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Spontaneous Versus Directed Recognition: The Relativity of Automaticity

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We examined the contrast between *spontaneous* and *directed* recognition by using the flanker paradigm. Our reasoning was that spontaneous recognition of a flanking word would be reflected by the influence that word had on recognition of a target word. In a first experiment, when attention was divided at test, recognition decisions were made more rapidly when flanker and target words were congruent, rather than incongruent, with regard to the response they dictated. In later experiments, we attempted to specify factors that influence spontaneous recognition of a flanking word. We examined the effects of number of prior presentations and physical similarity between study and test. To anticipate, the nature of our results leads us to question whether recognition is ever truly spontaneous. The findings are discussed in relation to the relativity of automaticity (cf., Neumann, 1984).

Sometimes we call memories into consciousness by an act of will and reproduce them voluntarily in response to a direct question about the past. On other occasions, however, memories come to consciousness with apparent spontaneity; that is, they are reproduced involuntarily. This contrast, drawn by Ebbinghaus (1885/1964, pp. 1–2), is one that we will refer to as a contrast between *directed* and *spontaneous* remembering. It is directed remembering that has been the topic of most memory research. Experimenters have typically directed remembering by asking subjects to recall or recognize events from their personal pasts. However, outside the laboratory, spontaneous remembering seems as common as and, sometimes, more important than, directed remembering. Recognition directed by instruction may differ in important ways from spontaneous recognition. As a commonplace example, the factors that are important for recognition of an acquaintance encountered on the street might be different from those important for recognition of the same acquaintance in response to a direct question.

Spontaneous recognition is unintentional in the sense of not being directed by instructions, and it may be more automatic than directed recognition. Consequently, it might be useful to think of the contrast between spontaneous and directed remembering in terms of the contrast between automatic and consciously controlled processing that has been popular in theories of attention and memory (e.g., Hasher & Zacks, 1979; Jacoby, 1991; Posner & Snyder, 1975; Shiffrin & Schneider, 1977). For spontaneous recognition to occur it may be necessary for the "pastness" of an event to "capture" attention, whereas directed recognition involves the "giving" of attention (cf. James, 1890; Johnston, Hawley, Plewe, Elliott, & Dewitt, 1990).

To measure spontaneous recognition, what is needed is some means of measuring recognition of an item that does not require asking people whether they recognize the item, that is, an indirect test of memory. There has recently been a great deal of research showing dissociations between performance on direct and indirect tests of memory (for reviews see, Hintzman, 1990; Richardson-Klavehn & Bjork, 1988; and Roediger, 1990). However, the indirect tests of memory that have been most commonly used will not suffice as measures of spontaneous recognition. Indirect tests of memory such as word completion (e.g., Tulving, Schacter, & Stark, 1982) and perceptual identification (e.g., Jacoby & Dallas, 1981) do not require subjects to be aware of using memory for effects of memory to be shown. Similarly, use of memory for an earlier problem to solve a later problem does not require awareness of memory for the earlier problem (Needham & Begg, 1991). To measure spontaneous recognition, recognition of an item as old must influence performance on the indirect test of memory. Although it may be argued that identification processes can account for any observed effects, our use of the term *spontaneous recognition* is to emphasize our interest in the effects of prior presentation. Indeed, our manipulations concentrate on those factors that are thought to influence recognition processing, and the results point to the similarity of "oldness" between flankers and targets as an important component of spontaneous recognition.

We used a measure of distraction as an indirect test of spontaneous recognition. The notion is that spontaneous recognition of an item that people are told to ignore will affect performance of an ongoing task and that differences in performance can be used as an index of spontaneous recognition. The experimental arrangement we used is similar to the flanker paradigm introduced by B. A. Eriksen and Eriksen (1974; see also Shaffer & LaBerge, 1979) to examine the processing of unattended items. In the first phase of each of our experiments, a long list of words was presented for study. For a recognition test, each test word was presented flanked above and below by either an old word or a new word. Sub-

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jects were to make their recognition decision about the test word (the middle word) while ignoring the flanking word. The effect of the relation between the flanker and the test word was used to measure spontaneous recognition in the form of automatic processing of the flanker. If the flanker was spontaneously recognized despite instructions that it be ignored, we predicted that recognition decisions for test words would be fastest when the flanker and test word were congruent (old flanker, old test word; new flanker, new test word) rather than incongruent (new flanker, old test word; old flanker, new test word) with regard to the decision they would dictate. Incongruent flankers might also produce more errors than would congruent flankers. For example, in the condition in which a new target is flanked by an old word, the familiarity of the flanker may be misattributed to the target, with the result that the target is incorrectly called old. Thus, spontaneous recognition of an item that is to be ignored can be indexed by its influence on performance of an ongoing task, the test of directed recognition.

