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Parallels between Perception without Attention and Perception without Awareness

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Do studies of perception without awareness and studies of perception without attention address a similar underlying concept of awareness? To answer this question, we compared qualitative differences in performance across variations in stimulus quality (i.e., short vs. long prime-mask stimulus onset asynchrony) with qualitative differences in performance across variations in the direction of attention (i.e., focused vs. divided). The qualitative differences were based on three different phenomena: Stroop priming, false recognition, and exclusion failure. In all cases, variations in stimulus quality and variations in the direction of attention led to parallel findings. These results suggest that perception with and without awareness and perception with and without attention are equivalent ways of describing the same underlying process distinction.

Do we perceive information even when we do not have the subjective experience of perceiving? This question has been the focus of considerable research and discussion for more than 100 years (e.g., Peirce & Jastrow, 1884; Sidis, 1898), and there is now fairly widespread agreement that perception can occur even when we are unaware that we are perceiving (cf. Cohen & Schooler, 1997). However, even though the existence of perception without awareness, or in other words unconscious perception, is well documented, it is still unclear whether perception without awareness is a laboratory curiosity that occurs only under a limited set of conditions or whether perception without awareness is an instance of a much more general phenomenon that occurs in a wide variety of contexts. In this paper, we consider parallels between perception without awareness and perception without attention to explore the question of whether perception without attention is the more general example of perception without awareness.

Intuitively, the distinction between perception with and without attention seems closely related to the distinction between perception with and without awareness. In fact, it is often assumed that we are aware of stimuli that are within our focus of attention and unaware of stimuli that are outside the current focus of attention (e.g., Cowan, 1995; Klatzky, 1984; Mandler, 1975; Posner & Boies, 1971; Miller, 1962). However, at the empirical level, the methods used to study perception without attention and perception without awareness are very different (cf., Greenwald, 1992; Holender, 1986; Velmans, 1991). In studies of perception without awareness, stimulus

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quality has been varied to establish whether unnoticed, degraded stimuli are perceived; in studies of perception without attention, task demands have been varied to establish whether unnoticed stimuli outside the focus of attention are perceived. Given these methodological differences between studies designed to assess perception of unattended stimuli and studies directed at assessing perception without awareness, it is unknown whether these two types of studies address similar or different underlying concepts of awareness (cf. Natsoulas, 1978).

To assess whether studies of perception without attention and studies of perception without awareness address a similar underlying concept of awareness, we compared qualitative differences in performance across variations in stimulus quality with qualitative differences in performance across variations in the direction of attention. The qualitative differences that we chose to compare were based on three very different phenomena: Stroop priming, false recognition, and exclusion failure. Each of these phenomena has been used to show that stimuli perceived with awareness can lead to different consequences than stimuli perceived without awareness. Demonstrations of qualitative differences have provided particularly compelling evidence for the distinction between perception with and perception without awareness because they seriously constrain alternative interpretations (see Merikle, 1992). In this paper, we ask whether variations in the direction of attention lead to qualitative differences in performance that are comparable to those found when stimulus quality has been varied. If variations in the direction of attention and variations in stimulus quality do lead to parallel findings, then such findings would indicate that these two very different experimental manipulations may be influencing a common underlying process.

EXPERIMENTS 1A AND 1B: PARALLELS IN STROOP PRIMING

The purpose of Experiments 1A and 1B was to establish whether variations in stimulus quality and variations in the focus of attention lead to similar qualitative differences in Stroop priming. The experiments were based on a variant of the Stroop (1935) task in which two color words—RED or GREEN—are used to prime responses to two target colors—also red or green (cf. Logan, Zbrodoff, & Williamson, 1984). The important characteristic of this two-color variant of the Stroop task is that the typical Stroop effect is reversed whenever incongruent (e.g., GREEN–red) prime–target pairings occur more frequently than congruent (e.g., RED–red) prime–target pairings (e.g., Merikle & Joordens, 1997; Merikle, Joordens, & Stolz, 1995). In other words, in contrast to the typical Stroop effect that shows slower reaction times on incongruent trials than on congruent trials, the reaction times to incongruent prime–target pairings are faster than the reaction times to congruent prime–target pairings if incongruent trials occur more frequently than congruent trials. One explanation of the reversed Stroop effect is that participants capitalize on the predictive information provided by the primes (e.g., Merikle et al., 1995). Given that there are only two possible colors, the intelligent strategy when incongruent trials occur more often than congruent trials is to expect that the target color on each trial will be the color NOT named by the prime. Such a strategy would facilitate performance on the incongruent trials and slow performance on the congruent trials.

Previous research has shown that the predictive strategy in the two-color variant of the Stroop task is adopted only when the primes are consciously perceived (e.g., Merikle & Cheesman, 1987; Merikle & Joordens, 1997; Merikle et al., 1995). For example, Merikle and Joordens (1997) presented the primes for either a relatively long duration so that they were consciously perceived or for such a short duration that participants experienced no awareness of the primes. They found that the participants adopted the predictive strategy and responded faster on incongruent trials than on congruent trials only when the primes were presented for the long duration. In contrast, when the primes were presented for the short duration, the typical Stroop effect was observed; namely, the participants responded faster on congruent trials than on incongruent trials. This change in the direction of the difference in performance between incongruent and congruent trials across long and short prime durations indicates that perception with awareness and perception without awareness can lead to qualitatively different consequences (e.g., Merikle et al., 1995).

