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Unconscious Perception: Attention, Awareness, and Control

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Conscious perception is substantially overestimated when standard measurement techniques are used. That overestimation has contributed to the controversial nature of studies of unconscious perception. A process-dissociation procedure (L. L. Jacoby, 1991) was used for separately estimating the contribution of conscious and unconscious perception to performance of a stem-completion task. Unambiguous evidence for unconscious perception was obtained in 4 experiments. In Experiment 1, decreasing the duration of a briefly presented word diminished the contribution of both conscious and unconscious perception. In Experiments 2–4, dividing attention reduced the contribution of conscious perception while leaving that of unconscious perception unchanged. Discussion focuses on the measurement of awareness and the relation between perception and memory.

Unconscious perception is perhaps the oldest and most controversial area within experimental psychology (for reviews, see Greenwald, 1992, and accompanying commentaries). Kihlstrom, Barnhardt, and Tataryn (1992) suggested that an experiment examining unconscious perception done by C. S. Peirce and Joseph Jastrow in 1884 was the first psychological experiment performed in America. Peirce and Jastrow's experiment, in which they themselves were the subjects, concerned people's ability to discriminate minute differences in the pressure placed on their fingertips. The task amounted to deciding which of two pressures was the heavier and then rating confidence in that decision. Peirce and Jastrow's results demonstrated that discrimination was at an above-chance level even when conditions were such that they considered their decisions to be pure guesses.

The dissociation between effects in performance and awareness reported by Peirce and Jastrow (1884) is directly analogous to findings from many subsequent studies of unconscious perception. By far, the most popular methodology for studying unconscious perception has been the task-dissociation paradigm (Reingold & Merikle, 1990). Conditions are first established such that conscious perception, as measured by one task (e.g., subjective report), is eliminated. According to the logic of the paradigm, under these conditions any effects obtained on a second task must be attributable to unconscious perception. Although such discrepancies between effects on behavior and awareness are extremely robust and have been replicated repeatedly in different domains (e.g., Adams, 1957; Cheesman & Merikle, 1986; Marcel, 1983a; Sidis, 1898/1973), their classification as "unconscious" was severely criticized by Eriksen in 1960 and more recently by Holender (1986). Both critics concluded, on the basis of methodological concerns, that the supposed demonstrations of unconscious perception were in fact caused by conscious perception. Important for their conclusion is the method used to measure conscious perception.

How should conscious perception be measured? Although it is generally acknowledged that measures of unconscious perception are sometimes "contaminated" by effects of aware perception, much less attention has been given to the converse case. That is, measures of conscious perception are sometimes contaminated by effects of unconscious perception. In this article, we provide evidence of such contamination by showing that "guessing" is informed by unconscious perception. For measures that are used standardly, informed guessing results in the overestimation of conscious perception. One specific instance of this difficulty is found in Holender's (1986) recent review of the literature on unconscious perception. Holender (1986) stated that "conscious identification can be indicated by overt behavior, for example, by naming the stimulus, discriminating it as familiar, categorizing it, pointing to a matching object, and so on" (p. 1). In fact, it is arguable whether any of those behaviors provides a pure measure of conscious perception.

We report experiments in which we used a process-dissociation procedure (Jacoby, 1991; Jacoby, Toth, & Yonelinas, 1993) to better measure conscious perception and to separate the effects of unconscious perception from those of conscious perception. Use of that procedure allowed us to go beyond demonstrating the existence of unconscious perception and on to investigating factors that differentially influence the magnitudes of conscious and unconscious perception. In the course of our discussion, we highlight the similarity of the problems faced when studying unconscious perception and unconscious influences of memory.

The Advantages of Opposition

Most experiments purporting to demonstrate unconscious perception can be described as using "facilitation" paradigms. That is, in those experiments, effects of unconscious processing served to facilitate performance on a task. For example,

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Forster, Booker, Schacter, and Davis (1990) reported evidence indicating that unconscious perception influences stem-completion performance. In their experiment, words flashed for a brief duration were "sandwiched" between words presented for a longer duration (i.e., one before and one after the briefly flashed word), followed by presentation of a word stem that subjects were to complete. On some trials, the flashed word could be used to complete the stem (e.g., elastic; ela_ _ _ _), whereas on other trials it could not (e.g., lattice; ela_ _ _ _). Results showed that flashing a word increased the likelihood of its being given as a completion, even though subjects professed to be unaware that the completion had been flashed. Thus, the findings reported by Forster et al. (1990) revealed a dissociation between effects on a direct measure (subjective report) and an indirect measure (completion performance) of perception.

Of course, those results would not convince the nonbeliever that unconscious perception truly exists. Critics (e.g., Holender, 1986) would argue that subjects actually saw some of the flashed words even though they did not report doing so. The controversy arises because the procedure used by Forster et al. (1990) constitutes a facilitation paradigm; conscious perception of the masked word would produce the same pattern of responding as would unconscious perception. Because both processes can contribute to performance on such tests, it is impossible to determine whether the obtained effects are attributable to conscious processes, unconscious processes, or, as is most likely the case, a combination of the two.

This difficulty is not limited to the perceptual domain. Rather, interpretational problems are encountered whenever a task (e.g., subjective report) is identified with a single process (e.g., conscious perception). Such problems are most obvious in the literature concerned with unconscious influences of memory (Jacoby, 1991; Richardson-Klavehn & Bjork, 1988). According to one currently popular method, conscious recollection is revealed by performance on direct tests of memory (e.g., cued recall), whereas unconscious influences of memory are measured by indirect tests (e.g., stem completion). Rather than equating process with task, Jacoby et al. (1993) used a procedure to separately estimate the two sources of memory contributing to performance of a single task. This technique, termed the *process-dissociation procedure,* is described in detail later with reference to its use for separating conscious and unconscious perception. First, we describe results obtained from the application of the procedure in a memory paradigm.

In the Jacoby et al. (1993) experiments, a list of words was presented for study followed by a test of stem completion. In one condition—the inclusion test condition—subjects were instructed to complete stems with words from the study phase or, if they could not do so, to give the first completion that came to mind. Thus, the inclusion test was akin to a direct test of cued recall. Both conscious recollection and automatic influences of memory would increase the likelihood of a study item being given as a response on an inclusion test. Hence, comparing performance on an inclusion test to baseline, as is common practice, does not provide an accurate estimate of conscious recollection. That estimate is "contaminated" by automatic influences of memory gained from reading the words in the study phase.

Jacoby et al. (1993) incorporated a second condition—the exclusion test condition—in which consciously controlled and automatic influences were placed in opposition. This was accomplished by instructing subjects to complete the stems with words not seen earlier in the study phase. Given these instructions, recollection of study list items would decrease the probability of their being given as a response. In the absence of recollection, however, any automatic influences gained from previously reading the words would increase the likelihood of their being given as a response. Thus, although an above-baseline probability of responding with "old" words on an exclusion test would provide solid evidence for the existence of automatic influences, it would not be an accurate estimate of those influences. In this case, any conscious recollection occurring on the task would contaminate the estimate of automatic influences.

The process-dissociation procedure used by Jacoby et al. (1993) combines performance in an inclusion and an exclusion condition to better estimate the contribution of the two influences of memory to stem-completion performance. In Experiment 1b, they used this procedure to investigate the influence that dividing attention during the study phase had on estimates of consciously controlled and automatic influences of memory. Results revealed that study words read under full attention were given more often on the inclusion test than on the exclusion test. This difference in performance between the inclusion and exclusion tests indicates that some study items were recollected. These recollected items were output on the inclusion test and withheld on the exclusion test, thus yielding a difference between the two tests. By contrast, words studied under divided attention (i.e., while performing a concurrent digit-monitoring task) were given equally often on inclusion and exclusion tests and at a rate that was significantly higher than baseline. This pattern shows that the divided-attention manipulation eliminated recollection of the study words; subjects were not able to respond with study words any more often when told to (inclusion) as compared with when told not to (exclusion). Importantly, automatic influences of memory were not affected by the divided-attention manipulation. Estimates of automatic influences for words read under full attention were nearly identical to those for words read under divided attention, although the two types of study items differed greatly for estimates of recollection.