Our measure of spontaneous recognition differs in a potentially important way from the example of spontaneously recognizing an acquaintance. The latter typically eventuates in awareness of the evoking stimulus (the acquaintance), whereas in our experiments subjects were instructed to ignore the flankers and, consequently, might have remained unaware of their influences. Indeed, only data from subjects who claimed that they had successfully ignored the flankers were used in the analyses. We used this criterion to increase the likelihood that any flanker effects that were observed were not because of directed recognition that was contrary to instructions.

Our use of the flanker paradigm to investigate spontaneous recognition is similar to B. A. Eriksen, Eriksen, and Hoffman's (1986) use of that paradigm to study memory search processes. They examined the effect of presenting a flanking letter on the time required to judge whether a test letter was a member of a memory set of up to 10 letters. When the response that would be dictated by a flanking letter was incongruent with that dictated by the test letter, decision time was slowed compared with the case in which the two letters dictated the same response. However, the slope of the memory-set size function was not influenced by the presentation of flanking letters. This pattern of results was interpreted in terms of a dual-process model of recognition similar to that proposed by Juola, Fischler, Wood, and Atkinson (1971). The effect of flanking letters was said to be produced by their familiarity, independent of memory search. Similarly, it was the familiarity of flanking words that we expected to be important for their spontaneous recognition (cf. Jacoby, 1991; Mandler, 1980).

One factor that might be expected to influence spontaneous recognition of a flanking word is the extent to which attention is focused on the test word. If attention is sufficiently focused, spontaneous recognition of a flanking word may not occur. In Experiment 1, we examined the effects of distribution of attention on spontaneous recognition. Other factors that might influence the familiarity of a flanking word and thereby be important for its spontaneous recognition are the number of prior presentations of the flanking word and the perceptual similarity between the earlier presentation of a word and its presentation as a flanker. Dual-process theories of recognition memory (e.g., Jacoby & Dallas, 1981; Mandler, 1980) have emphasized number of repetitions and perceptual similarity as determinants of familiarity. The importance of those factors for spontaneous recognition, as indexed by flanker effects, was examined in later experiments. To anticipate, our experiments produced some surprising results. The nature of those results led us to question whether recognition is ever truly spontaneous. In the General Discussion, we relate spontaneous recognition to automaticity and consider the relativity of automaticity (cf. Neumann, 1984).

Experiment 1

In our first experiment we examined the effects of dividing attention at test. The ability to selectively attend to items presented in a particular spatial location may rely on consciously controlled processing and thus may be reduced by requiring subjects to engage in a secondary task. Focus of attention has been described as analogous to a spotlight (Broadbent, 1982; LaBerge, 1983) or a zoom lens (C. W. Eriksen & Rohrbaugh, 1970; C. W. Eriksen & St. James, 1986). A common feature of those analogies is that the "breadth" of attention is treated as varying across situations. Items that are to be ignored are said to influence responding only if they appear within the portion of the visual field that is "illuminated" by attention. Research on tunnel vision also relates spatial selection to attention. Contraction of the functional visual field, tunnel vision, can occur to effectively prevent overloading of the visual system. Williams (1988) showed that the finding of tunnel vision depends on instructions meant to influence the distribution of attention. Tunnel vision was found when instructions stressed that subjects should concentrate on the foveal item of a display but not when instructions advised subjects to distribute attention across foveal and peripheral items.