The two-color variant of the Stroop task was used in Experiments 1A and 1B to establish whether variations in stimulus quality and variations in the focus of attention lead to parallel qualitative differences in priming. Experiment 1A was basically a replication of our previous studies showing qualitative differences in Stroop priming across long and short prime durations. In Experiment 1A, stimulus quality was varied by masking the primes following either a short (i.e., 33 ms) or a relatively long (i.e., 167 ms) prime-mask stimulus onset asynchrony (SOA). The short prime-mask SOA was selected on the basis of previous studies showing that a 33-ms prime-mask SOA is below most participants' threshold for subjective awareness (e.g., Cheesman & Merikle, 1985, 1986). In Experiment 1B, the SOA between the primes and the masking stimulus was relatively long (i.e., 300 ms), and the basic experimental manipulation involved instructing the participants either to identify the colors (i.e., focused attention) or to identify the colors while simultaneously monitoring a sequence of auditory digits (i.e., divided attention). The single- vs. dual-task manipulation in Experiment 1B allowed us to establish whether the differences in performance across conditions of focused and divided attention were similar to the differences in performance across conditions of high and low stimulus quality in Experiment 1A.

Method

Experiment 1A

Participants. Thirty-two undergraduate students at the University of Waterloo were recruited from a pool of students who had agreed to participate in experiments for pay. All participants had normal or corrected-to-normal vision, and English was their first language. Different groups of students were tested with the long and short SOAs. The students were assigned to these groups in an alternating fashion at the time they arrived in the laboratory for the experiment. Each participant was paid $4.00 at the end of the experimental session.

Apparatus. All stimulus materials were presented on a Zenith color monitor (Model ZCM-1490) that was connected to a Zenith computer equipped with an 80286 processor. The stimuli were displayed as uppercase letters against a black background, and they were centered both horizontally and vertically. Each letter measured approximately 3 mm wide by 4 mm high, and the viewing distance was approximately 65 cm.

The participants indicated their decision on each trial by pressing one of two buttons on a mouse that was located on a table in front of them. One button on the mouse was labeled GREEN in green ink, and the other button was labeled RED in red ink. The participants kept their right hand on the mouse throughout the experiment.

Procedure. Each participant received one block of 24 practice trials followed by six blocks of 48 experimental trials. The participants initiated each block of trials by pressing the space bar on the computer keyboard. Once a block of trials was initiated, it ran to completion. Thus, the participants could rest only between blocks of trials.

Each trial with the short prime-mask SOA consisted of the following sequence of events: (1) a blank field presented for 300 ms, (2) the word GREEN or RED displayed in gray letters and presented for 33 ms, (3) the mask (i.e., &&&&&&&) displayed in gray and presented for 267 ms, and (4) the target (i.e., &&&&&&&) displayed in either red or green and presented until a response was made. A string of seven ampersands served as both the mask and the target, with the only difference being that the mask consisted of seven gray ampersands and the targets consisted of either seven red or seven green ampersands. On 75% of the trials, the prime and the target were incongruent (e.g., GREEN–red), whereas on the remaining 25% of the trials, the prime and the target were congruent (e.g., GREEN–green). The participants' task on each trial was to indicate the color of the ampersands as quickly as possible after the color changed from gray to red or green. The red or green ampersands remained on the screen until a response was made, and the next trial began immediately following the response.

The only difference between trials with short and long prime-mask SOAs was that the presentation of each prime on the long prime-mask SOA trials was followed by a 133-ms presentation of a blank field, which in turn was followed by a 133-ms presentation of the mask. With this exception, the long prime-mask SOA trials were exactly the same as the short prime-mask SOA trials.

Experiment 1B

Participants. Thirty-two students at the University of Waterloo were recruited from the same pool of paid volunteers sampled in Experiment 1A. The students were assigned to either a focused- or a divided-attention group in an alternating fashion at the time they arrived in the laboratory for the experiment. All participants had normal or corrected-to-normal vision, and each participant was paid $4.00 at the end of the experimental session.

Procedure. In general, the method was similar to that in Experiment 1A. However, unlike Experiment 1A in which the prime-mask SOA was varied across groups, the two groups of participants in Experiment 1B differed in terms of whether they performed a single task (i.e., focused attention) or a dual task (i.e., divided attention). For this reason, the primes were presented for the full 300-ms prime-target SOA, and each trial consisted of the following sequence of events: (1) a black field presented for 300 ms, (2) the word GREEN or RED displayed in gray letters and presented for

300 ms, and (3) the target (i.e., &&&&&&&) displayed in either red or green and presented until a response was made.

The participants assigned to the focused-attention group were simply required to decide on each trial whether the target was red or green. The task was considerably more complex, however, for the participants assigned to the divided-attention group. Not only were these participants required to decide on each trial whether the target was red or green, but they were also required to monitor a sequence of auditory digits continuously throughout each block of trials and to report at the end of the block of trials the number of times that three consecutive odd digits occurred. The participants assigned to the divided-attention group were told that the monitoring task was their primary task and that they should try to detect all sequences of three odd digits.

