) stimulus was used only once, and then also slowed the rate of trials by enforcing a 2-s delay after trials, before subjects could self-initiate another trial.

Stimuli. Target words and primes were selected from published norms of evaluative meaning judgments for 399 words (Bellezza, Greenwald, & Banaji, 1986). The norms consisted of mean judgments by 62–76 college students on a five-point scale, ranging from 1 = very unpleasant to 5 = very pleasant, with 3 = neither pleasant nor unpleasant. Primes and targets were limited to words between four and eight letters in length. Primes were selected from the extremes of the norms, such that virtually all subjects would agree on their pleasant versus unpleasant classification. Unpleasant primes had normative means below 1.6 on the five-point scale, and pleasant primes had normative means above 4.4. Target words were selected from less extreme ranges (below 2.5 or above 3.5), with the consequence that they were not uniformly easy to classify, and a minority of subjects might disagree with the normative classification as pleasant or unpleasant. Nevertheless, responses to target words were scored as errors when they disagreed with the classification based on the Bellezza et al. (1986) norms. Examples of prime words, with their pleasantness norms in parentheses, are rape (1.22), killer (1.25), devil (1.37), poison (1.39), rainbow (4.55), terrific (4.55), happy (4.56), mother (4.56). Examples of target words are irritate (1.73), debt (1.75), horror (1.78), stupid (1.80), savior (4.08), learn (4.11), profit (4.12), river (4.14).

Accuracy measure. Because the measure of accuracy for the evaluative decision task came entirely from judgments of visible target words, it indicated nothing about visibility of masked priming words. This measure was useful, nevertheless, in identifying the few subjects whose data should not be included in hypothesis tests for various reasons, including poor vision, lack of fluency in English, and the undesired behavior of keeping one eye closed during the task.

Indirect latency-based measures. Mean latencies were computed separately for correct responses to words receiving repetition priming (same prime and target, although in upper and lower case, respectively), congruent semantic priming (both prime and target evaluatively negative or both

[5] As this article underwent final preparations for publication, these additional experiments were completed and a report prepared (Greenwald & Draine, in press). The additional findings supported conclusions reached in the present article and are described briefly in the *Discussion* section.

evaluatively positive), and incongruent semantic priming (one positive and the other negative). On the basis of several previous results (e.g., Bargh, Chaiken, Govender, & Pratto, 1992; Fazio, Sanbonmatsu, Powell, & Kardes, 1986; Greenwald et al., 1989), congruent priming was expected to be facilitative, in comparison with incongruent priming. Two latency-based indirect measures were computed: One was the log ratio of the subject's mean latency for incongruent primes divided by the mean latency for repetition primes; the other was the similar log ratio for incongruent primes relative to congruent primes. Because of the randomization procedures used to pair primes with targets, the latencies for the three types of trials (congruent, incongruent, and repetition priming) were based on comparable sets of target words and therefore were expected to be equal in the absence of priming effects. Accordingly, the expected value of each ratio index in the absence of priming was 1.0. The logarithms of these ratios provided the desired rational zero values, with positive values indicating expected priming effects (incongruent primes having greater latencies than congruent or repetition primes). Indices in ratio form were used rather than in difference form so that subjects' varying baseline latencies would not be an extraneous source of variance.

Indirect error-based measures. Priming effects could also take the form of higher error rates with incongruent than with congruent or repetition priming. Therefore, two error-based priming ratio indices were constructed, one dividing the error percentage for incongruent-primed trials by that for repetition-primed trials, and the other similarly using the error ratio for incongruent relative to congruent trials. These indices were used in ratio form rather than in difference form so that subjects' overall error rates would not be an extraneous source of variance. As for the latency ratio measures, the error ratios have an expected value of 1.0 in the absence of priming effects, and their logarithms therefore provided the desired rational zero values. A disadvantage of the logarithm ratio index for errors is that it is not computable when either a numerator or a denominator is zero (no errors for one or more types of trials). In order to retain the data from these subjects, zero error rates for any of the three conditions were replaced by a numerically small value computed from the subject's overall error rate on priming trials.[6]

Results

Regression analyses for relations between performance on direct and indirect measures were based on data combined across experiments whenever this could be justified by similarity of procedures.

Data-selection strategies. Very high scores on the direct measure indicated that masking was ineffective. Further, data for subjects performing at the highest levels of accuracy on the direct measure were not of interest for testing hypotheses about dissociation because of the likely lack of any contribution of unconscious cognition to their performance on indirect measures. Therefore, subjects having direct measure scores of $d' \geq 3.29$, which corresponds approximately to 95% correct at the position discrimination task, were excluded from the analyses that are reported below. Also, for analyses of the evaluative decision data, trials with latencies lower than 300 ms (considered anticipations) or greater than 2,000 ms (considered to reflect inattention) were dropped from analyses of either latency or error measures, as were all the data of subjects for whom latencies fell outside these limits for 20% or more of trials or for whom evaluative decision performance was less than 75% correct. (Chance accuracy was 50%; accuracy lower than 75% was considered to be a likely indicator of either nonfluency in English or poor vision.)

Latency-based indirect measures for the evaluative decision task were computed only for trials that had correct responses to the visible target word. Error-based indirect measures for the evaluative decision task were analyzed only for subjects whose error rates for retained trials exceeded 5% of retained trials. (The subsample of subjects with error rates lower than 5% was expected to display excessively high variability for the error-based indirect measures.)

A final strategy for data selection was based on inspection of distributions of the indirect measures. For each measure, there was a small number of outliers in the positive tail of the distribution. It was possible that these subjects misunderstood instructions. Regardless of the cause of their high levels of performance, dropping them was considered a conservative hypothesis-testing strategy—one that tended to reduce evidence for indirect effects. Dropping of high-score outlying cases was balanced by dropping the same number of cases from the low tail of the indirect measure.

Check on data-selection strategies. The strategies described above were chosen on the basis of a priori criteria before regression results were examined, and were intended to reduce noise in the data. To check on possible distortions introduced by the data-selection strategies, the data for the two largest subsets of the position discrimination task data (using Versions 1 and 2 of the task) were subject to numerous alternative analyses using varied criteria for data retention, including the strategy of retaining all subjects. These alternative analyses indicated clearly that the significant regression intercept effects that are reported below were not due to contributions of outliers on either direct or indirect measures. That is, when outliers from both ends of the indirect measure were dropped from analyses, evidence for statistical significance of intercept effects became stronger than is evident in analyses reported below in Figure 5. Dropping high scorers on direct measures tended to reduce slope effects, indicating (not surprisingly) that slope effects

[6] *Technical note on replacing zero error values:* Corrected values varied with the subject's overall error rate, using a procedure developed and described by Banaji and Greenwald (1995). In unpublished simulations, Banaji and Greenwald showed that this form of correction performs better in estimating true values of generating proportions than do other corrections, such as dropping subjects, adding 0.5 to all numerators and denominators, or adding very small constants (see Agresti, 1990).