Returning to the question of spontaneous recognition, we suggest that for an item to be spontaneously recognized, that item must appear within the field of attention. In Experiment 1, subjects in a divided-attention condition engaged in a listening task at the same time as they made recognition-memory judgments to visually presented target words surrounded by flankers. Subjects in a full-attention condition only made recognition-memory judgments. Requiring subjects to engage in a secondary task might prevent them from focusing their attention to a degree of precision sufficient for them to totally ignore flankers. That is, spatial selection might be reduced by dividing attention (cf. Yantis & Johnston, 1990). If focus of attention is important, one would expect larger flanker effects under conditions of divided attention than under conditions of full attention.

Method

Subjects

Subjects were 37 volunteers from an introductory psychology course at McMaster University who served in the experiment for course credit. Subjects were randomly assigned to each of two between-subjects conditions defined by a manipulation of attention at test (full vs. divided). Only data from 32 subjects were included in the analyses, 16 in each of the two attention conditions. Data from the other 5 subjects were excluded because of the failure of those subjects to meet one or both of the following criteria: At the conclusion of the experiment subjects were asked whether they had ignored the flankers. For the most part, subjects reported having successfully ignored the flankers. If, however, a subject reported having attended to the flankers on some trials, the subject was questioned about the absolute number of trials. If this number was greater than 5% of the trials, the subject was eliminated from data analysis. A second criterion was based on performance in the divided-attention condition. Data from subjects detecting fewer than 55% of the target sequences were discarded. The rationale here was that if performance did not meet that criterion, then the subject's attention was not truly divided.[1] Of the 5 subjects whose data were excluded, 2 were excluded because they did not ignore greater than 95% of the flankers, and the remaining 3 did not meet the criterion set for the divided-attention task.

Materials and Design

A pool of 360 five-letter nouns was selected from the medium- and low-frequency words scaled by Thorndike and Lorge (1944). These 360 words were used to form nine sets of 40 words each. Word sets were equated with regard to frequency in the language. A 200-word list presented in the study phase was constructed using five of those nine sets of words; words in one set served only as fillers. Of the other four sets, two sets served as old targets and two sets served as old flankers in the test phase. The remaining four sets of 40 words each (160 words) were used as new items in the test list; two sets served as new targets and two sets served as new flankers. The 160-item recognition-test list included 40 items representing each of the four experimental conditions: old targets, old flankers; old targets, new flankers; new targets, old flankers; and new targets, new flankers. Four formats were constructed by rotating sets of words through experimental conditions of old–new and target–flanker such that each set of words represented each combination of experimental conditions equally often.

When constructing test items, we made an effort to minimize the repetition between flanker and target of a letter in the same serial position. Special effort was made to minimize the occurrence of target and flanker words starting with the same first letter (occurrence less than 5%). The presentation order of the words for both study and test lists was random but with the restriction that not more than three items representing the same condition could be presented consecutively.

The listening task used in the divided-attention condition was one previously used by Craik (1982). For that task, subjects monitored a tape-recorded list of digits to detect target sequences of three odd numbers in a row (e.g., 3, 9, 7). The digits were random with the exception that a minimum of one and a maximum of five numbers occurred between the end of one and the beginning of the next target sequence. Digits were recorded at a 1.5-s rate. Forty-three sequences of odd numbers (target sequences) occurred within a list of 244 random numbers. If subjects completed one full cycle through the list of 244 numbers, the list was repeated without interruption.

Procedure

A Zenith monochrome green monitor interfaced with an Apple IIe computer was mounted near eye level and positioned approximately 55 cm from where subjects were seated. Words with a character size of 4 mm × 4 mm were presented in lowercase letters in the center of the screen. During the recognition test, three words were presented simultaneously. The middle word was the target, and the word presented above and below the target was the flanker. The total visual angle of the three-word display subtended approximately 1.45° vertically and 2.2° horizontally with a 0.2° angular separation between a flanker and the target.

Study phase. In this first phase, words were presented at a rate of 800-ms per word. Subjects were instructed to read each word aloud and to try and remember the words for a later test of recognition memory.

Recognition-test phase. In the recognition-test phase, subjects in the full-attention condition only made recognition judgments, whereas those in the divided-attention condition simultaneously engaged in the task of listening for series of three odd-number digits. The subjects in the divided-attention condition were told that it was very important not to miss a target sequence (three odd numbers in a row) and that they should make the recognition judgments somewhat automatically so as not to disrupt their performance of the listening task. For the listening task, subjects responded verbally, saying "now" to indicate their detection of a target sequence. The experimenter monitored the subjects' listening task performance and prompted them if they missed two or more sequences in a row.