The aforementioned pattern of results was described by Jacoby et al. (1993) as a "process dissociation" (p. 144). Estimates gained from the process-dissociation procedure showed that one process was radically reduced by a manipulation that left the other process unchanged. Jacoby and his colleagues (e.g., Jennings & Jacoby, 1993; Toth, Reingold, & Jacoby, 1994) have relied on process dissociations of that sort to argue that consciously controlled and automatic influences of memory make independent contributions to performance on tasks such as stem completion. We propose a similar relationship between conscious and unconscious perceptual processes.

The Relationship Between Perception and Memory

What delineates the area of perception from that of memory? Certainly, there is a fine line between the two. Both areas of study could be effectively described as investigating the influences of a prior experience on present performance. Indeed, the similarities between perceptually generated and memorially generated unconscious influences are striking. In each case, a subjective awareness of the initial processing event is absent, although performance may clearly show effects of this event. Although the interval of time between presentation of an item and its test is shorter in investigations of unconscious perception than in investigations of memory, forgetting may occur during that interval. Similarly, visual masking may have the effect of producing a failure in retrieval or recovery of memory for a briefly flashed word (cf. Marcel, 1983b). At the extreme, it is impossible to discriminate between unconscious influences of memory and unconscious perception, and, fortunately, it does not seem terribly important to do so. Awareness at the time an effect operates is more important than any earlier difference in awareness. If one is to avoid a source of influence, one must be aware of that influence when it exerts its effect. In that regard, both unconscious perception and unconscious influences of memory have their effects by means of processes that are not under current volitional control.

Regardless of their similarities, the fields of perception and memory have had distinct histories. In terms of methodology, there appear to be three important elements that differentiate studies of perception from those of memory. Typically, the intervals between "study" and "test" are much shorter when studying perception. In addition, many fewer stimuli (usually only one) are presented prior to the test phase of a perception study. As a final contrast, studies of unconscious perception usually involve some manipulation for reducing the likelihood of awareness at input (i.e., reducing duration). Thus, for unconscious influences of perception, the lack of awareness is induced by the input manipulation. In studies of memory, on the other hand, input is ensured and unconscious influences are instead revealed by lengthy delays between study and test.

Consistent with the previous discussion, we believe that conscious and unconscious influences of perception operate in a manner similar to consciously controlled and automatic influences of memory. Nevertheless, given their separate histories, our chief goal was to demonstrate unconscious influences using a design associated with traditional studies of unconscious perception (i.e., a short study–test interval, few study items, uncertain input). To accomplish this goal, we adopted the stem-completion task used by Forster et al. (1990). Rather than attempting to reveal unconscious perception by preventing awareness of the flashed words, however, we chose to separately estimate the contribution of the two processes to performance by using the process-dissociation procedure (Jacoby, 1991).

The Process-Dissociation Procedure: Separating Effects of Conscious and Unconscious Perception

Our experiments followed the Forster et al. (1990) design whereby a word was flashed for a brief duration immediately prior to the onset of a stem that subjects were to complete. We assumed that conscious and unconscious perception of the flashed words would contribute independently to performance on the stem-completion task. Moreover, like the process of recollection described by Jacoby et al. (1993), we postulated that conscious perception supports intentional control of responding. By contrast, unconscious perception serves to increase the likelihood that the flashed solution will be given as a response, irrespective of intention. To separately estimate the effects of these two perceptual processes, we used the process-dissociation procedure. Thus, instead of instructing subjects to complete the stems with the first word that came to mind, as Forster et al. did, we gave subjects inclusion and exclusion instructions.

In the inclusion condition, conscious perception acts in concert with unconscious perception just as in facilitation paradigms (e.g., Forster et al., 1990; Marcel, 1983a). A stem could be completed with a flashed word either because the subject consciously perceived the flashed word (C), or, because even though conscious perception failed (1 − C), the effects of unconscious perception (U) were sufficient for the flashed word to be given as a completion. That is, conscious perception and unconscious perception serve as independent bases for responding. Stated formally, the probability of completing a stem with a flashed word in the inclusion test condition is as follows:

$$\text{inclusion} = C + U(1 - C) = C + U - UC. \qquad (1)$$

Because conscious and unconscious perception act in concert, a finding that the probability of completing a stem with an old word is above baseline does *not* provide evidence for the existence of unconscious perception. It is the possibility of conscious perception producing such an effect that is the basis for criticisms of supposed demonstrations of unconscious perception (e.g., Eriksen, 1960; Holender, 1986). By the same token, an above-baseline probability of responding with an old word for an inclusion test also does *not* provide unambiguous evidence for the existence of conscious perception. The above-baseline performance might have resulted from guessing that it was informed by unconscious perception.

For the exclusion test condition, subjects were instructed *not* to complete stems with the flashed word or, if they did not see the flashed word, to use the first word that came to mind. Given exclusion instructions, awareness of the presentation of a flashed word results in its being withheld as a response. Consequently, a flashed word should be given as a completion in an exclusion condition only if unconscious perception is sufficient for its being given as a response (U) and the word is not consciously perceived (1 − C). Stated formally, the probability of responding with a flashed word that should be excluded is as follows:

$$\text{exclusion} = U(1 - C) = U - UC. \qquad (2)$$

Placing effects in opposition is a powerful technique for demonstrating the existence of unconscious perception. If, in an exclusion condition, previously flashed words are more likely to be given as completions, compared with baseline, one can be certain that the words were unconsciously perceived; conscious perception would cause the words to be given less often. However, unless conscious perception has been fully eliminated (i.e., C = 0), performance in an exclusion condition underestimates the contribution of unconscious perception. To the extent that conscious perception is not fully eliminated, it offsets any influence of unconscious perception. The process-dissociation procedure corrects for the contamination caused by conscious perception on an exclusion test thus producing more accurate estimates of conscious and unconscious perception.

The process-dissociation procedure requires the combination of an exclusion condition with an inclusion condition. Given these two conditions, the probability of conscious perception (C) can be estimated as

$$C = \text{inclusion} - \text{exclusion}. \quad (3)$$

Once an estimate of the contribution from conscious perception (C) has been obtained, that of unconscious perception (U) can be estimated by means of simple algebra. The easiest way to do this is by dividing "exclusion" by the estimated probability of a failure in conscious perception (1 − C). Hence,

$$U = \text{exclusion}/(1 - C). \quad (4)$$

The probability of conscious perception provides a measure of consciously controlled processing defined in terms of selective responding. If people were always aware of the flashed word (i.e., C = 1.0), they would always complete the stem with the flashed word in the inclusion condition and never complete the stem with the flashed word in the exclusion condition; selectivity of responding would be complete. In many cases, of course, conscious perception would not be so complete (i.e., would be less than 1.0), and so both types of perceptual process will contribute to overall performance. Unlike conscious perception, unconscious perception is not assumed to support selectivity of responding. The effect of unconscious perception is to increase the probability of responding with an old word regardless of whether doing so is in accord with (inclusion test) or counter to (exclusion test) the intention set by instructions.

We adopt the simplifying assumption that effects of unconscious perception of a flashed word add to the baseline probability of completing a stem with that word. Hence,

$$U = P + B. \quad (5)$$

The use of Equation 4 to estimate unconscious influences, then, results in an estimate (U) that is the sum of the effects of unconscious perception (P) and baseline (B). Effects resulting from unconscious perception of the flashed word can thus be estimated by subtracting a measure of baseline from the estimate of U derived from Equation 4. Given that baselines do not differ across conditions, subtracting baselines will not change the pattern of results. Consequently, when one is interested in showing that unconscious influences differ between conditions, rather than interested in the absolute level of unconscious influences, one does not subtract baselines. It is important that baselines not differ because if they did, U for the inclusion test would not be the same as U for the exclusion test. Consequently, Equation 4 could not be used to gain a measure of conscious perception.