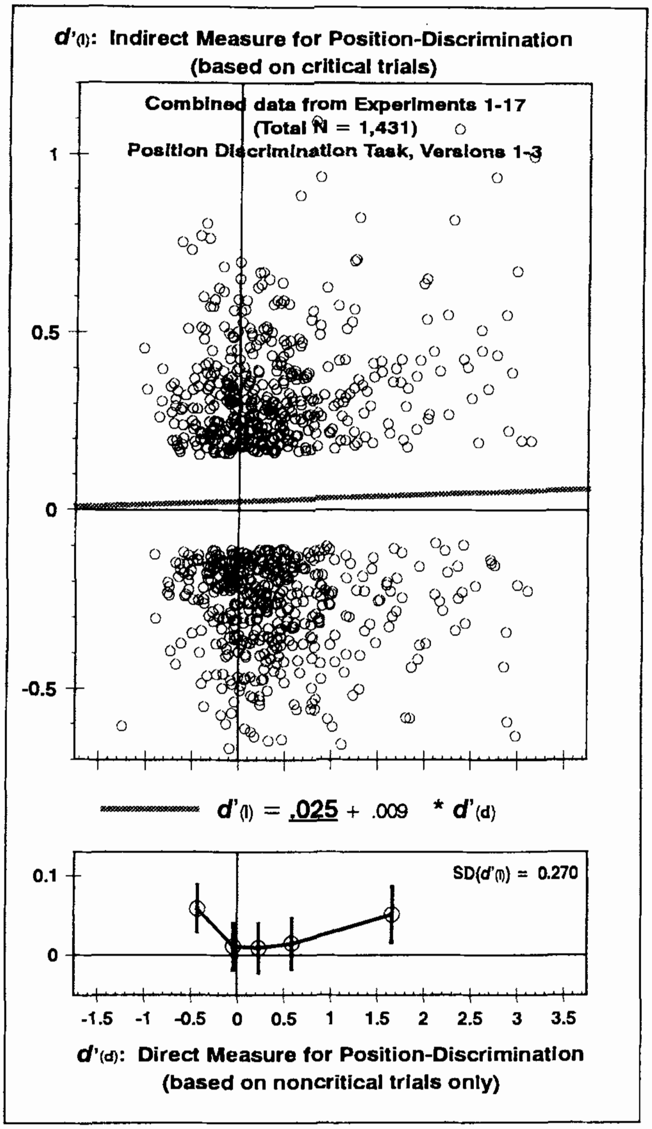

Figure 4. Regression test showing indirect measure ($d'_{(i)}$, based on response to position meaning of LEFT or RIGH) as a function of direct measure ($d'_{(d)}$, based on position discrimination accuracy for dichoptically masked left- or right-positioned four-letter words). Data are shown for the 17 experiments that used Versions 1–3 of the position discrimination task, which are combined because similar procedures were used for their direct measures. The scatter plot in the upper panel shows the data for all subjects in these experiments except those falling in a swath within one half a standard deviation above or below the linear regression function. These cases were deleted from the plot (not from regression analyses) in order to show clearly the fitted regression function. The lower panel shows a descriptive summary of the same data, 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 $d'_{(d)}$. Interpretation of significance tests for the regression function, which is shown between the two panels, is explained in the caption of Figure 5.

were contributed to importantly by subjects scoring relatively high on direct measures. On the other hand, dropping high scorers on direct measures produced little change in intercept effects. The additional analyses also included some on which low scorers—ones with largest negative values of d' on direct measures—were dropped. Dropping as many as 5% of subjects from the low extreme of direct measures still left significant intercept effects intact.[7]

Tests of Unconscious Influence on Position Responses

All the experiments included one of four versions of the position discrimination task. Versions 1–3 were almost identical in their noncritical trials (which provided direct measures), although they differed in the spatial separation of the left and right positions on critical trials (ones with the stimulus strings LEFT or RIGH). Version 4 was substantially different and more difficult; it required discrimination of displays in which a four-letter word appeared left of center accompanied by its reverse-spelled counterpart nonword right of center (e.g., ITCH HCTI) from displays with nonword left and word right (e.g., HCTI ITCH).

The data for each of the four versions were examined with linear regression analyses. Figure 4 presents regression results for the combined data of Versions 1, 2, and 3 of the position discrimination task and provides the most powerful hypothesis tests that are available in the present research. The combination of Versions 1–3 was justified by their very similar direct measures of position discrimination accuracy.

The scatter plot on Figure 4 shows the superimposed best-fitting linear regression function while also reporting the intercept and slope parameters of the regression function. The intercept term was significantly greater than zero, $t = 3.15$, $df = 1{,}429$, $p = .0016$. This intercept effect indicated that above-chance performance on the indirect measure was associated with chance performance on the direct measure (the indirect-without-direct-effect data pattern). Of the three theory-defined patterns shown in Figure 2, the results depicted in Figure 4 most closely resemble the first (significant intercept, nonsignificant slope), a finding that is consistent with unconscious cognition dissociated from conscious cognition.

Figure 5 uses the pentile display format of the lower panel of Figure 4, presenting data separately for each of the four versions of the position discrimination tasks and reporting their fitted linear regression equations. It can be seen that there were significant intercept terms for both Version 1 and Version 2. For Versions 2 and 3, analyses also showed significant positive effects for slope terms.

[7] As an illustration, in 17 variations (using different criteria for dropping subjects) of the analysis for Version 2, intercept effects ranged from .031 to .042, (compare with .039 in the second panel of Figure 5), the median value was .036 ($t = 3.17$, df $= 545$, $p = .0016$), and the range of t values was from $t = 2.62$, df $= 541$, $p = .0091$, to $t = 4.20$, df $= 556$, $p < .0001$. Details of additional analyses are available from the first author on request.