For the test of recognition memory, all subjects were instructed to direct their attention to the middle word (target) and to ignore the flankers. They were told to judge whether target words were old and to make their judgments as quickly and as accurately as possible. Subjects made their recognition judgments by pressing a key on the right for old and a key on the left for new. Once a key was pressed the screen cleared for a 500-ms delay and then the next test item was presented. Each judgment and its latency were recorded by the computer. A computer program then computed the median decision times for each subject for each of the combinations of experimental conditions. Analyses were performed on these medians; means of medians are reported. Medians were used in the data analyses because the number of responses contributing to some of the experimental conditions was small; deviant scores could unduly affect mean scores.

For all experiments reported in this article, the significance level for all tests was set at $p < .05$ unless otherwise indicated. Main effects of variables that entered into significant higher order interactions are not reported. Tukey post hoc tests were used to assess the significance of differences between means.

Results and Discussion

Subjects in the divided-attention condition missed an average of 17 of 62 target sequences (27.4%) in the listening task.

[1] The majority of subjects who were excluded were discarded because of their performance on the divided-attention task. We acknowledge that this produces some ambiguity in the interpretation of the results. By imposing these task requirements we selected only those subjects who were able to adequately divide their attention between the two tasks. Such a selection process eliminates certain individual differences that may have been of interest. Perhaps subjects who were not able to perform the divided-attention task according to our standards were subjects who were attempting to use recollection to make the recognition judgments.

Accuracy Data

The accuracy scores (see Table 1) were analyzed as the probability of judging an item as old using a 2 (attention: full vs. divided) × 2 (target: old vs. new) × 2 (flanker: old vs. new) analysis of variance (ANOVA) with repeated measures on the last two factors. As would be expected, a main effect for target, $F(1, 30) = 336.2$, $MS_e = 0.02$, indicated that old targets had a higher probability of being identified as old (.66) than new targets (.21). In addition, an interaction between attention and target, $F(1, 30) = 4.7$, $MS_e = 0.02$, showed that subjects in the divided-attention condition were more likely to mistakenly identify a new target as old (.25) than were subjects in the full-attention condition (.17). Identification of old targets in the divided-attention condition (.64), however, did not differ from that in the full-attention condition (.67). The Target × Flanker interaction was not significant, $F < 1.0$.

Decision Time Data

Decision times were analyzed using a 2 (attention: full vs. divided) × 2 (target: old vs. new) × 2 (flanker: old vs. new) ANOVA with repeated measures on the last two factors. Analyses showed that subjects were faster to respond under conditions of full attention (940 ms) than under conditions of divided attention (1,543 ms), $F(1, 30) = 24.1$, $MS_e = 481{,}042$. More important, the three-way interaction between attention (full vs. divided), target, and flanker type was significant, $F(1, 30) = 6.9$, $MS_e = 42{,}520$. Flankers produced effects under conditions of divided attention but not when subjects fully directed their attention to the recognition-memory task (see Table 1). In the divided-attention condition, when old targets were surrounded by old flankers, decision times were considerably faster than when old targets were flanked by new words (1,396 ms vs. 1,565 ms). Conversely, when new targets were flanked by old words, decision times were slower than when they were flanked by new words (1,698 ms vs. 1,510 ms). Tukey post hoc tests revealed that both differences were significant. No significant effects of flankers were found in the full-attention condition.

Table 1
Accuracy Scores (Probability of Judging an Item as Old) and Decision Times (in Milliseconds) for Recognition Memory Judgments in Experiment 1

	Flanker type			
	Old		New	
Target type	Accuracy	Decision time	Accuracy	Decision time
	Full attention			
Old	.67	860	.67	869
New	.17	1,008	.17	1,025
	Divided attention			
Old	.65	1,396	.64	1,565
New	.26	1,698	.24	1,510

The processing of the flankers was not generally accompanied by awareness. After the experiment, subjects were asked if they had successfully ignored the flankers. Thirteen of the 16 subjects in the divided-attention condition reported that they had fully ignored the flankers. The remaining 3 subjects whose data were used indicated that for the most part they had ignored the flankers but that they did notice flankers accompanying approximately 5% of the test items. Thus, the influence of the flankers occurred without subjects' conscious intent or awareness, as measured by self-report.