The audiotape with the digit sequences was modeled after the tapes used by Craik (1982) and Jacoby (1991). It consisted of 1350 single digits (the digits 1 to 9), and it contained 258 target sequences of 3 consecutive odd digits. The target sequences were separated by filler sequences that were 1, 3, 4, or 5 digits in length. These filler sequences never contained consecutive even digits and never had leading or trailing odd digits. A total of 152 filler sequences was used, and they were randomly interspersed between target sequences, with the sole constraint being that the first sequence on the tape was a filler sequence. Once the master list of digit sequences was created, the digits were recorded on tape using a Kursweil automated scanner. The scanner read the digits in an automated voice at a rate of two digits per second.

Results and Discussion

The mean color-naming latencies in Experiments 1A and 1B are shown in Fig. 1, and the error rates associated with these reaction times (RTs) are presented in Table 1. Two aspects of Fig. 1 are of interest. First, the results of Experiment 1A successfully replicate previous results (e.g., Merikle & Cheesman, 1987; Merikle & Joordens, 1997; Merikle et al., 1995) showing that different patterns of Stroop interference are associated with short and long prime-mask SOAs. Second, the patterns of Stroop interference found for the divided and focused attention conditions in Experiment 1B parallel the patterns of interference found for the short and long prime-mask SOAs in Experiment 1A.

The RTs for Experiment 1A were analyzed using a 2×2 repeated-measures analysis of variance. This analysis revealed a significant interaction between prime-mask SOA and prime-target congruency, $F(1, 30) = 17.48$, $p < .001$. This interaction was examined more closely by performing pairwise t tests at each prime-mask SOA. The t tests revealed that the participants responded faster on congruent trials than on incongruent trails at the short SOA, $t(15) = 3.53$, $p < .003$. However, at the long SOA, the participants responded faster on incongruent trials than on congruent trails, $t(15) = 2.81$, $p < .013$. Thus, these results replicate findings showing that different patterns of Stroop interference are associated with short and long prime-mask SOAs.

The RTs for Experiment 1B were analyzed in the same manner as the RTs for Experiment 1A. The analysis of variance revealed that the divided-attention participants responded significantly slower than the focused-attention participants, $F(1, 30) = 12.93$, $p <. 001$. More importantly, there was a significant interaction between attention (focused vs. divided) and prime–target congruency, $F(1, 30) = 13.52$, $p <$

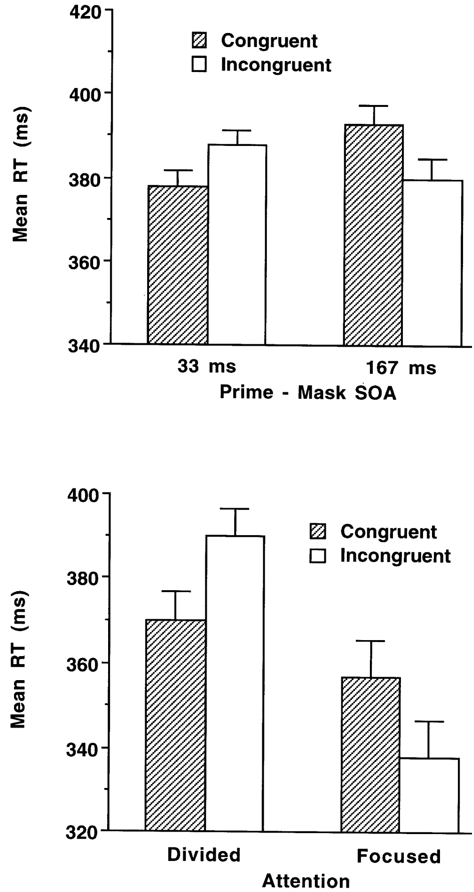

FIG. 1. Patterns of Stroop interference in Experiments 1A and 1B. (Note: In this figure, 250 ms is subtracted from each mean in the divided-attention condition.)

TABLE 1
Mean Percentage Errors in Experiments 1A and 1B

Condition	Prime–target relationship	
	Congruent	Incongruent
Experiment 1A		
33-ms SOA	2.3	3.2
167-ms SOA	6.5	3.6
Experiment 1B		
Divided attention	8.1	7.9
Focused attention[a]	17.7	10.4

[a]Congruent and incongruent conditions differ significantly, $p < .01$.

.001. Pairwise t tests revealed that the participants in the divided-attention condition responded faster on congruent than on incongruent trials, $t(15) = 2.99$, $p < .009$, but that the participants in the focused-attention condition responded faster on incongruent trials than on congruent trails, $t(15) = 2.21$, $p < .043$. Thus, as suggested by Fig. 1, the results of Experiment 1B parallel the results of Experiment 1A.

Taken together, the results of Experiments 1A and 1B show parallel effects across two very different experimental manipulations. The manipulation in Experiment 1A is closely associated with the distinction between perception with and without awareness, whereas the manipulation in Experiment 1B is associated with the distinction between attended and unattended information. The fact that these two very different experimental manipulations led to parallel results suggests that the two distinctions may describe a similar underlying concept of conscious awareness.