A strong assumption embodied in the equations is that effects of unconscious perception are independent of those of conscious perception. By use of the process-dissociation procedure, our goal was to find variables that would produce dissociations in the estimated effects of conscious and unconscious processes. To validate the use of the procedure, we thought it important to be able to find such dissociations. At first glance, there is an air of circularity to this argument: We were using equations, derived from an assumption of independent processes, to collect evidence to show that the processes were indeed independent. The worry of circularity dissipates, however, when one realizes that the rationale for our approach rests on manipulations that, on a priori and empirical grounds, can be hypothesized to affect one process and not the other. Process dissociations of this sort have been found in investigations of memory (Jacoby, 1991; Jacoby et al., 1993; Jennings & Jacoby, 1993; Toth et al., 1994) and Stroop task performance (Lindsay & Jacoby, in press).

Experiment 1

In Experiment 1, we examined the variable of presentation duration. Like many researchers before us, we hypothesized that reducing the duration of a flashed word would differentially impair conscious but not unconscious perception of that word. In our case, however, we did not have to satisfy the criterion of fully eliminating conscious perception; the effects of conscious perception could be separated from those of unconscious perception with the process-dissociation procedure. This experiment had two objectives: (a) to provide convincing evidence for unconscious perception by showing above-baseline performance in an exclusion condition and (b) to measure, using the process-dissociation procedure, the contribution of conscious and unconscious perception to performance across different presentation durations.

Method

Subjects. Twenty-one subjects enrolled in an introductory psychology course at McMaster University served in the experiment for course credit. Data from 1 subject had to be discarded because of a programming error. Subjects were tested individually.

Materials and design. A pool of 588 five-letter words was used for construction of the test materials. From this pool, 120 words were selected as "critical items" and divided into 10 groups of 12 words each. These groups of critical items were equated in terms of word frequency (Thorndike & Lorge, 1944). As described shortly, the other 468 words were used to fulfill the remaining requirements of the experimental conditions. In addition, 44 random letter strings were constructed for use in nonword trials. Two sets of stimuli, each containing an equal number of critical items, filler words, and random letter strings, were composed for use in the two different test conditions (inclusion vs. exclusion). Test instructions were manipulated within subjects such that the experiment consisted of two blocks of test trials.

Each test trial was made up of three stimuli presented in succession, followed by a three-letter word stem. The first and third stimuli of the sequence were always words. These words acted as forward and backward masks for the second stimulus item in the sequence, which was either a word or a random letter string. Because this procedure made a sort of "sandwich," we call the second stimulus item the *sandwiched item* throughout the rest of this article. Word stems were produced by replacing the last two letters of a five-letter word with underscores. All of the word stems used had at least 2 five-letter solutions (e.g., tab _ _ could be table, tabby, or taboo).

On critical trials, the three-letter word stem was drawn from one of the items in the critical groups. There were three different types of critical trials produced by manipulation of the sandwiched item in the sequence: (a) match trials, in which the sandwiched item was a word that completed the word stem (i.e., "scalp" for the stem *sca _ _*); (b) nonmatch trials, in which the sandwiched word did not complete the stem (e.g., "fatal" for the stem *sca _ _*); and (c) nonword trials, in which the sandwiched item was a random letter string (e.g., "oeddv" for the stem *sca _ _*). Nonword trials provided a means for assessing stem-completion performance when the sandwiched item was not meaningful. Long-duration nonword trials were omitted from the design so as to disguise the existence of nonword trials. Thus, five different conditions were produced from the combination of the three trial types and the presentation duration (short vs. long) of the sandwiched item.

On filler trials, a word that could complete the stem always occurred in either the first or third position in the sequence; the sandwiched word was never a completion for the word stem. These trials were included in the design so that attention would be somewhat distributed across the three flashed stimuli. Six types of filler trials were produced from the factorial combination of solution word position (first vs. third), sandwiched item type (word vs. letter string), and duration of sandwiched item (short vs. long). The three factors were not fully crossed because two of the eight possible combinations—the two long-duration letter-string conditions—were excluded from the design. These two types of filler trials were excluded for the same reason as described previously for the critical trials.

Five list formats were constructed by rotating each group of critical items through each of the five different critical trial conditions. Filler items were not rotated through conditions. This design produced a test list of 60 critical and 30 filler trials for each of the two test blocks. Thus, a total of 180 test trials were presented in the entire experiment.

In addition to the 180 test trials, 3 practice trials were placed at the beginning of each test block. The practice trials consisted of 1 long-duration match trial, 1 short-duration nonmatch trial, and 1 short-duration nonword trial.

Procedure. The experiment was programmed using the software package *Micro Experimental Laboratory* (Schneider, 1990). All stimuli were presented by means of a Zenith Data Systems computer interfaced with a Zenith VGA color monitor. Stimuli appeared as white lowercase letters on a black background. The character size of the stimuli was approximately 2.5 mm × 4 mm. The subjects were seated at a distance of approximately 45–55 cm from the screen.

Experimental trials consisted of the following sequence of events: (a) presentation of a fixation point for 2 s; (b) presentation of a premasking word for 50 ms; (c) presentation of the sandwiched item, either a word presented for 50 ms (short) or 500 ms (long) or a random letter string presented for 50 ms; (c) presentation of a postmasking word for 500 ms; (d) a delay of 500 ms in which the screen was blank; and (f) presentation of a word stem that the subject was to complete. All events occurred in the same location in the center of the screen.

Instructions (inclusion or exclusion) were given at the beginning of each of the two test blocks. Half of the subjects received inclusion instructions first and the other half received exclusion instructions first. All subjects were informed that they would be shown the first three letters of a word (i.e., a word stem) and were asked to generate a five-letter word that would be a completion for that stem. In addition, they were told that prior to the appearance of the word stem a sequence of either two or three words would be flashed briefly on the screen and that this sequence would sometimes contain a completion to the stem.

Inclusion instructions emphasized that the word stem *should* be completed with one of the words from the sequence flashed immediately prior to its appearance. Subjects were instructed that if none of those words completed the stem, then they should respond with the first word that came to mind that was an acceptable completion for the stem.

Exclusion instructions emphasized that the word stem should not be completed with a word from the sequence flashed immediately preceding the stem. If a completion word did occur in the preceding sequence, then they were to produce an alternative completion for the stem. As in the inclusion instructions, if no completion word occurred in the sequence preceding a stem, subjects were to respond with the first word that came to mind that was an acceptable completion for the stem. Before the start of each block, subjects were asked to repeat the instructions so as to ensure that the instructions were clearly understood.

Responding on the stem-completion task was verbal. Subjects were given 7.5 s to solve the word stem. If the subject gave a solution within the allotted time, the experimenter recorded the solution and initiated the next trial sequence. If, after 7.5 s, no solution had been given, the computer generated a tone that signaled the experimenter to initiate the next trial.

For each stem, there was one particular "target" solution. This solution corresponded to the sandwiched word that was presented on match trials. Thus, *table* would be a target completion to *tab _ _* but *taboo* would not because *table* occurred as the sandwiched word during match trials for the stem *tab _ _*. For all experiments, analyses were performed on the probability of completing critical stems with their target solution, and, unless otherwise specified, the significance level for all tests was set at the .05 level. Also, main effects were not reported when higher order interactions were significant. For all experiments, data from nonmatch and match trials were analyzed separately.

Results and Discussion

The mean probabilities of responding with a target word when inclusion instructions were given were .38, .34, and .34 for nonword, 50-ms nonmatch, and 500-ms nonmatch trials, respectively. Under exclusion instructions, the mean probabilities for those same trials were .36, .35, and .33, respectively. Data from nonword and nonmatch trials were analyzed in a 3 × 2 repeated measures analysis of variance (ANOVA) that included the variables of duration (50-ms nonword, 50-ms nonmatch, and 500-ms nonmatch) and instruction (inclusion vs. exclusion). Results from that analysis revealed no significant effects. The mean of the nonmatch trials (.34) was taken as the "baseline" probability for giving the target word as a completion and was used for comparison with match trials.