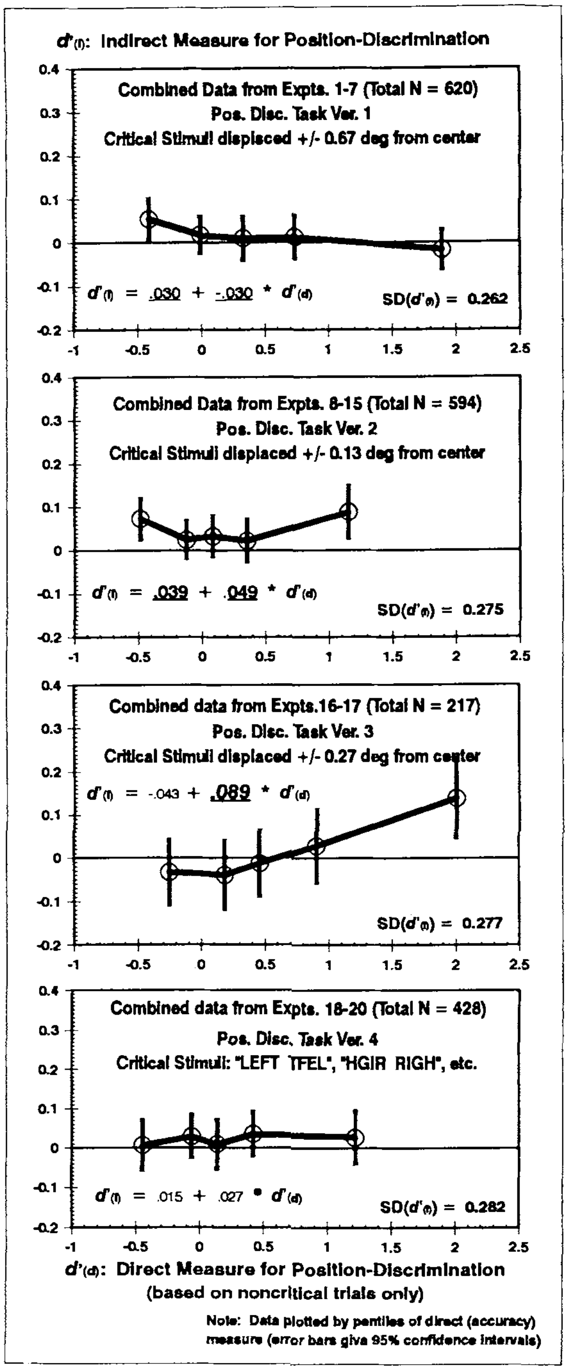

Figure 5. Analyses of relationships between direct and indirect measures for the four versions of the position discrimination task. As explained in the text, data are presented separately for the sets of experiments using these four versions because of their varying procedures for the indirect measure of semantic activation. Statistical significance for intercept and slope parameters of linear regression functions is indicated by printing the significant coefficient in underline ($p \leq .05$), bold + underline ($p \leq .005$), or bold + underline + italic ($p \leq .0005$). The first number to the right of the equal sign is the intercept, and the next number is the slope. $d'_{(i)}$ and $d'_{(d)}$ are signal detection sensitivity indices for the indirect and direct measures, respectively.

Test of Unconscious Influence on Evaluative Decisions

Each of Experiments 4–20 included a version of the evaluative decision task. In 8 of these 17 experiments, masked priming SOAs of either 250 or 300 ms were used. An additional three experiments used visible priming with a 250-ms SOA. The eight experiments that used masked priming are described here in two groups: First described are five experiments that were done with Versions 1, 2, or 3 of the position discrimination task. (It is important to recall that those three versions had near-identical procedures for assessing the direct measure of perceptibility of masked stimuli.) Following the results of those five experiments are results for the three experiments that used the more difficult variation (Version 4) of the position discrimination task.[8]

The upper two panels of Figure 6 give results for the error-based indirect measure for the five experiments that used masked priming of evaluative decisions, had SOAs of 250 or 300 ms, and used Versions 1, 2, or 3 of the position discrimination task as the basis for the direct measure. The left, upper panel gives the log ratio measure that compared error rates for incongruent versus repetition primes, and the right upper panel gives the similar measure comparing incongruent with congruent primes. These analyses yielded no statistically significant regression effects (see upper left and upper right panels of Figure 6).

The middle two panels of Figure 6 give results for the three experiments that used masked priming of evaluative decisions and also used (the relatively difficult) Version 4 of the position discrimination task. These analyses revealed clear and strong slope effects and also indicated the absence of intercept effects. These findings with Version 4 of the position discrimination task were therefore most similar to the third pattern of Figure 2 (significant slope with nonsignificant intercept); this pattern does not favor an interpretation in terms of dissociation of unconscious from conscious cognition.

The bottom two panels of Figure 6 present data from the three experiments that tested priming of evaluative decisions by visible (not masked) word stimuli. Because these experiments also used the masked position discrimination task (Versions 1 or 2), it was possible to test relations of the (visible) priming effects in these experiments to variations in performance at the masked position discrimination task. Of course, because there was no masking of the evaluative priming stimuli, there was no reason to expect patterns other than the flat horizontal functions that were observed.

[8] Relatively small numbers of subjects took part in experiments with masked priming of evaluative decisions at SOAs other than 250 or 300 ms. The other intervals used, with numbers of subjects available for each in parentheses, were −200 ms (44), 0 ms (71), 500 ms (39), and 1,000 ms (50). Because regression tests with these sample sizes had too little statistical power to yield compelling tests, data for experiments using SOAs other than 250 or 300 ms are not presented here.