Of course, parallel results do not necessarily imply similar underlying processes. Given the differences between the procedures used in Experiments 1A and 1B, it is always possible to argue that the parallel results across experiments are nothing more than a chance finding. Thus, the parallel results found in Experiments 1A and 1B may not be indicative of similar underlying cognitive processes but may simply reflect different cognitive processes that happen to lead to parallel findings in these particular circumstances. Other than invoking the law of parsimony, it is difficult to argue against this alternative view solely on the basis of the results of Experiments 1A and 1B. However, if parallel findings between manipulations of attention and stimulus quality can be demonstrated in other, very different, experimental situations, then it would become more difficult to maintain that the parallel results reflect different rather than similar underlying processes.

EXPERIMENTS 2A AND 2B: PARALLELS IN FALSE RECOGNITION

Jacoby and Whitehouse (1989) reported a qualitative difference in recognition memory that appears to be a consequence of whether a biasing context is perceived with or without awareness. Their experiment centered on false recognition, which is defined as an ‘‘old’’ response to a new word on an old/new recognition test. A unique aspect of their experiment was that the presentation of each word on the old/new recognition test was preceded immediately by the presentation of another word selected to bias the context in which decisions were made. Each word selected to bias the context was either the same word as the immediately following test word (i.e., matched context) or a completely different word (i.e., nonmatched context). The interesting result found by Jacoby and Whitehouse is that the matched and nonmatched contexts had different effects depending on the exposure duration of the context words. When the context words were presented for a relatively short duration (e.g., 50 ms), a new test word was *more* likely to be judged as being an old word when the context word and test words were the same (i.e., matched context) than when the context and test words were different (i.e., nonmatched context). However, when the context words were presented for a longer duration (e.g., 200 ms), a new test word was *less* likely to be judged as being an old word in the matched-context than in the nonmatched-context condition.

Jacoby and Whitehouse (1989) suggested that this qualitative difference in false recognition reflects an underlying difference in how a context word influences subsequent attributions of perceived familiarity depending on whether the context word is perceived with or without awareness. A basic assumption underlying their interpretation is that each prior presentation of a word increases its perceptual fluency, which, in turn, increases its perceived familiarity (cf. Jacoby & Dallas, 1981). Given this assumption, whenever a context word and a test word are the same, the perceived familiarity of the test word is enhanced compared to when the context and test words are different. However, this enhanced familiarity is attributed in different ways depending on whether the context word is perceived with or without awareness. When the context word is perceived with awareness, any perceived familiarity associated with the subsequent test word is attributed to its previous presentation as a context word. For this reason, the enhanced familiarity produced by a matched context *decreases* false recognition relative to a nonmatched context whenever the context word is perceived with awareness. On the other hand, when the context word is perceived without awareness, any perceived familiarity associated with a test word is attributed to the test word's prior presentation on the study list. Therefore, a matched context *increases* false recognition relative to a nonmatched context, whenever the context word is perceived without awareness.

The purpose of Experiments 2A and 2B was to establish whether variations in the direction of attention lead to qualitative differences in false recognition that are similar to the qualitative differences found when the stimulus quality of the context words is varied. Experiment 2A was designed to replicate the basic qualitative difference in false recognition across long and short context-word durations that has been found in previous studies (e.g., Jacoby & Whitehouse, 1989; Joordens & Merikle, 1992). The experiment was very similar to several our previous studies (e.g., Joordens & Merikle, 1992; Merikle et al., 1995) investigating false recognition. Based on the results of these previous studies, the context words were presented either for a relatively short duration (i.e., 57 ms), which has been found to lead to perception without awareness, or for a somewhat longer duration (i.e., 114 ms), which has been found to lead to perception with awareness. In Experiment 2B, the context words were presented only for the longer duration (i.e., 114 ms), and the participants performed the old/new recognition test either by itself (i.e., focused attention) or while simultaneously monitoring a sequence of auditory digits (i.e., divided attention). Our primary interest was in assessing whether the patterns of false recognition under conditions of focused and divided attention parallel the patterns of false recognition under conditions of high and low stimulus quality.

Method

Experiment 2A

Participants. Twenty-four undergraduate students at the University of Waterloo were recruited from the same population sampled in Experiments 1A and 1B. All participants had normal or corrected-to-normal vision, and English was their first language. Each participant was paid $5.00 at the end of the experiment.

Materials and apparatus. A pool of 540 five-letter nouns was compiled from Kucera and Francis (1967). Word frequency for these nouns ranged from 3 to 60 occurrences per million. For each participant, 126 words were randomly selected from the pool for the study list, and another 126 words were selected from the pool to serve as the new words on the old/new recognition test. In addition, 84 words were selected to be used as the context words on the nonmatch trials of the old/new recognition test.

The equipment was basically the same as used in Experiments 1A and 1B. The only difference was that the participants indicated their decision on each trial of the old/new recognition test by using two touch-sensitive plates rather than a computer mouse. One plate was labeled OLD, the other was labeled NEW. The participants were allowed to position the touchplates in a comfortable manner on the table in front of them prior to beginning the old/new recognition test.

Procedure. The first phase of the experiment involved the presentation of a study list of 126 words. The words were presented at a rate of 1 word/s, with each word being presented for 500 ms and followed by a 500-ms blank field. The participants were instructed to read each word silently to themselves. The participants were told that their memory for the words would be tested later in the experiment.