Evidence for the existence of unconscious perception. Table 1 shows a summary of the completion data from match trials. Results from the exclusion test condition provide unambiguous evidence of the existence of unconscious perception. In particular, the probability of completing a stem with the target word on short-duration trials (M = .50) was found to be significantly higher than that of baseline (M = .34), $t(19)$ = 3.66, SE = .04. That high probability of producing flashed words as responses on exclusion trials was caused by unconscious perception, not by a failure to understand and follow instructions. This was demonstrated by the finding that when words were presented for a longer duration so as to make their conscious perception highly likely, subjects had little difficulty excluding the words. On long-duration trials, stems were completed with their target words at a rate that was reliably lower than that of baseline (.10 vs. .34), $t(19) = 8.13$, $SE = .03$. Thus, the increased probability of responding with words flashed for a brief duration (50 ms) could not be explained as being produced by conscious perception because conscious perception had the opposite effect. Although performance in the exclusion test condition provided strong evidence for the existence of unconscious perception, it underestimated the magnitude of unconscious influences. This underestimation was a result of the effects of unconscious perception being partly offset by effects of conscious perception.

The clear evidence of unconscious perception gained by use of the exclusion test condition could not have been revealed by use of standard self-report procedures. The inclusion test condition corresponded to a direct test of perception akin to those standardly used to measure awareness. For the inclusion test, presentation of a completion word increased the likelihood of its being given as a response over baseline (.34), regardless of whether the word was presented for a short ($M = .63$) or a long ($M = .96$) duration. Both increases were highly significant, $ts(19) = 7.41$ and 30.90, $SEs = .04$ and .02, respectively. Results on the inclusion test may be interpreted as showing that subjects consciously perceived many of the words that were flashed for a short duration. To correct for guessing, baseline (.34) would be subtracted from the probability of responding with the target completion (.63). Doing so, the probability of conscious perception would be estimated as being .29. However, estimating conscious perception in that way ignores the contribution of unconscious perception and indeed defines unconscious perception out of existence.

The difference between performance in the inclusion test condition and baseline undoubtedly overestimated the probability of conscious perception. If the probability of consciously perceiving words flashed for a short duration were .29 and unconscious perception did not play a role, the probability of responding with an old word in the exclusion condition should have been below, not above, baseline. Conscious perception of the flashed words would allow them to be either included or excluded, whichever was dictated by instructions. As evidence for this assumption, the ability to control responding was clearly demonstrated for words flashed at a longer duration. A better measure of conscious perception is provided by the difference between performance in the inclusion and exclusion test conditions. It is that measure that is used in the process-dissociation procedure.

Table 1
Observed Probabilities of Completing Word Stems With Target Words on Match Trials Across Instruction and Duration in Experiment 1

	Instruction			
	Inclusion		Exclusion	
Duration	*P*	*M*[a]	*P*	*M*[a]
50 ms	.63	(.61)	.50	(.51)
500 ms	.96	(.95)	.10	(.15)

Note. The mean rate of completion on nonmatch trials was .34.
[a]These numbers represent observed probabilities of completing word stems with target words after removing the data from 6 subjects who achieved perfect performance in the inclusion and exclusion conditions.

Table 2
Estimates of the Contribution of Conscious Perception and Unconscious Perception to Stem Completion Performance in Experiment 1

Duration	Conscious perception	Unconscious perception
50 ms	.10	.58
500 ms	.80	.76

Note. Data from 6 subjects were excluded from these estimates because an estimate for unconscious perception could not be calculated (see the text).

Estimating effects of conscious and unconscious perception. The process-dissociation procedure was used to estimate the separate effects of conscious and unconscious perception. Estimates of the two types of effects were computed for each subject using Equations 3 and 4, along with performance on inclusion and exclusion tests for match trials. For 6 subjects, performance in the inclusion and exclusion test conditions was perfect (i.e., 1.0 and 0.0, respectively) when words were presented for a long duration. Their data had to be discarded for purposes of analyses because, for them, the estimate of unconscious perception was undefined; the use of Equation 4 would entail dividing by zero. The mean estimates for the remaining 14 subjects are shown in Table 2. Reducing the duration of the sandwiched word drastically decreased the probability of conscious perception and, to a lesser extent, that of unconscious perception. Separate one-tailed t tests showed both effects to be significant, $ts(13) = 13.28$ and 1.86, $SEs = .05$ and .10, respectively. We used one-tailed t tests because, on a priori grounds, we expected that any effect of decreasing duration would be to decrease conscious and unconscious perception.

It was perfect responding on the long-duration trials that made it impossible for us to estimate the effects of unconscious perception for some subjects. For the long-duration trials, the generally high level of accuracy including or excluding earlier-presented words shows that subjects followed instructions. Why did not all subjects show perfect performance when words were presented for a duration (500 ms) that allowed awareness of their presentation? One possibility is that because of a lapse in attention, subjects might not have consciously perceived some of the long-duration words and consequently failed to exclude those words. In Experiments 2 through 4, we examined the effects of dividing attention on conscious and unconscious perception. A second possibility is that, although consciously perceived, subjects might have sometimes forgotten the word that had been presented and, for that reason, failed to follow instructions. Given that the filler trials forced them to pay attention to the first and third items of the "sandwich," this hypothesis seems reasonable. To claim that forgetting played some role is to suggest that the results we take as showing unconscious perception sometimes arose from unconscious influences of memory (cf. Jacoby et al., 1993). Indeed, our contention is that the two types of influences are closely related and may even share common mechanisms.

Unconscious perception, as well as conscious perception, decreased with decreases in presentation duration. At some level, this should not be surprising. If a masked word were presented for 1 ms, neither the effects of unconscious perception nor conscious perception would result. However, that both conscious and unconscious perception are tied to presentation duration does make clear the difficulties faced by those who have tried to demonstrate the existence of unconscious perception by traditional means. To show effects of unconscious perception while holding the probability of conscious perception at zero requires that one find a presentation duration that is sufficiently long to allow unconscious perception and sufficiently short to disallow conscious perception. The range of presentation durations that satisfy these dual constraints is probably a narrow one and different across subjects, levels of practice, and so forth. Because the target range of presentation durations is small and moving, it is unlikely that many supposed demonstrations of unconscious perception actually hit that target.

By using the process-dissociation procedure, we could avoid the necessity of hitting such small moving targets and instead separately estimate the contributions of conscious and unconscious perception to performance. However, to validate the use of that procedure, it was necessary to find some variable that, for example, would reduce the probability of conscious perception but leave the effects of unconscious perception unchanged (a "process dissociation"). It should be possible to find such process dissociations if conscious and unconscious perception do in fact serve as *independent* bases for responding. In Experiment 2, we examined the effects of dividing attention during the presentation of the flashed word. On the basis of the results of experiments examining unconscious influences of memory (Jacoby et al., 1993), we expected divided attention to reduce the probability of conscious perception but to leave invariant the effects of unconscious perception.

Experiment 2

Experiment 1 supplied strong evidence for unconscious perception using the traditional variable of duration. In this experiment, we examined the effect of another variable, attention, which has been used less commonly in studies of unconscious perceptual processes. There were many reasons for manipulating attention. First, Joordens and Merikle (1992) manipulated attention, rather than presentation duration, to replicate Jacoby and Whitehouse's (1989) finding of an influence of unconscious perception on false recognition. Furthermore, results from Experiment 1 show that lengthening the presentation duration of a word produced increases in both conscious and unconscious perception. Thus, larger effects of unconscious perception may be attainable by presenting stimuli for longer durations, but under conditions of divided attention. Finally, there is an ecological argument for manipulating attention to, rather than duration of, the stimuli: Divided attention is much more likely to occur in a nonlaboratory setting, and, as others have argued, may in fact be the normal state of affairs (e.g., Jacoby, Toth, Lindsay, & Debner, 1992; Neumann, 1984).