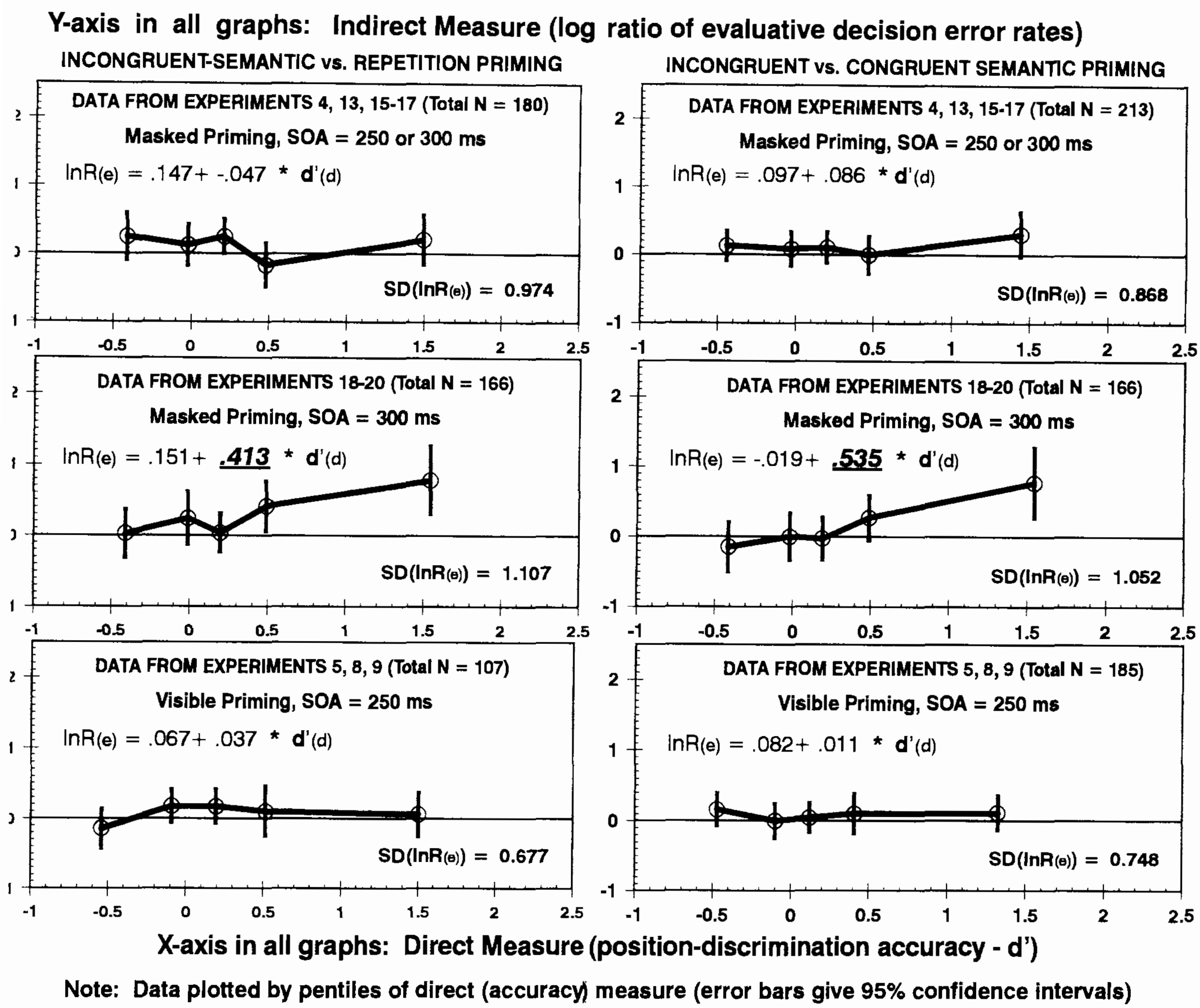

Figure 6. Log ratio error-based indirect measures, lnR(e), of evaluative decision priming as a function of $d'_{(d)}$, the latter based on performance at position discrimination of masked stimuli. These relationships are presented for three sets of experiments in which the evaluative decision task used 250- or 300-ms SOAs between primes and target words. See caption of Figure 5 for interpretation of regression-function significance tests.

Figure 7 presents analyses parallel to those of Figure 6, but using the latency-based measures in place of the error-based measures. No significant intercept effects were observed, and a significant (but weak) slope effect was observed for only one of the four regression tests of data sets based on masked priming. The lower two panels of Figure 7 show only one effect, a sizable intercept effect in the measure that compared priming by visible incongruent versus visible repetition primes (lower left panel).

Two features of the visible priming data that are shown in the bottom panels of Figures 6 and 7 were surprising. First, the only evidence for visible priming effects was in the comparison of incongruent with repetition priming; second, this evidence for visible priming was obtained only for the latency-based priming measure, not for the error-based priming measure. Previous studies (e.g., Bargh et al., 1992; Fazio et al., 1986; Greenwald et al., 1989) have found considerably more robust visible priming effects in evaluative decision tasks. The shortage of visible priming effects in the evaluative decision task, which was especially surprising because masked priming effects were found, is considered further in the *Discussion* section.

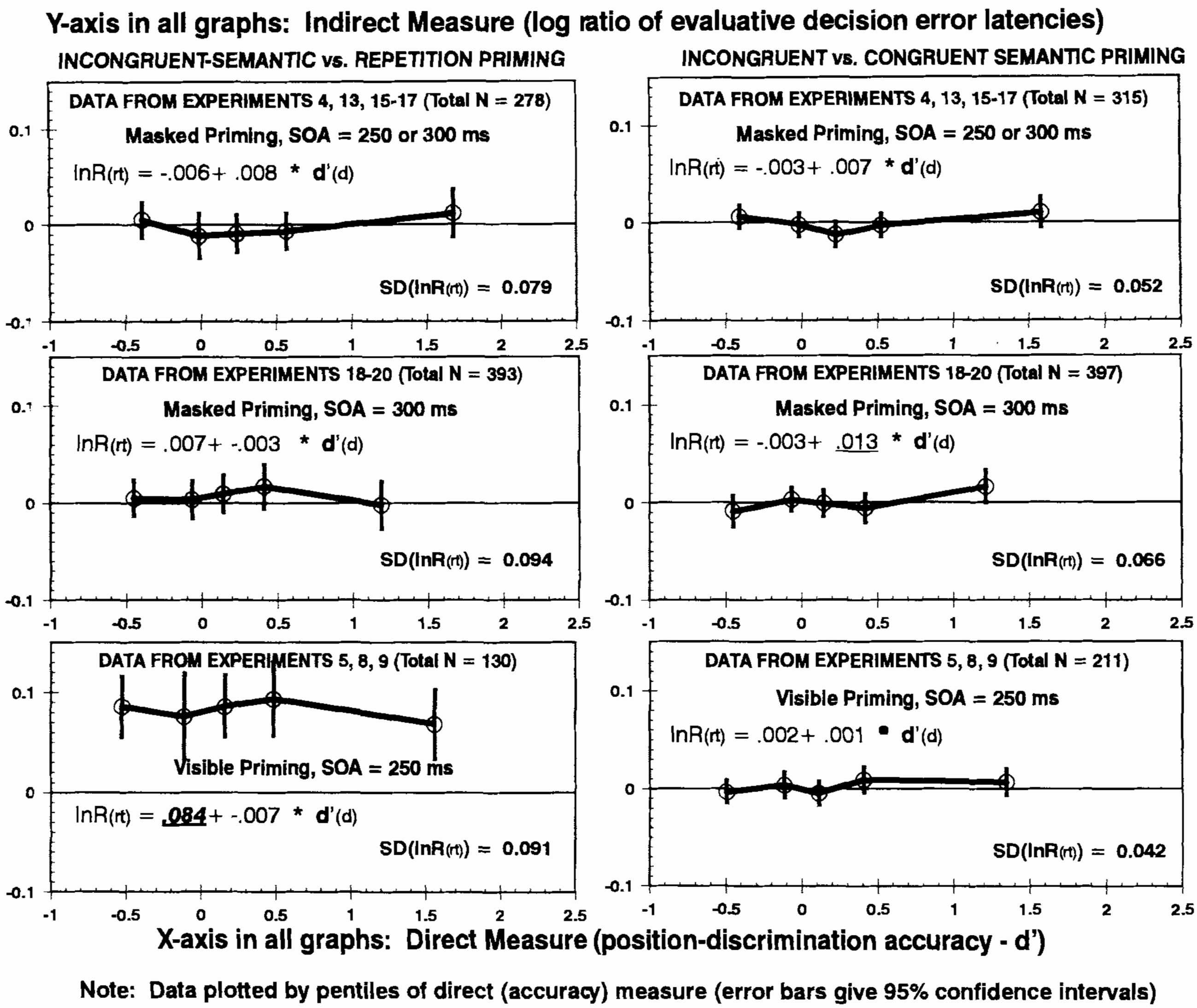

Figure 7. Log ratio latency-based indirect measures, lnR(rt), of evaluative decision priming as a function of $d'_{(d)}$, the latter based on performance at position discrimination of masked stimuli. These relationships are presented for three sets of experiments in which the evaluative decision task used 250- or 300-ms SOAs between prime and target words. See caption of Figure 5 for interpretation of regression-function significance tests.