The second phase of the experiment involved the old/new recognition test of the words studied in the first phase of the experiment. Each trial of the recognition test consisted of the following sequence of events; (1) the masking stimulus (i.e., &&&&&&&) presented for 500 ms, (2) a context word presented for either 57 or 114 ms, (3) the masking stimulus presented for another 500 ms, and (4) a test word presented until a response was made. All stimuli for the recognition test were centered at the same screen location. The participants were instructed to read each context word silently to themselves, if possible, and then to categorize each test word as ‘‘old’’ or ‘‘new’’ with respect to the initial study list.

Recognition memory was tested in three different contexts: match, nonmatch, and baseline. On the match trials, the context word and the test word were identical; on the nonmatch trials, the context word and the test word were different, and the context word was always a new word. On the baseline trials, the context word was the letter string xoxox. For all three contexts, the test words were old on half the trials and new on the remaining trials.

The old/new recognition test consisted of 12 practice trials followed by 240 experimental trials. The practice trials consisted of four exemplars of each of the three contexts. The six old test words used for the practice trials were the first and last three words of the study list. The 240 experimental trials consisted of 120 trials in which the context word was presented for 57 ms, and 120 trials in which the context word was presented for 114 ms. The duration of the context word on any specific trial was determined randomly within the constraint that the same duration was never used on more than 3 consecutive trials. Each context was used equally often at each exposure duration.

Experiment 2B

Participants. Forty-eight undergraduate students at the University of Waterloo were recruited from the same population sampled in Experiment 2A. Different groups of participants were assigned to the focused and divided attention conditions. The participants were assigned to these groups in an alternating fashion when they arrived at the laboratory for the experiment. Each participant was paid $5.00 at the end of the experiment.

General. The method was very similar to Experiment 2A, except for two changes in the administration of the old/new recognition test. First, in contrast to Experiment 2A, the exposure duration of the context words was not varied. Rather, the context words were exposed for a constant 114 ms in both the focused- and the divided-attention conditions. The second modification to the old/new recognition test concerned only those participants assigned to the divided-attention condition; these participants were required to perform the digit-monitoring task at the same time that they performed the test of recognition memory. The digit-monitoring task was administered in the same way as in Experiment 1B. All other aspects of the method were the same as in Experiment 2A.

Results and Discussion

The false recognition scores across the match and nonmatch contexts of Experiments 2A and 2B are shown in Fig. 2. Two aspects of Fig. 2 are of prime importance. First, the results of Experiment 2A replicate previous findings showing that different patterns of false recognition are associated with short and long context-word durations (e.g., Jacoby & Whitehouse, 1989; Joordens & Merikle, 1992). Second, the results of the attention manipulation in Experiment 2B parallel the results of the stimulus quality manipulation in Experiment 2A. With both divided attention and the short context-word duration, the participants said ''old'' to new test words more often on match trials than on nonmatch trials, whereas with focused attention and the long context-word duration, the participants said ''old'' to new test words more often on nonmatch trials than on match trials.

The false recognition data from Experiment 2A were analyzed using a 2 $\times$ 3 repeated measures analysis of variance. This analysis revealed a significant main effect of context, $F(2, 46) = 3.28$, $p < .047$, and a significant interaction between context and duration, $F(2, 46) = 5.56$, $p < .007$. Further analysis of this interaction revealed that the participants responded old significantly more often on match than on nonmatch trials when the context words were presented for the short duration, $t(23) = 2.35$, $p < .028$, but they responded old significantly less often on match than on nonmatch trials when the context words were presented for the long duration, $t(23) = 2.59$, $p < .016$.

Analysis of the false recognition data from Experiment 2B by a 2 x 3 analysis of variance revealed a significant interaction between attention and context, $F(2, 92) = 8.81$, $p < .001$. Further analysis of this interaction revealed that the participants in the divided-attention condition categorized new test words as old significantly more often on match trials than on nonmatch trials, $t(23) = 2.98$, $p < .007$. Conversely, the participants in the focused-attention condition categorized new test words as old significantly less often on match trials than on nonmatch trials, $t(23) = 2.98$, $p < .007$. Thus, the pattern of false recognition associated with divided attention was similar to the pattern of false recognition associated with the short context-word duration, and the pattern of false recognition associated with focused attention was

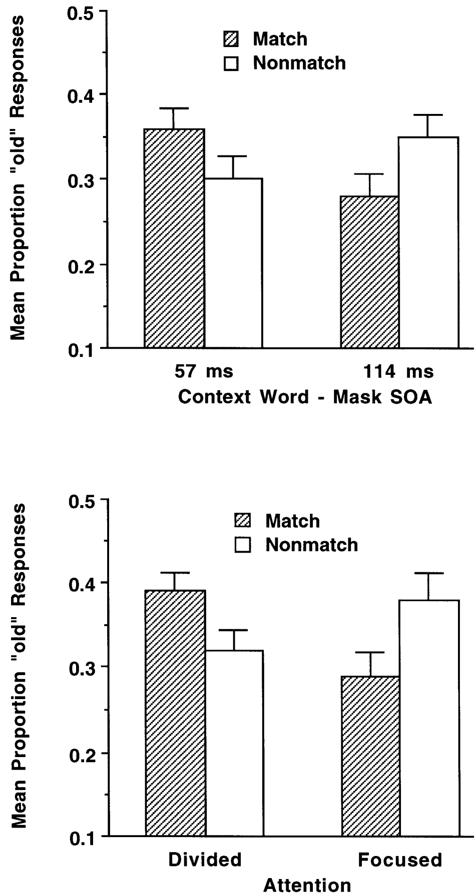

FIG. 2. Patterns of false recognition in Experiments 2A and 2B.

similar to the pattern of false recognition associated with the long context-word duration.