The procedure that we used to divide attention was similar to a procedure used by Wolford and Morrison (1980). Flashed words were flanked by a pair of numbers, and, in the divided-attention condition, subjects were required to add those numbers. The phenomenological experience in this task is often reported as being one of not "seeing" the flashed word because of attending to the presented numbers. The experience is much like that of visually fixating on an object while engaged in heavy intellectual work unrelated to the object. Are such unattended objects perceived unconsciously but not consciously?

Method

Subjects. Thirty-six subjects enrolled in an introductory psychology course at McMaster University served in the experiment for course credit. Data from 4 subjects had to be discarded because those subjects failed to follow instructions as evidenced by a high likelihood (> .40) of responding with the target solution under full-attention, exclusion conditions. Subjects were tested individually.

Materials and design. A pool of 128 different multiple-solution, three-letter word stems were selected for use in the experiment. The stems were chosen from a larger pool of five-letter words that had been used in earlier stem-completion experiments done in our laboratory. The 128 stems were used to create eight sets of 16 stems, with each set being equated on the probability of a stem being completed with its target word. In addition to the word stems, 320 five-letter words were used as pre- and postmasks and as sandwiched words for nonmatch trials.

The design incorporated four blocks of 32 trials each. These blocks corresponded to the factorial combination of two within-subjects variables: attention (divided vs. full) and instructions (inclusion vs. exclusion). Within each block there were 16 match trials and 16 nonmatch trials. Trials within each block were ordered randomly with the exception that no more than 3 trials from the same condition were presented in a row. Rotating the word groups through each possible combination of conditions produced eight different test formats.

An additional 32 three-letter stems were selected for use on practice trials. These practice trials required 80 five-letter words for use as pre- and postmasks and sandwiched items. Eight practice trials (4 match and 4 nonmatch) were placed at the beginning of each test block. Hence, there were 40 trials in each test block, which yielded a total test length of 160 trials.

Attention to the sandwiched word was manipulated using a secondary task. For this task, pairs of digits were placed on either side of the sandwiched word (e.g., 4 scalp 5) and the word stem (e.g., 3 sca _ _ 4). Digits from 1 to 9 were paired so as to produce sums ranging between 5 and 12. The sums were chosen randomly with the exception that identical digits did not flank the same word (i.e., if the sum was 10, the flanking digits could not be 5 and 5).

Procedure. The experimental apparatus and procedure were the same as those used in Experiment 1 with the following exceptions: Because nonword trials and nonmatch trials exhibited no differences in Experiment 1, we used only nonmatch trials here. Thus, the sandwiched stimulus was always a word.

Experimental trials consisted of the following sequence of events: (a) presentation of a fixation point for 2 s; (b) presentation of a premasking word for 500 ms; (c) presentation of the sandwiched word flanked by digits for 150 ms; (d) presentation of a postmasking word for 500 ms; (e) a delay of 500 ms in which the screen was blank; and (f) presentation of a word stem flanked by digits. All events occurred in the same location on the screen. It is important to note that the digits flanking the sandwiched word were not pre- or postmasked.

The experiment was conducted in four blocks. Half of the subjects received divided-attention instructions for the first two blocks and full-attention instructions for the last two blocks. The other half of the subjects were given instructions in the reverse order. Within each attentional condition, all subjects received exclusion instructions for the first block and then inclusion instructions for the second block. Exclusion instructions emphasized that the stem should not be completed with the sandwiched word. Thus, if subjects saw that the sandwiched word was a completion to the stem, then they were to come up with a different solution. By contrast, inclusion instructions emphasized that the stem should be completed with the sandwiched word if it was appropriate (i.e., a match trial). In both instructional conditions, subjects were told that if the sandwiched word was not a completion for the stem, then they should respond with the first solution word that came to mind.

On each trial the subject had to perform a secondary task prior to completing the word stem. This task consisted of reporting the sum of a pair of digits presented during each trial (Wolford & Morrison, 1980). In the divided-attention condition, subjects were required to report the sum of two digits flanking the sandwiched word before completing the stem. This condition was labeled *divided attention* because during the presentation of the sandwiched word, attention was split between the word and its flanking digits. Given that the divided-attention condition called for a sum to be reported prior to completion of the stem, we felt it necessary that the full-attention condition also include a summation task. Hence, the full-attention condition required that the sum of two digits flanking the word stem be reported prior to stem completion. In this condition, full attention could be devoted to the sandwiched word at the time of its presentation.

Responding on both tasks was verbal. Subjects reported the sum as soon as the stem appeared on the screen and then attempted to solve the stem. Feedback was given when errors were made on the addition task. Subjects were given 7.5 s to report the sum and complete the stem. In all other ways, responding was the same as in the first experiment.

Results and Discussion

Errors on the secondary task were analyzed by a 2 × 2 × 2 repeated measures ANOVA, with variables of trial type (match vs. nonmatch), attention (full vs. divided), and instruction (inclusion vs. exclusion). This analysis showed a reliable main effect of attention, $F(1, 31) = 22.82$, $MS_e = 0.027$, with more errors being made in the divided-attention condition than in the full-attention condition (*M*s = 3.0% and 1.0%, respectively). This finding is not surprising given that the digits to be summed in the divided-attention condition were on the screen for a much shorter period of time. No other main effects or interactions were found to be significant.

The mean probability of responding with a target word on nonmatch trials given inclusion instructions was .32 and .33 for the full-attention and divided-attention conditions, respectively. Given instructions to exclude, those same probabilities were .32 and .34, respectively. Data from nonmatch trials were analyzed in a 2 × 2 repeated measures ANOVA, with the variables of attention (divided vs. full) and instruction (inclusion vs. exclusion). Results from that analysis revealed no significant effects. Consequently, mean performance on all nonmatch trials (.33) was taken as the baseline probability of giving the target word as a completion and was used for comparison with match trials.

Table 3
Observed Probabilities of Completing Word Stems With Target Words on Match Trials Across Instruction and Attention in Experiment 2

	Instruction			
	Inclusion		Exclusion	
Attention	*P*	*M*[a]	*P*	*M*[a]
Divided	.85	(.84)	.42	(.43)
Full	.96	(.95)	.09	(.12)

Note. The mean rate of completion on nonmatch trials was .33.
[a]These numbers represent observed probabilities of completing word stems with target words after removing the data from 8 subjects who achieved perfect performance in the inclusion and exclusion conditions.

Evidence for the existence of unconscious perception. The completion data for match trials are shown in Table 3. As in Experiment 1, results from the exclusion test condition provided unambiguous evidence of the existence of unconscious perception. Although instructed not to complete the stems with the target words, subjects responded with target completions reliably more often than baseline when attention to the presentation of the word was divided (.42 vs. .33), $t(31) = 2.84$, $SE = .03$. Yet, when full attention was devoted to the presentation of the words, subjects completed stems with their target completions less often than baseline ($M = .09$ vs. .33), $t(31) = 11.30$, $SE = .02$. These effects were comparable in magnitude to those produced by the manipulation of duration used in Experiment 1.

For the inclusion test, presentation of a target word increased the probability of its being used as a completion over baseline regardless of whether attention to its presentation was full (.96 vs. .33) or divided (.85 vs. .33). Both increases were reliable, ts(31) = 51.27 and 22.16, *SE*s = .01 and .02, respectively. Again, subtracting baseline from performance in the inclusion test condition would overestimate the probability of conscious perception. This overestimation results from a failure to take effects of unconscious perception into account.

Estimating effects of conscious and unconscious perception. Estimates of the probabilities of conscious and unconscious perception were calculated in the same manner as in Experiment 1. For 8 subjects, performance in the inclusion and exclusion conditions was perfect (i.e., 1.0 and 0.0, respectively). Their data had to be discarded from the following analyses because estimates of unconscious perception could not be calculated. Analysis of the remaining 24 subjects showed that dividing attention to the sandwiched word drastically reduced conscious perception, $t(23) = 9.37$, $SE = .04$, but that it left the effects of unconscious perception unchanged ($t < 1$, $SE = .06$; see Table 4).