Discussion

Overview of Major Findings

Hypotheses were framed as expectations for regression functions that related indirect effects to direct effects of marginally visible masked stimuli. In these regression tests, intercepts greater than zero indicated existence of unconscious cognition (and, plausibly, dissociation of unconscious from conscious cognition), whereas slopes greater than zero indicated that indirect effects were associated with (and, possibly, dependent on) conscious cognition. The regression analysis strategy permitted these two types of effects to coexist; a single data set could provide evidence for both dissociation and association. The experiments employed two types of indirect measures, one derived from a position discrimination task, the other from an evaluative decision task. Both of these tasks were used previously in studies of much smaller samples in which semantic activation by masked primes was demonstrated (Greenwald et al., 1989).

Summary of findings for position discrimination task. The indirect measure for the position discrimination task assessed effects of the masked stimulus strings LEFT and RIGH (shortened from RIGHT to hold stimulus width constant) on choice of the left or right response keys. Subjects' instructed task was to respond to the position of the stimulus. Neither the possible relevance of stimulus meaning to responses nor any indication of the existence of the critical stimulus strings was mentioned in instructions. The series of 20 experiments provided four groups of tests of this indirect effect, one from experiments using each of four versions of the position discrimination task (with, respectively, 620, 594, 217, and 428 subjects). The most powerful test combined the data from the first three task versions, which had employed near-identical measures of direct effects. Two of the four separate tests (see Figure 5), as well as the combined one (see Figure 4), revealed significantly positive intercept effects. Also, two of the separate tests showed significantly positive slope effects. The intercept effects are of greatest importance because they display the indirect-without-direct-effect data pattern. Although these intercept effects were small and were statistically significant in large part because of the cumulative high power of the present research, the finding of them nevertheless provides the statistically most secure evidence now available for this highly sought data pattern.

Summary of findings for evaluative decision task. The second indirect measure sought effects of masked evaluatively polarized words on judgments of evaluative meaning of clearly visible words that were presented with onsets 250–300 ms after onsets of the masked primes. This test was available in eight data sets, with four measures used in each of two groups of similar experiments. (These eight data sets appear in the upper four panels of Figure 6 and the upper four panels of Figure 7.) The results showed slope effects (significant positive slope coefficients of linear regression functions) in three of the eight data sets and intercept effects in none of the eight. That is, when indirect effects of masked, evaluatively polarized priming words occurred, they occurred only to the extent that these stimuli were also capable of producing direct effects. This pattern does not indicate dissociation of unconscious from conscious cognition.

Conclusions. For the position discrimination task, the data corresponded most closely to the top panel of Figure 2. These data strongly support a conclusion of the existence of unconscious cognition and also suggest (but do not demand) the dissociation interpretation. For the evaluative decision task, the data pattern possibly indicates association of unconscious with conscious cognition, but it is also consistent with nonexistence of unconscious cognition. The remaining discussion focuses on possible error of the two major conclusions (existence and dissociation).

Appraisal of the Existence (of Unconscious Cognition) Conclusion

The statistically significant intercept effects shown in Figures 4 and 5 support the conclusion of existence of unconscious cognition. The p value associated with this finding (e.g., $p = .0016$, two-tailed, for the result in Figure 4) indicates that Type I statistical error is a very unlikely (1 in 625) alternative interpretation. However, other possibilities merit consideration. The two considered here are based on the possible incorrectness of assumptions underlying either the regression analysis method or the interpretation of direct measure data.

Measurement error? An assumption underlying interpretation of numerical values of slope and intercept coefficients in linear regression is that the predictor variable is free of measurement error (e.g., Neter, Wasserman, & Kutner, 1985). The predictor variable in the present research was the direct measure of performance in the position discrimination task. The reliability of this measure could be estimated from Experiments 1–7, which provided two direct measures, one based on noncritical trials and the other on critical trials. (Unlike the later experiments, the critical and noncritical trials for Experiments 1–7 used identical spatial separation of left and right positions.) Although the reliability correlation between these two measures was high ($r = .85$), it was clearly less than perfect, indicating the presence of some measurement error. Further indication of measurement error is the presence of negative observed values of d' for the direct measure, for which d' should have a rational minimum of zero. Under some conditions, measurement error in the predictor can cause a statistically significant intercept to materialize when the true underlying regression function passes through the origin. In particular, a spurious intercept effect can occur when the slope of the regression function is positive and the mean of the predictor is substantially greater than zero. It can be seen (in Figure 4, for example) that these conditions did not characterize the present research; the regression slope was approximately flat, and the mean of the predictor was not much above zero. (Greenwald & Draine, in press, provide a more detailed discussion of the possibility of obtaining an artifactually significant intercept with the regression analysis method; see also the discussion, below, of below-chance scores on the direct measure.)

Nonlinear regression functions? The present use of regression analyses assumes that the relation between direct and indirect measures is described by a linear function. Visual inspection of the combined data of Versions 1–3 of the position discrimination task (see lower panel of Figure 4) and Version 2 individually (second panel of Figure 5) suggest that the regression function may have been U-shaped. Tests using a regression equation with a quadratic term (which should capture a U-shaped relationship) showed statistically significant quadratic terms ($.005 < p < .05$) for both the data in Figure 4 and those in the second panel of Figure 5. Because these quadratic functions themselves had statistically significant intercepts (intercepts = .024, .033, ps = .0024, .0049, respectively), the apparent deviation from linearity of the regression function does not disturb the evidence for the indirect-without-direct-effect data pattern. (A possible interpretation of the curved shape of the regression function in Figure 4 is considered further, below, in the discussion of indirect effects associated with below-chance direct-measure performance.)