The results of Experiments 2A and 2B provide another example of parallel effects across two very different experimental manipulations. What makes these results interesting is that one manipulation varied how much attention the participants directed toward the context words, whereas the other manipulation varied how visible the context words appeared to the participants. The parallel findings suggest that both experimental manipulations influenced the same underlying process, namely, the participants' conscious awareness of the context words.

PARALLELS IN THE ABILITY TO FOLLOW EXCLUSION INSTRUCTIONS

A recent approach to the study of unconscious perception has been the development of measures of perception that are influenced in opposite ways by consciously and unconsciously perceived information. One measure that has been used successfully in a number of contexts is the stem completion task administered under exclusion instructions. This measure, which was originally developed by Jacoby (1991), can be used either in conjunction with the process-dissociation procedure to estimate the separate contributions of conscious and unconscious influences (e.g., Jacoby, Toth, & Yonelineas, 1993) or by itself to estimate the relative contributions of conscious and unconscious influences (e.g., Merikle et al., 1995). The distinguishing characteristic of the measure is that subjects are instructed *not* to use particular responses when completing word stems. For example, consider the version of this measure used by Debner and Jacoby (1994) to study perception without awareness. In their studies, a single five-letter word (e.g., spice) was presented and masked on each trial. Immediately following the presentation of each word, a three-letter stem (e.g., spi____) consisting of the first three letters from the target word was presented, and the subjects were instructed to complete this stem with any word that came to mind except the word that had just been presented.

Debner and Jacoby (1994) found that subjects were able to follow the instructions to exclude the immediately preceding words from their completions when these words were presented for 150 ms (Experiment 3). However, when the words were presented for 50 ms (Experiment 1), the subjects had difficulty following the instructions and they used many of the immediately preceding words to complete the word stems, despite the instructions not to use these words. The general pattern of findings is shown at the top of Fig. 3. As can be seen in the figure, target words were used to complete the stems less often than the baseline level when they were presented for 150 ms but more often than the baseline level when they were presented for 50 ms. These findings show that the target words were perceived whether they were presented for 150 or 50 ms. However, the influence of the words presented for 50 ms was in the opposite direction of the influence of the words presented for 150 ms.

The different effects of words presented for short and long durations provide another type of evidence showing that variations in stimulus quality can determine the likelihood that a stimulus is perceived with or without awareness (Merikle & Joordens, 1997; Merikle et al., 1995). If we make the very reasonable assumption that a stimulus must be consciously perceived before it is capable of guiding our actions in the world, then a successful exclusion of a target word as a stem completion indicates that the word was consciously perceived, and a failure to exclude a target word indicates that the word was unconsciously perceived. As applied to the results shown at the top of Fig. 3, this assumption leads to the conclusion that the lower than baseline performance when the target words were presented for 150 ms indicates that these words were consciously perceived more often than they were unconsciously perceived, whereas the higher than baseline performance when the words were presented for 50 ms indicates that these words were unconsciously perceived more often than they were consciously perceived.

To evaluate whether a variation in the direction of attention leads to a similar qualitative difference in the ability of subjects to follow exclusion instructions, we looked at another subset of the data reported by Debner and Jacoby (1994). The critical data are presented at the bottom of Fig. 3. These data are taken from a study in which each target word was presented for 100 ms under conditions of either fo-

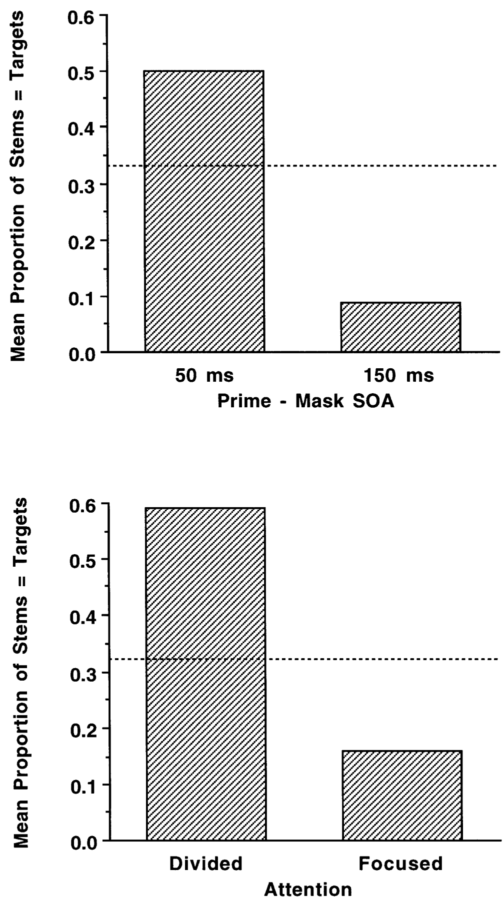

FIG. 3. Probability of NOT following the exclusion instructions across stimulus duration and across conditions of focused vs. divided attention (Data from Debner & Jacoby 1994).