Similar to reducing presentation duration (Experiment 1), dividing attention produced a radical reduction in conscious perception. However, unlike the manipulation of duration, the manipulation of attention left invariant the effects of unconscious perception. The process dissociation produced by manipulating attention provides strong support for the assump-

Table 4
Estimates of the Contribution of Conscious Perception and Unconscious Perception of Stem-Completion Performance in Experiment 2

Attention	Conscious perception	Unconscious perception
Divided	.41	.75
Full	.83	.76

Note. Data from 8 subjects were excluded from these estimates because an estimate for unconscious perception could not be calculated (see the text).

tion that conscious perception and unconscious perception make independent contributions to stem-completion performance. In addition, the results corroborate those of others who have found a similar process dissociation within the area of memory (Jacoby et al., 1993).

Experiment 3

Experiment 3 was identical to Experiment 2, except that the presentation duration of the sandwiched word was reduced from 150 ms to 100 ms. In Experiments 1 and 2, several subjects performed perfectly on inclusion and exclusion tests and their data therefore could not be used to estimate the contributions of conscious and unconscious perception. Reducing the presentation duration of the sandwiched word should lower performance in the full-attention condition to a level such that estimates can be gained for all subjects in the experiment.

Method

Subjects. Nineteen subjects enrolled in an introductory psychology course at McMaster University served in the experiment for course credit. Data from 3 subjects had to be discarded because those subjects had a high likelihood (>.25) of responding with the target solution under full-attention, exclusion conditions. The criterion was deliberately lowered in this experiment because we wanted to be certain that subjects could perform the task as instructed. From the standpoint of demonstrating unconscious perception, this was an extremely conservative move because subjects with high exclusion scores would be more likely to show large effects of unconscious perception. Subjects were tested individually.

Materials and design. The materials and design for this experiment were identical to those of Experiment 2.

Procedure. In this experiment, a Zenith VGA monochrome (white) monitor was used for presentation of all stimuli. Because the stimuli presented in Experiment 2 were also white on black, the displays were virtually identical.

The procedure was identical to that of Experiment 2 with the following exceptions: The sandwiched word was presented for 100 ms in order to make conscious perception more difficult. Also, the two full-attention blocks were always done before the two blocks of divided attention.

Results and Discussion

An analysis of errors on the secondary task revealed a reliable main effect of attention, $F(1, 15) = 8.13$, $MS_e = 0.027$; more errors were made in the divided-attention condition than in the full-attention condition (*M*s = 4.1% and 1.2%, respectively). There was also a significant main effect of trial type, $F(1, 15) = 5.00$, $MS_e = 0.008$; nonmatch trials produced more errors than did match trials (*M*s = 3.4% and 1.9%, respectively). No other main effects or interactions were significant. As in the previous experiment, the main effect of attention was expected, although we cannot explain the significant effect of trial type. Given the low percentage of errors overall, however, we do not believe that this finding affects our conclusions.

The mean probabilities of responding with a target word on nonmatch trials for the inclusion test were .33 (full attention) and .35 (divided attention). For the exclusion test, those same probabilities were .27 (full attention) and .33 (divided attention). ANOVA results revealed no significant effects. Consequently, mean performance on all nonmatch trials (.32) was taken as the baseline probability of giving the target word as a completion and was used for comparison with match trials.

Evidence for the existence of unconscious perception. Table 5 shows a summary of the completion data for match trials. Results from the exclusion test condition provide striking evidence for the existence of unconscious perception. When words were presented for a brief duration and attention was distracted, those words were highly likely to be used as completions even though doing so would be countered by any conscious perception of the presented words. The probability of responding with a flashed word for the exclusion test was much higher than baseline (.60 vs. .32), $t(15) = 5.77$, $SE = .05$. That finding stands in contrast to the results from trials on which full attention was devoted to the presentation of the sandwiched words. After full attention, subjects completed stems with flashed words less often than baseline ($M = .16$), $t(15) = 8.98$, $SE = .02$. Performance in the full-attention condition showed that subjects were following instructions by excluding consciously perceived words.

For the inclusion test, flashed words were likely to be given as a completion, regardless of whether full attention was devoted to their presentation (.71 for divided attention and .90 for full attention). Performance in both conditions was significantly higher than baseline, ts(15) = 11.56 and 28.83, SEs = .03 and .02, respectively. As in earlier experiments, performance in the inclusion test conditions by far overestimated the probability of conscious perception because of the effects of unconscious perception.

Estimating effects of conscious and unconscious perception. Estimates of the contributions of conscious and unconscious perception were calculated as in the first two experiments. Because of the reduction in presentation duration, none of the

Table 5
Observed Probabilities of Completing Word Stems With Target Words on Match Trials Across Instruction and Attention in Experiment 3

	Instruction	
Attention	Inclusion	Exclusion
Divided	.71	.60
Full	.90	.16

Note. The mean rate of completion on nonmatch trials was .32.

Table 6
Estimates of the Contribution of Conscious Perception and Unconscious Perception to Stem-Completion Performance in Experiment 3

Attention	Conscious perception	Unconscious perception
Divided	.11	.68
Full	.75	.66

subjects attained perfect performance and consequently it was possible to gain estimates for all subjects. Dividing attention during the presentation of the sandwiched word substantially reduced the probability of conscious perception but left the effects of unconscious perception invariant (see Table 6). That is, the manipulation of full versus divided attention had a large effect on conscious perception, $t(15) = 10.97$, $SE = .06$, but its influence on unconscious perception did not approach significance ($t < 1$, $SE = .06$). Thus, these results replicate the pattern of results found in Experiment 2.

Experiment 4

In the previous three experiments, words were used to mask the flashed, sandwiched word. Although the subjects were instructed to ignore these words in Experiments 2 and 3, it is possible that these irrelevant words induced a type of memory load and were thus responsible for the effects obtained. Although we would argue that the source of these unconscious influences is immaterial, we were interested in showing that a "memory load" is not necessary to obtain the effect. Thus, in this experiment, we used random letter strings as masks so that the target word was the only word presented prior to onset of the stem.

A second methodological change introduced in this experiment concerned the instructions. Whereas in the previous experiments we used a blocked format to implement the inclusion–exclusion instructions, we used a mixed format in this experiment. This format was instantiated so that subjects would not know, prior to each trial, whether the trial would be an inclusion or an exclusion trial. In this way, any deliberate attentional effects brought about by knowledge of the trial type (i.e., not paying attention on exclusion trials) can be ruled out.

Method

Subjects. Sixteen subjects enrolled in an introductory psychology course at McMaster University served in the experiment for course credit. Subjects were tested individually.

Materials and design. The materials and design of this experiment were identical to Experiment 2 with the following exceptions: Some of the stimuli (including stems and solutions) were changed. In addition, four pseudorandom letter strings were created such that there was somewhat of an alternation of ascenders and descenders in the string (e.g., gpkjklqfp). Letters were chosen so as to avoid overlap with the target word as much as possible. The appearance of the letter strings as pre- or postmasks was randomly determined on each trial.

Procedure. An IBM-compatible VGA color monitor was used for presentation of all stimuli. The stimuli were presented as in Experiment 2 (white on black) except that (a) the presentation duration of the target was reduced to 83 ms, (b) the duration of the pre- and postmasking letter strings was reduced to 300 ms, and (c) the stems were displayed in either red or green. The color of the stem was used to signal the instruction: Green stems were a cue for inclusion instructions and red stems were a cue for exclusion instructions. In addition, a card was placed below the computer screen that reminded subjects that a green stem meant that they were to use flashed words as completions, whereas a red stem meant that they were not to use flashed words as completions. All other aspects of the procedure were identical to Experiment 2.

Results and Discussion

A $2 \times 2 \times 2$ analysis of errors on the secondary task revealed a reliable main effect of attention, $F(1, 15) = 6.02$, $MS_e = 0.006$; more errors were made in the divided-attention condition than in the full-attention condition (*M*s = 4.9% and 1.8%, respectively). No other main effects or interactions were significant.