Appraisal of the Dissociation Interpretation

Interpretation of the present significant intercept-effect findings as indicating existence of unconscious cognition depends in part on the assumption that the direct measure is at least as sensitive as the indirect measure to conscious stimulus effects. This is Reingold and Merikle's (1988) "minimal" assumption (see right panel of Figure 1). However, any decisive interpretation of these results as indicating dissociation of unconscious from conscious cognition requires a stronger assumption: that the direct measure is sensitive to all conscious stimulus effects, as in Holender's exhaustiveness assumption (see left panel of Figure 1). Without an exhaustiveness assumption, it is possible to assume that indirect-without-direct-effect data indicate only that (a) the direct measure was insensitive to some conscious effects of the task stimuli (consistent with association), rather than that (b) the indirect measure assessed influences that had no effect on conscious cognition (dissociation).

One can easily think of direct measures for which an exhaustiveness assumption is implausible. As an example from the present research, consider the lexical-decision-plus-position-discrimination task used in Experiments 18–20, which required subjects to discriminate the side on which a four-letter word was properly spelled. It is plausible that substantial stimulus information might be available consciously, perhaps enough to support performance well above chance on a detection task, even when the direct measure of instructed performance on this task was at chance.

The other side of the preceding argument is that the exhaustiveness assumption may be valid for some direct measures. In the present research, an empirical case can be made (and is presented in the following paragraphs) for plausibility of an exhaustiveness assumption for the direct measure based on the position discrimination task of Experiments 1–17. To the extent that the exhaustiveness assumption is plausible for these experiments, their data can support a conclusion of dissociation of unconscious from conscious cognition.

In the position discrimination task of Experiments 1–17, the direct measure assessed subjects' sensitivity to the position variation of a four-letter string being left or right of center. This position discrimination task provided three opportunities to find results inconsistent with an exhaustiveness assumption. Although none of these tests individually, nor their combination, can conclusively establish exhaustiveness (cf. the discussion of such evidence by Greenwald et al., 1989, p. 43), nevertheless a different pattern in any of them would have undermined the dissociation interpretation.

Sensitivity of the position discrimination direct measure. Experiments 1–3 used a detection task along with the position discrimination task and used identical (critical and noncritical) stimuli for both tasks. Comparison of performance on the detection and position discrimination direct measures indicated that the mean value of $d'_{(d)}$ for position discrimination averaged 0.23 higher than the mean value of $d'_{(d)}$ for detection, $t(433) = 6.06$, $p < .0001$. This finding indicated that the position discrimination task enabled greater conscious pickup of stimulus information than did the detection task. (To repeat, this result does not demand a conclusion that the position discrimination task was exhaustive in its sensitivity to consciously available information.)

Comparison of direct measures for critical and noncritical trials. Direct measures used for the tests shown in Figures 4 and 5 were based on noncritical trials that used 75 different four-letter words as stimuli, whereas the indirect measure used only the two four-letter strings (LEFT and RIGH) that defined critical trials. Possibly the critical-trial stimuli were more discriminable or detectable than the other 75, permitting more consciously available information on trials comprising the indirect measure. If so, the exhaustiveness assumption (at least in regard to the tests shown in Figures 4 and 5) would be undermined. This concern was testable by comparing the mean scores on direct measures computed from critical and noncritical trials. For both the detection and the position discrimination tasks of Experiments 1–3, this comparison indicated that mean scores were very slightly (nonsignificantly) lower for the direct measure based on critical trials. Again, the possible disconfirmation of exhaustiveness did not materialize.

Use of regression method with multiple predictors. The preceding analysis indicated that there was not *more* information consciously available on critical trials than on noncritical trials. Nevertheless, there may have been *different* consciously available information. To the extent that different information was consciously available, the direct measure of position discrimination was not exhaustive. Furthermore, if the indirect measure was sensitive to consciously available information to which the direct measure was insensitive, a regression test using a direct measure based on critical trials—rather than the one based on noncritical trials, which was used for the present major analyses—might not reveal the significant intercept. The strongest test of this sort would use direct measures from both critical and noncritical trials simultaneously as regression predictors. That test was conducted for the two versions of the position discrimination task (Versions 1 and 2) that had shown significant intercept effects (see Figure 5). For both Versions 1 and 2 and for the combined test including Versions 1–3, the significant intercept effects remained in evidence when the two predictors were used simultaneously, again sustaining plausibility of the exhaustiveness assumption. (The numerical magnitude of the intercept effect was decreased slightly for Version 1, increased slightly for Version 2, and unchanged for the combined test of Versions 1–3.)

In summary, plausibility of the dissociation conclusion rests on plausibility of the exhaustiveness assumption for the direct measure based on Versions 1–3 of the position discrimination task. The dissociation conclusion remains plausible because the three tests that could have disconfirmed the exhaustiveness assumption failed to do so. At the same time, these data do not stand as sufficient basis for accepting dissociation as empirically established. Rather, 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 conclusion should become increasingly acceptable.

Applied Significance of the Dissociation Interpretation

The present evidence for dissociation supports public concerns that undetectable communications might cause unwanted influences on people being advertised to, educated, entertained, or otherwise communicated with by media that can transmit marginally perceptible stimuli. Even findings that do not suggest a dissociation interpretation—such as those from the present evaluative decision task—raise concerns about the difficulty of defending against influences by marginally perceptible stimuli, because the effects obtained with such stimuli did not appear when the same stimuli were visible (see Figure 6). It is important to note, however, that the present procedures were remote from any that might be used in an attempt to produce subliminal influences through mass media. Consequently, although they suggest the possibility of influences that might be cause for concern, the present findings do not demonstrate such influences.

Theoretical Significance of the Dissociation Interpretation

Cheesman and Merikle's (1984) subjective threshold interpretation of SSA was welcomed in the published literature, as was Holender's (1986) skeptical appraisal of evidence for dissociation in SSA experiments. Although neither of those publications was explicitly intended as such, nevertheless each can be seen as reassuring to adherents of the information processing theoretical framework that dominated cognitive psychology from the mid-1960s to the mid-1980s. A central feature of standard versions of information processing theory is the assumption that perceptual analysis proceeds in a single path through successive stages that are often identified as sensory registration, preattentive processing, attention, and response selection (cf. Smith, 1967).

In the single-path version of the information processing framework, influence of a stimulus on an indirect measure indicates that the stimulus has been processed at least through sensory registration and preattentive stages, during the latter of which word meaning can be partly analyzed. Furthermore, when the processor allocates attentional resources to a sensory channel that has been preattentively processed, the content of that channel should be attended and, therefore, detectable. In this theoretical context, a finding of the indirect-without-direct-effect data pattern is highly problematic because (a) the indirect effect implies the existence of output from preattentive processing, whereas (b) the absence of a direct effect (e.g., detection), when attention is directed to the corresponding sensory channel, simultaneously implies the nonexistence of that preattentive output.