cused or divided attention (Experiment 3). To divide attention, each target word was sandwiched between two single digits (e.g., 5 spice 4), and the participants were instructed to report the sum of the two digits before completing the word stem (cf., Wolford & Morrison, 1980). When attention was focused on the target words alone, the target words were also sandwiched between flanking digits, but the participants were instructed to ignore the digits. As can be seen in Fig. 3, this variation in the focus of attention led to a pattern of findings that parallels the pattern of findings found when the exposure duration of the target words was varied. When participants were able to focus their attention on the target words alone, the target words were used to complete the stems less often than the baseline level. These results suggest that the participants were likely to perceive the target words in the focused-attention condition with awareness. However, when participants were required to report the sum of the digits before completing a word stem, the target words were used to complete the stems more often than the baseline level. These results suggest that the subjects were often unaware of the target words in the divided-attention condition. Thus, these findings suggest that variation in the focus of attention led to changes in the likelihood of conscious or unconscious influences that parallel the changes found when the quality of the stimulus information was varied.

GENERAL DISCUSSION

The goal of this paper was to assess whether studies of perception without awareness and studies of perception without attention address a similar concept of conscious awareness. The logic underlying our approach was to consider qualitative differences in performance that have been shown to occur when stimulus quality is varied in studies of perception with vs. perception without awareness. We asked whether variations in the direction of attention lead to comparable qualitative differences. The results from both our experiments and from Debner and Jacoby's (1994) experiments show that variations in the direction of attention and variations in stimulus quality do in fact lead to parallel qualitative differences.

Do these parallel findings indicate that variations in the direction of attention and variations in stimulus quality influence common underlying processes? Although the results do not demand such a conclusion, we believe that such a conclusion merits serious consideration. The three parallel qualitative differences described in the paper are based on three very different phenomena. However, despite the considerable methodological differences associated with each phenomenon, manipulations of the direction of attention and manipulations of stimulus quality led to parallel crossover interactions. Given that these types of qualitative differences are considered to provide strong support for the distinction between perception with vs. perception without awareness (cf. Merikle, 1992), it is certainly not unreasonable to suggest that these parallel findings indicate that variations in the direction of attention are another way of demonstrating a distinction between perception with and without awareness. Thus, in many instances, studies investigating perception without awareness and studies investigating perception without attention may be addressing the same underlying concept of conscious awareness.

The idea that variations in the direction of attention and variations in stimulus quality affect common underlying processes is certainly not new. Previous interpretations of backward masking, the manipulation used to vary stimulus quality, and previous conceptualizations of attention suggest that masking, stimulus quality, and attention are closely related concepts. In fact, it is possible to interpret the effects of a mask on perceived stimulus quality in terms of attention and to discuss attention in terms of its effect on perceived stimulus quality.

Backward visual masking by an overlapping pattern is often interpreted as an interruption in attention directed toward a stimulus (e.g., Marcel, 1983; Turvey, 1973). This attentional interpretation of masking was captured elegantly by Kolers (1968) when he presented the following clerk/customer analogy to illustrate how a mask works backward in time to affect the perception of an earlier-presented stimulus:

> A customer who enters a store is usually treated as fully as the attending clerk can treat him; a second customer then entering, the clerk tends to shorten the amount of time he spends with the first. In a store whose customers enter aperiodically, the amount of treatment given to anyone

> depends upon whether a second enters; if he does, treatment of the first is usually shortened. (Kolers, 1968, p. 38)

In this analogy, the actions of the clerk represent how attention is directed. The analogy implies that a mask captures attention, and as a consequence, the time available to process earlier-presented stimuli is shortened. As applied to the studies discussed in this paper, the clerk/customer analogy suggests that the masks were an effective method for controlling stimulus quality (i.e., stimulus duration) because they directed attention away from the priming stimuli in Experiment 1B, the context stimuli in Experiment 2B, and the target stimuli in Debner and Jacoby's (1994) experiments.

In contrast to viewing variations in stimulus quality produced by a mask in terms of attention, the effects of changes in the direction of attention can be viewed in terms of their effect on perceived stimulus quality. Treisman's (1960) attenuation hypothesis suggests that whenever attention is directed to one channel or source of stimulus information, there is a reduction in the strength or level of activation for all channels or sources of information that are outside the focus of attention. From this point of view, any manipulation of the direction of attention can be thought of as another way of altering the perceived quality of a stimulus. As applied to the single-task vs. dual-task manipulation used in the experiments described in this paper, the attenuation hypothesis suggests that this manipulation decreased the amount of activation initiated by the priming stimuli in Experiment 1B, the context stimuli in Experiment 2B, and the target stimuli in Debner and Jacoby's experiments, which in turn decreased the perceived quality of these stimuli.