The mean probabilities of responding with a target word on nonmatch trials for the inclusion test were .34 (full attention) and .31 (divided attention). For the exclusion test, those same probabilities were .33 (full attention) and .40 (divided attention). Analysis of these data by a 2×2 ANOVA revealed no significant effects. Consequently, mean performance on all nonmatch trials (.35) was taken as the baseline probability of giving the target word as a completion and was used for comparison with match trials.

Evidence for the existence of unconscious perception. Table 7 shows a summary of the completion data for match trials. As in the previous three experiments, the exclusion test provided solid evidence for the existence of unconscious perception. When attention was diverted from the briefly presented words, those words were often used as completions. The probability of responding with a flashed word for the exclusion test was higher than baseline (.48 vs. .35), $t(15) = 3.41$, $SE = .04$. That finding stands in contrast to the results from trials on which full attention was devoted to the presentation of the flashed words. After full attention, subjects completed stems with flashed words less often than baseline ($M = .20$), $t(15) = 4.39$, $SE = .03$. Performance in the full-attention condition showed that subjects were excluding consciously perceived words as instructed.

For the inclusion test, flashed words were likely to be given as completions, regardless of whether full attention was devoted to their presentation (*M*s = .54 for divided attention and .82 for full attention). Performance in both conditions was significantly higher than baseline, $ts(15) = 5.24$ and 22.18, *SE*s = .04 and .02, respectively.

Table 7
Observed Probabilities of Completing Word Stems With Target Words on Match Trials Across Instruction and Attention in Experiment 4

	Instruction	
Attention	Inclusion	Exclusion
Divided	.54	.48
Full	.82	.20

Note. The mean rate of completion on nonmatch trials was .35.

Table 8
Estimates of the Contribution of Conscious Perception and Unconscious Perception to Stem-Completion Performance in Experiment 4

Attention	Conscious perception	Unconscious perception
Divided	.06	.51
Full	.62	.50

Estimating effects of conscious and unconscious perception. Estimates of the contributions of conscious and unconscious perception were calculated as in the previous experiments. Importantly, because none of the subjects attained perfect performance, it was possible to obtain estimates for all subjects. Dividing attention during the presentation of the flashed word substantially reduced the probability of conscious perception but left the effects of unconscious perception invariant (see Table 8). That is, the manipulation of full versus divided attention had a large effect on conscious perception, $t(15) = 16.88$, $SE = .03$, but its influence on unconscious perception did not approach significance ($t < 1$, $SE = .07$).

The results from this experiment replicate the pattern of results found in Experiments 2 and 3. Although we did not rule out "forgetting" explanations, the use of a single word flashed only 1 s prior to the stem does make a memory-load explanation unlikely. These findings, in addition to those of the previous three experiments, confirm that unconscious influences of perception contribute considerably to performance on a stem-completion task. Moreover, these unconscious influences are proposed to operate independently of any consciously controlled responding occurring on the task.

General Discussion

The experiments reported here as evidence of unconscious perception are highly similar to experiments reported by Jacoby et al. (1993) as evidence of unconscious influences of memory. In each case, a stem-completion task was used to assess the influence of a prior processing event. The similarity between the two sets of experiments is a reflection of the relatively fine line that is drawn between memory and perception. From a historical viewpoint, however, there is no question that ours is a study of perception. Some of the most notable investigations of unconscious perception to date have involved the presentation of a single pattern-masked target followed by an immediate test (e.g., Balota, 1983; Cheesman & Merikle, 1986; Marcel, 1983a). Therefore, we feel justified in reporting our results as evidence of unconscious perception. Furthermore, we are equally comfortable discussing our results in terms of previous research on both unconscious perception and unconscious influences of memory.

Experiment 1 revealed that briefly flashed, pattern-masked words can produce unconscious influences on stem-completion performance. This experiment is consistent with many traditional studies of unconscious perception whose purpose was to eliminate conscious perception of a target through a reduction in the presentation duration (e.g., Marcel, 1983a). In our case, however, use of the process-dissociation procedure (the exclusion condition in particular) made elimination of conscious perception unnecessary. Thus, we avoided the age-old criticism that attributed supposedly unconscious influences to residual conscious perception (Eriksen, 1960; Holender, 1986). We have also shown (Experiments 2 through 4) that effects produced by presenting words for a brief duration can be mimicked by dividing attention during the presentation of those words (cf. Joordens & Merikle, 1992). That is, inattention to an event can yield unconscious perception just as can the occurrence of an event in a perceptually difficult setting. In each of these experiments, unambiguous evidence of the existence of unconscious perception was provided by an exclusion test condition. Such evidence cannot be explained as truly resulting from conscious perception because conscious perception would produce an opposite result.

Results from the exclusion test conditions are sufficient to demonstrate the existence of unconscious influences, but those results underestimated the magnitude of unconscious effects. Because presentation conditions were not such as to totally eliminate conscious perception, unconscious influences were partly offset by conscious perception. To separately estimate the contributions of conscious and unconscious perception to performance, we used the process-dissociation procedure. This procedure is based on the assumption that conscious and unconscious perception provide independent bases for responding. Using this procedure, we uncovered a difference between the effects of reducing duration and dividing attention that would have gone unnoticed by other measures of conscious and unconscious influences (e.g., direct and indirect tests). Specifically, we found that decreasing the presentation duration of the flashed words (Experiment 1) decreased the probability of both conscious and unconscious perception. Further support for that conclusion was found in Experiments 2 through 4, in which reductions in the estimates of conscious and unconscious perception paralleled the reductions in presentation duration across those three experiments. Effects derived from manipulation of presentation duration stand in contrast to effects of dividing attention. Experiments 2 through 4 demonstrated that dividing attention during the presentation of flashed words radically reduced the probability of conscious perception, although effects of unconscious perception were left unchanged. This latter finding of a dissociation between estimates of conscious and unconscious perceptual processing is important for several reasons.

Dissociations of conscious and unconscious influences lend support to the assumption that the two processes operate independently. Although some have argued that our reasoning is circular in that our evidence for independence was gained from a metric that was based on the assumption of independence, we disagree. True, the dissociation of conscious and unconscious influences found within any single experiment is important, but of far more importance is the converging evidence demonstrated by Experiments 2 through 4. We doubt that such consistent findings would be obtained if the two processes were not independent. The argument is strengthened even more when one considers that dividing attention produces the same dissociation between consciously controlled and automatic influences of memory (Jacoby et al., 1993; Jennings & Jacoby, 1993), processes that we consider to be analagous to those of conscious and unconscious perception. Thus, from our view, the process dissociation induced by dividing attention is robust across a range of situations, including different stimuli, different testing conditions, and even different paradigms. In addition, other process dissociations have been found in investigations of unconscious influences of memory (Jacoby, 1991; Jacoby et al., 1993; Jennings & Jacoby, 1993; Toth et al., 1994) and investigations of Stroop interference (Lindsay & Jacoby, in press).

Conscious Perception and Measures of Awareness

Use of the process-dissociation procedure has important advantages over self-report measures of conscious perception. First, directly asking a person to report a flashed word may direct attention toward that word, making perception conscious, whereas if not asked to report, conscious perception may not occur. More important, the process-dissociation procedure takes into account the likely possibility that performance on direct tests is contaminated by effects of unconscious perception. For stem-completion experiments, a standard way of measuring conscious perception would be to subtract baseline performance from performance on the inclusion test. For each of our experiments, that standard measure of conscious perception would substantially overestimate conscious perception. This is because unconscious perception adds to correct guessing and therefore the true probability of guessing is underestimated by baseline performance. Signal-detection theory is of no help for measuring conscious perception because it does not distinguish between effects of conscious perception and those of unconscious perception (cf. Eriksen, 1960).