In response to the challenge posed by the indirect-without-direct-effect pattern, the information processing approach can be rescued by devices that assume multiple information processing paths (cf. the information processing account of unconscious cognition in Figure 1 of Greenwald, 1992). This solution, however, has the unattractive feature of abandoning the most powerful theoretical device of standard information processing models, which is the assumption of an ordered series of processing stages arrayed in a single path.

The indirect-without-direct-effect pattern of the present findings is not problematic for recent approaches that employ a parallel distributed network form (e.g., Rumelhart & McClelland, 1986). In such network models, any stimulus input can readily develop independent pathways to different responses and multiple pathways to the same response (cf. Figure 2 of Greenwald, 1992). Thus, responses that indicate direct and indirect (uninstructed) effects of marginally perceptible stimuli might use separate network paths and, therefore, be independent of (i.e., dissociated from) one another.

Unexpected Findings

Limited visible priming effects. Previous studies with the evaluative decision task found that prime-target pairs composed in the same fashion as those in the present research, when visible, produced substantial priming effects that appeared as faster evaluative judgments of targets for congruent than for incongruent pairs (Bargh et al., 1992; Fazio et al., 1986; Greenwald et al., 1989). This effect was not obtained in the present research (see lower right panel of Figure 7). Of the various procedural differences between the present and previous studies, one that may explain this difference in findings is the present use of self-initiated trials and, following self-initiation, a fixed brief interval to onset of the prime-target sequence. This procedure was implemented with the aim of maximizing subjects' ability to attend to the stimuli. In retrospect, it may have worked too well. Other research indicates that attentional focus can suppress automatic activation (see reviews by Greenwald & Banaji, 1995; Mandler, 1994).

Even though no visible priming effects were obtained on error-based measures for the evaluative decision task, sizable masked priming effects were found on the error-based measure (compare middle and lower panels of Figure 6). This contrast is consistent with the suggestion in the preceding paragraph that subjects in the present research may have used attention strategically to suppress automatic priming effects. Presumably, that is, subjects could suppress automatic interfering effects of visible incongruent primes but were unable to suppress those interfering effects for masked incongruent primes, because the masked primes escaped attentional capture.

Masked evaluative-decision priming more apparent in errors than latencies. Visible priming effects differed qualitatively from masked priming effects. Specifically, visible priming was not evident at all on error-based measures (lower panels of Figure 6) and was evident only for repetition priming of latencies (lower left panel of Figure 7), whereas masked priming was indicated primarily by error-based measures in congruent and repetition priming (middle panels of Figure 6). These observations of a qualitative difference have bearing on the strong appeals, in discussions of empirical criteria for demonstrating unconscious cognition, to the importance of establishing qualitative differences between effects of purportedly subliminal stimuli and those of clearly perceptible stimuli (Cheesman & Merikle, 1986; Dixon, 1981; Holender, 1986).

Different priming effects for position discrimination and evaluative decisions. The indirect-without-direct-effect pattern for masked stimuli in the position discrimination task provided evidence suggestive of dissociation of unconscious from conscious cognition, whereas the corresponding analyses for masked priming in the evaluative decision task provided evidence only for association of indirect effects with direct effects. Possibly related to this difference, the indirect-without-direct-effect pattern was obtained in the position discrimination task when Versions 1–3 of that task were used to establish stimulus presentation conditions, whereas masked priming effects for the evaluative decision task were obtained only when Version 4 of the position discrimination task was used to establish stimulus presentation conditions. An important consequence of the introduction of Version 4 of the position discrimination task (Experiments 18–20) was an easing of masking conditions: Masked stimuli became somewhat more visible as a consequence of the increased difficulty of the task for the direct measure, caused in turn by the computer program's procedures for maintaining average levels of direct-measure performance that were slightly above chance. Therefore, it appeared that priming in the evaluative decision task occurred only under conditions that permitted relatively high levels of consciously visible information to penetrate the dichoptic masks.

Two differences between the position discrimination and evaluative decision tasks were substantial enough to merit serious consideration as possible explanations for the difference in their masked priming effects. First, the position discrimination task called for a response to the masked stimulus, whereas the evaluative decision task required a response to a subsequent stimulus. Second, for the position discrimination task, subliminal activation involved a response being influenced by denotative meaning of the masked stimulus (e.g., influence of LEFT on pressing the left key), whereas for the evaluative decision task, subliminal activation involved a response being influenced by a more abstract aspect of meaning, an associated evaluation.[9]

Comparison of repetition and congruent priming. A reason for including both repetition and congruent semantic priming in the present research was the finding, by Carr and Dagenbach (1990), that facilitative masked priming of lexical decisions by repetition primes occurred under some instructional and task conditions that did not yield facilitative masked priming by semantically related primes. Although these previous results did not lead firmly to any expectation that the present procedures should yield differences between repetition and congruent priming, they nevertheless called attention to the possibility of finding such differences. As can be seen by comparing the left and right sides of Figures 6 and 7, for the most part the present research did not yield differences between repetition and congruent priming for masked primes. The only such discrepancy appeared in the comparison of the two middle panels of Figure 7, where it is shown that, for latency measures, only congruent priming (and not repetition priming) was related to detectability of the priming stimuli. However, because masked priming effects were relatively weak on latency measures and because of the clear similarity between repetition and congruent masked priming effects on error-based measures (see Figure 6), the present findings are viewed best as indicating similarity, not differences, between repetition and congruent masked priming. At the same time, the finding of visible priming only by repetition (and not congruent) primes (see lower panels of Figure 7) does show a difference that may be consistent with the Carr and Dagenbach hypothesis of a "center-surround" attentional mechanism that can "enhance activation of sought-for codes and . . . inhibit related codes stored nearby in the semantic network" (p. 341).

Indirect effects associated with below-chance performance on direct measures. Perhaps the most surprising finding in the present research was the evidence from Experiments 1–15 that subliminal activation of position responses occurred for subjects who performed *below* chance on the direct measure of performance at the position discrimination task, but not for subjects who performed *at* chance (see Figure 4 and upper two panels of Figure 5). An explanation of this pattern might be based on fallibility (measurement error) of the direct measure of position discrimination performance. Because $d'_{(d)}$ has a theoretical lower bound of zero, there is certainly a measurement-error component to negative d'scores. Similarly, there should also be a measurement-error component to $d'_{(d)}$ scores that are in the vicinity of zero. Some of the subjects with $d'_{(d)}$ scores near zero must have true accuracy scores that are greater than zero; that is, compared to those who scored below chance, a higher proportion of subjects scoring at or near chance should have true above-zero accuracy scores. This reasoning can explain the observed pattern, if it is assumed that conscious pickup of small amounts of visible information interferes with subliminal activation. In other words, subjects who performed below chance include a relatively large proportion who were receiving no consciously visible stimulus information and therefore did not experience the hypothesized interference associated with low levels of conscious information. Although this interpretation is not test-

[9] Some other differences that should be noted, even though their possible role in producing the observed results is not obvious, are that (a) the masked evaluative priming words were centered (not left- or right-positioned) and ranged between four and eight letters in length (not fixed at four letters) and (b) for position discrimination, direct and indirect measures were obtained from the same blocks of trials, whereas the evaluative decision task did not provide its own direct measure (its analysis used instead the direct measure obtained from position discrimination performance).

able with the present data, it fits with equally puzzling findings in two previous studies. Dagenbach et al., (1989, p. 423, Figure 1) reported statistically significant priming for their detection threshold condition but not for their "informed choice" threshold condition, which involved longer stimulus onset asynchronies (i.e., less effective masking). Klinger and Greenwald (in press) repeatedly found that priming was stronger for their subset of subjects with d' scores below 0.25 (including subjects with negative values of d') than for their subset of subjects with $d' > 0.25$. Klinger and Greenwald offered the interpretation also suggested here—that low levels of visibility likely increased active efforts to process the prime, which in turn might have interfered with priming.