Figure 4 illustrates some preliminary ideas regarding how stimulus quality, direction of attention, and awareness may be interrelated. The basic conceptualization illustrated in the figure is based on Cowan's (1995) interpretation of Treisman's (1960) filter-attenuation theory. The large box in the figure represents the memory storage system, the blobs within the box represent individual units of information stored in memory, and the density of the shading of the blobs represents the degree to which an individual unit is activated by a perceived stimulus. The blobs located above the box represent the two types of perceived stimuli that are capable of influencing ongoing actions. The blobs above the awareness level represent the stimuli that are consciously perceived and capable of guiding intentional actions. In contrast, the blobs below the awareness level represent the stimuli that are unconsciously perceived and capable of influencing actions, although not necessarily in a manner that is consistent with current conscious intentions.

The basic dynamics of the conceptualization illustrated in Fig. 4 are as follows. First, whenever attention is focused on one source of information (i.e., Stimulus Channel A), this source of information leads to the greatest level of activation. Second, if the level of activation exceeds the awareness level, then the information is consciously perceived. Third, the activation produced by sources of information other than the attended source of information (i.e., Stimulus Channels B and C) is attenuated but still capable of activating relevant memory representations sufficiently to support perception. Depending on the level of this activation, these unattended sources of information may be either unconsciously (i.e., Stimulus Channel B) or consciously perceived (i.e., Stimulus Channel C).

The conceptualization shown in Fig. 4 provides a basis for understanding why

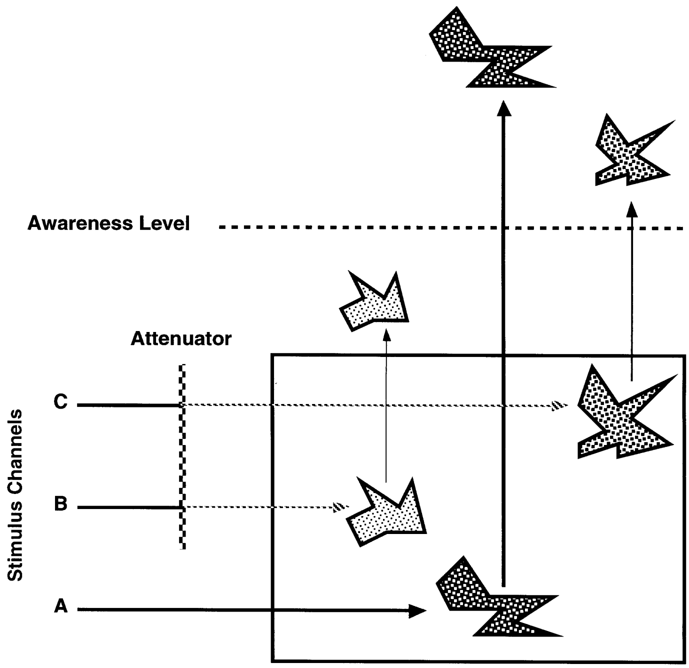

FIG. 4. An interpretation of Treisman's filter-attenuation theory (reprinted, by permission of Oxford Univ. Press from Cowan, 1995. Copyright © 1995 by Oxford Univ. Press.

variations in stimulus quality and variations in the direction of attention lead to parallel qualitative differences in performance. The clear implication of Fig. 4 is that both stimulus quality and the direction of attention influence the level of activation for units of information in memory. When the level of activation exceeds the awareness level, a stimulus is consciously perceived. However, if a unit of information in memory is activated by a stimulus but the level of activation is insufficient to exceed the awareness level, then the stimulus is still perceived but perception is not accompanied by the subjective experience of perceiving. Given that both stimulus quality and the direction of attention influence the same underlying processes, namely, activation and awareness, the proposed conceptualization provides a framework for understanding why changes in stimulus quality and the direction of attention lead to parallel qualitative differences in performance.

The view of consciousness that emerges from the experiments described in this paper is that when stimuli are consciously perceived either because the stimulus quality is good or because the stimuli are within the focus of attention, they can guide intentional actions. In contrast, when stimuli are unconsciously perceived either because the stimulus quality is poor or because the stimuli are outside the focus of attention, they may lead to more automatic or habitual reactions. For example, in Experiments 1a and 1b, when the primes were consciously perceived, the predictive information in the primes led to a reversal of the normal pattern of Stroop interference; however, when the primes were unconsciously perceived, the predictive information in the primes had little or no effect on Stroop interference. Likewise, in the Debner and Jacoby experiments, when words were consciously perceived, the participants were able to follow the instructions NOT to use these words to complete the word stems; however, when the words were unconsciously perceived, the participants were unable to follow these instructions and frequently used the previously presented words to complete the word stems despite explicit instructions not to use these words. These findings suggest that consciously perceived stimuli can guide intentional actions, whereas unconsciously perceived stimuli lead to more automatic or habitual reactions, which may even interfere with ongoing intentional actions.

The experiments described in this paper provide considerable evidence that perception with vs. perception without awareness and perception with vs. perception without attention are equivalent ways of describing the same underlying process distinction. One way to further document the proposed close relation between attention and awareness would be to establish the possible trade-offs between stimulus quality and attention. For example, does increased attention increase the likelihood that a poor-quality stimulus will be perceived with awareness, and conversely, does increased stimulus quality increase the likelihood that a stimulus outside the current focus of attention will be perceived with awareness? If there are systematic trade-offs between attention and stimulus quality in determining whether a stimulus is perceived with or without awareness, this would provide further empirical support for the intuitively appealing conclusion that studies of perception with vs. perception without awareness are instances of the more general contrast between perception with vs. perception without attention.

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