One of the most common criticisms of supposed demonstrations of unconscious perception concerns criterion differences (e.g., Eriksen, 1960; Holender, 1986). For example, perceptual defense has been generally dismissed as arising from subjects' hesitancy to report awareness of the presentation of a taboo word. Appeals to criterion differences treat unconscious perception only as a weaker form of conscious perception. By contrast, we have shown that conscious and unconscious perception serve as independent bases for responding. The results from our experiments join a growing body of evidence indicating that conscious and unconscious influences have qualitatively different effects on behavior (Cheesman & Merikle, 1986; Jacoby, 1991; Jacoby & Whitehouse, 1989; Joordens & Merikle, 1992; Marcel, 1980, 1983a; Weiskrantz, 1986). For example, Weiskrantz (1986, pp. 152–155) argued that blindsight cannot be understood as resulting from only a quantitative difference in a single criterion for responding (i.e., signal-detection theory). Rather, he suggested that normal visual functioning results from the operation of two independent visual pathways, one of which is dysfunctional in the case of blindsight.

The Relation Between Conscious and Unconscious Perception

The measure of conscious perception provided by the process-dissociation procedure is a commonsense one that is based on the assumption that awareness of the presentation of an item allows intentional control of responding. If subjects "see" a flashed word, they can either use that word as a response (inclusion test) or avoid using that word as a response (exclusion test) as dictated by instructions. This estimate of conscious perception is important in its own right and is crucial for estimating influences of unconscious perception by means of the process-dissociation procedure. What if one were to assume, however, that the two perceptual processes were not independent? For example, what if conscious processing occurred only for items that were also processed unconsciously?

The relationship mentioned earlier as an alternative to the independence model is known as a *redundancy model* (Jones, 1987). The redundancy model holds that only a subset of the stimuli processed unconsciously are also processed at the conscious level. For the redundancy model, because conscious processing occurs only in the presence of unconscious processing, the inclusion test serves as an estimate of unconscious perception. Generate–recognize models of cued-recall performance serve as an example of a redundancy model of the relation between conscious and unconscious influences of memory. Jacoby et al. (1993) compared a generate–recognize model with a model that was based on the assumption of independence and gave reasons for preferring the assumption of independence.

We believe that the assumption of independence for the relation between conscious and unconscious perception is more plausible than is that of redundancy. First, to say that an inclusion test provides an estimate of unconscious perception is to make a factor-pure assumption that seems particularly curious against the backdrop of controversy surrounding claims of unconscious perception. As indicated earlier, a common criticism has been that performance on indirect tests of perception is contaminated by conscious perception (e.g., Holender, 1986; Reingold & Merikle, 1990). Against that backdrop, it seems farfetched to claim that a direct test (an inclusion test) serves as a pure measure of unconscious influences if it is admitted that an indirect test does not do so.

Perhaps the strongest argument for independence comes from the data. Experiments 2–4 revealed that dividing attention left the contribution of unconscious perception to performance unchanged. Similar findings of invariance have been reported in studies of memory (Jacoby et al., 1993; Jennings & Jacoby, 1993). Two points should be made about these results. First, if conscious and unconscious processes are actually redundant, findings of invariance gained by mistakenly assuming independence could occur only by chance and should be difficult to replicate. It strains credibility that, given their number, our findings of invariance are happy accidents. Second, we emphasize the fact that the variables (e.g., attention) for which we have found invariance in our estimates of the unconscious component are ones that have been classically associated with automatic processing. These invariances would not be found if the inclusion condition were used as a pure measure of unconscious perception.

What if the truth lies someplace between the redundancy model and the independence model? That is, what if conscious and unconscious influences are correlated but the correlation is not a perfect one? If the two are correlated, our estimate of conscious perception would be unaffected. That this is true is most easily understood by considering the equations for the inclusion and exclusion test conditions. Adding a term to each of those equations to represent the correlation between conscious and unconscious influences would simply result in that term being subtracted out when conscious perception was estimated. By contrast, any correlation between conscious and unconscious influences would bias estimates of unconscious perception. If there are occasions when stimuli are processed consciously in the absence of concurrent unconscious processing, the redundancy model will overestimate the level of unconscious perception. Such overestimation has been the reason for rejecting supposed demonstrations of unconscious perception that rely on performance on indirect tests and seems even more likely when a direct test of perception is used. By contrast, reliance on the independence model will underestimate unconscious influences to the extent that conscious and unconscious perception are correlated. Thus, the independence model generates estimates that are more conservative than those gained by relying on the redundancy model. The findings of invariance can be taken as showing that any correlation between conscious and unconscious influences is not large. Furthermore, given a choice between underestimating or overestimating unconscious influences, we would prefer the former on the same grounds that a Type II error is preferred over a Type I error when hypothesis testing: Failures to find "real" effects are generally considered to be of less cost than is treating "null" effects as real ones. Because of its controversial nature, this is especially true in the case of unconscious perception.

Perception, Memory, and Behavior

Unconscious perception may be best treated as a member of a larger class of phenomena, all of which reflect automaticity. The notion of automaticity sounds much more innocuous than does that of unconscious perception. Even critics grant a role for automaticity or habit in the form of effects on performance without awareness of the source of those effects (e.g., Eriksen, 1960). For both automaticity and unconscious perception, behavior is largely initiated by the stimulus environment without the intervention of conscious intention (however, see Jacoby et al., 1992). We contend that, under the right stimulus conditions, even a single prior presentation of an item can produce what is, in effect, a habit (i.e., an automatic influence of perception or of memory; Jacoby et al., 1992).

Although the effects of brief visual presentations have been given great prominence, they are probably less common than attentional factors as causes of unconscious influences that are unaccompanied by conscious perception. As described earlier, dividing attention during the occurrence of an event can produce results that are similar to those produced by brief visual presentations (Joordens & Merikle, 1992). Indeed, much larger unconscious influences can probably be produced by manipulations of attention than by flashing items for a brief duration. When attention is focused on attaining a high-level goal, lower level processes that support that goal may be carried out largely without awareness (Neumann, 1984). That is, as long as the high-level intention is being actualized, the lower level processes that enable it are largely automatic. One implication of these ideas is that people are especially susceptible to unconscious influences when they are "in flow" and so are not analytically monitoring sources of influence (cf. Jacoby et al., 1992; Wicklund, 1986). This highlights the positive nature of unconscious processing; automatic uses of memory (skills) and of perception (environment) are essential for expert performance.

Although a useful tool, there really is nothing special about presenting items in perceptually difficult ways such as briefly flashing an item. Indeed, the overemphasis on "hidden" presentation of messages might have obscured much more important effects of attention. For example, consider the controversy surrounding the effects of subliminal "backmasked" messages that are supposedly embedded in some rock music (Vokey & Read, 1985). There may be more to fear from supraliminal messages in "background music" than from any subliminal messages hidden in that music. The backgrounding of music, akin to dividing attention, may make one more open to the lyrics as a source of unconscious influences and persuasion. The human race may have more to fear from the ill effects of "backgrounding" than those of "backmasking."

Regardless, it is the possibility of unconscious perception that has captured the layperson's interest. The reason for that interest is the fear that unconscious perception techniques can be used to gain control over thought and behavior. Much of the work of experimental psychologists has been aimed at countering sensationalistic claims about the effects of unconscious perception. We, too, give little credibility to such claims. However, we agree with the layperson that the issue of control of thought and behavior is the *real* reason for interest in unconscious perception. The process-dissociation procedure centers on that issue. By emphasizing the question of control, we provide a measure of conscious perception that has important advantages over the direct tests of awareness that have traditionally been used.

For unconscious perception, what we find exciting is that our change in strategy opens the way to go beyond attempts to demonstrate the existence of unconscious influences by allowing us to explore factors that affect their magnitude. What is the difference between the structures and processes underlying conscious and unconscious perception? Why does divided attention reduce conscious perception while leaving unconscious perception invariant? We cannot yet fully answer these questions, but by providing a means of separating conscious and unconscious influences, we hope to have placed the answers to such questions within reach.

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