Limitations on Generalizability of Findings

Small magnitude of observed intercept effects. Although they are statistically secure, the intercept effects described in this article are small, representing about 0.1 standard deviation of the indirect measure that served as the dependent variable. One can expect to replicate these effects with large samples such as those used in the present research, but one cannot be confident in replicating them at statistically significant levels with small groups of subjects. Based on the combined data shown in Figure 4, it was calculated that, in order to have an 80% probability (power) of finding an intercept effect that was statistically significant at $\alpha = .05$, two-tailed, a replication should be conducted with approximately 900 subjects. An editorial consultant for this journal described it as "professional folly for any researcher to perform a follow-up experiment based on the paradigm described in this paper." Before being so deterred, Greenwald and Draine (in press) collected data from 363 subjects to obtain direct and indirect measures in procedures derived from the dichoptically masked detection task that was used in Experiments 1–3 (with `LEFT` and `RIGH` as stimuli on critical trials). Regression results for these subjects were meta-analytically combined with those from 396 subjects in the present Experiments 1–3, for whom the detection task data were deemed inconclusive by virtue of inadequate power. (Combination into a single regression analysis was not appropriate because of several substantial procedural differences between the new experiments and the earlier ones.) The resulting analysis showed clearly that the meta-analytically combined intercept effect was statistically significant (weighted mean intercept $d' = 0.039$, $p = .0004$). Procedural details and results of the additional studies, along with full reporting of meta-analytic findings (including data from the present position discrimination tasks), are provided by Greenwald and Draine (in press).

Generalization to other masking procedures? The present research used a simultaneous dichoptic masking procedure as the means of achieving subliminality (i.e., marginal perceptibility). There were several reasons for this choice, including that (a) this procedure allowed primes to be presented for relatively long durations and at relatively high illumination levels while keeping them effectively invisible for many subjects, (b) some theoretical treatments of visual masking have suggested that dichoptic pattern masking is more likely than other masking procedures to permit penetration of information from masked stimuli to central levels of visual processing (see Marcel, 1983; Turvey, 1973); and, especially (c) dichoptic masking was used successfully by Greenwald et al. (1989) to obtain masked priming effects. Although theoretical understanding of dichoptic masking is far from well established (see Breitmeyer, 1986; Bridgeman, 1986; Kahneman, 1968), a decade-long period of using dichoptic masking to test for subliminal activation was prompted by Marcel's (1983) apparent success in so doing. Unfortunately, it now seems clear from both the paucity of successful uses of dichoptic masking and the small magnitude of effects in the present research that dichoptic procedures do not provide the basis for an efficient laboratory model of subliminal activation.

Generalization to other instructional conditions? The instructions used in all the present experiments encouraged subjects to cope with the difficulty of the task of judging positions of masked words by taking a relaxed approach and letting the response occur to them, much as they might approach an extrasensory perception experiment. The instructions stated further that this advice was based on previous conclusions that performance might be maximized with this relaxed, or "passive," approach (Marcel, 1983). Recently, Mandler (1994) has reemphasized this point, proposing that effects of subliminal stimuli or of weak memory traces are most likely to emerge when subjects avoid conscious, attentional strategies for perception or memory tasks. The present research included no attempts to evaluate the effect of instructions experimentally, nor did it include any procedures to evaluate the extent to which subjects adopted the recommended, relaxed approach. Accordingly, the contribution of instructions to the present findings, as well as the generalizability of present findings to other instructional conditions, remains to be established.

Generalization to experimental manipulation of direct-measure performance? A limitation of the research design used for the present experiments was that variations in levels of performance on direct measures were partly a function of preexisting characteristics of subjects. That is, variations in performance on direct measures depended partly on differences among subjects in the effectiveness of dichoptic masking. It would have been possible to avoid this partial confounding by setting performance targets for each subject and then manipulating masking conditions until performance stabilized at that target. This alternative procedure was not used because it would have required experimental sessions at least twice as long as those used and because of the concern that the indirect effects being sought might be too fragile to survive such extensive testing (cf. Klinger & Greenwald, in press).

As a result of the possible confounding of performance on direct measures with preexisting differences among subjects, observed associations between indirect effects on each task and levels of performance on direct tests could reflect differences among subjects who achieved the different levels of direct-measure performance, rather than reflecting effects that depended only on the observed levels of direct-measure performance. At the same time, some indications that preexisting subject differences did not contribute in an important way to observed regression relationships were (a) the nonappearance, in regression tests for effects of visible evaluative decision priming, of the same slope effects that appeared for masked priming (See Figure 6) and (b) the association of priming effects with different levels of performance on the direct measure for the position discrimination and evaluative decision tasks.

Uncertainty of conditions on which significant intercept effects depend. The juxtaposition of statistically significant with nonsignificant effects is informative when the procedures on which this variation in findings depends are identifiable. Unfortunately, those critical procedures have not yet been identified for the findings of significant and nonsignificant intercept effects in the present research. Consequently, a substantial challenge for further research is to discover the critical variations of stimulus presentation or task materials on which the intercept finding depends.

Conclusion

The importance of the present experiments is in the evidence they provide for the existence of unconscious cognition and their consistency with the hypothesis that unconscious cognition was dissociated from conscious cognition in a portion of the data. These findings were obtained with a novel method for analyzing regressions of measures of indirect effects on measures of direct effects of marginally perceptible stimuli. The dissociation-supporting evidence produced by this method favors a view of unconscious cognition that heretofore has seemed unwelcome in cognitive psychology, presumably because that view opposes the standard (single-path) information processing conception that dominated cognitive psychology for much of the second half of the 20th century. At the same time, the dissociation interpretation is not at all problematic from the perspective of the parallel distributed network form of theory, which is in the process of supplanting the information processing approach.

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