Spontaneous recognition, as indexed by flanker effects, was found in the divided-attention condition but not in the full-attention condition. Presumably, engaging in a listening task while making recognition-memory judgments effectively expanded the field of attention within which stimuli were processed (cf. Broadbent, 1982; C. W. Eriksen & Rohrbaugh, 1970; Yantis & Johnston, 1990), with the result that the congruity of the flanker and target became important in the divided-attention condition. As well as any influence on the field of attention, dividing attention at test may also have influenced the basis used for recognition-memory decisions. Jacoby (1991) presented evidence to show that divided, compared with full, attention at the time of test makes subjects less able to use recollection and more reliant on familiarity as a basis for recognition-memory judgments. Recognition judgments based on familiarity may be more susceptible to flanker effects than are recognition judgments based on recollection. For example, the familiarity of the flanking word might be misattributed to the target word and thereby give rise to flanker effects when familiarity serves as a basis for recognition judgments. In contrast, such misattribution would be unimportant if recognition-memory decisions were based primarily on recollection, as is made possible when full attention is devoted to the recognition-memory test.

In the General Discussion, we further consider the relation between the "field-of-attention" and "bases-for-recognition" accounts of the reliance of flanker effects on the dividing of attention at test. In the experiments that are reported next we examined factors that were expected to influence the familiarity of words presented as flankers. A goal of Experiment 2 was to increase the familiarity of words presented as flankers so as to produce flanker effects under conditions of full, as well as divided, attention.

Experiments 2a and 2b

Dual-process theories of recognition memory (e.g., Jacoby & Dallas, 1981; Mandler, 1980) have emphasized the number of presentations of a word as a determinant of its familiarity. Furthermore, in a study using the flanker paradigm, Broadbent and Gathercole (1990) reported that the meaning of flanking words affected responses to targets only when words were frequently repeated and thus had become extremely familiar. Theories of automaticity typically hold that repeated exposure to a stimulus is required for its processing to become automatic (e.g., Logan, 1988; Shiffrin & Schneider, 1977). On the basis of results from those different lines of research, one might predict that the magnitude of flanker effects would be increased if the familiarity of words serving as flankers was increased by their repeated presentation. If flanking words were made very familiar by repetition during study, flanker effects might be found even under conditions of full attention at test. To examine this possibility, in Experiment 2 we varied the number of prior presentations of words that later served as flankers.

In Experiment 2, words that served as flankers were new, were presented once, or were presented five times during study. All old targets in the recognition test had been presented only once during study. Recognition was tested under conditions of either full or divided attention. Larger flanker effects were expected when flankers had earlier been presented five times than when they had been presented only once.

Method

Subjects

Fifty-nine students enrolled in a psychology course participated in the experiment for course credit. Subjects were randomly assigned to a full-attention or a divided-attention condition. Of the 59 subjects, 3 were dropped from data analysis because they reported attending to flankers, and 8 were dropped because of their poor performance on the listening task. This left 24 subjects in each of the two attention conditions.

Materials and Design

Two hundred forty words were selected from the pool of words used in Experiment 1 (five-letter nouns of low and medium frequency). These 240 words were divided into 12 sets of 20 words. Word sets were equated with regard to frequency in the language. A 300-word study list was constructed with 7 of the 12 sets of words. Of those seven sets, words in three sets served as targets for the later test of recognition memory and words in four sets served as flankers. For words that later served as flankers, two sets were presented five times and two sets were presented once in the study list. For words later serving as targets, all three sets of words were presented only once at study. The remaining five sets of 20 words each (100 words) were used as new words in the recognition-test list; three sets were used as targets and two sets as flankers. The 120-trial recognition test included 20 trials representing each of the six experimental conditions: old target, five-times-presented flanker; old target, once-presented flanker; old target, new flanker; new target, five-times-presented flanker; new target, once-presented flanker; and new target, new flanker. Other details of materials and list construction were the same as in Experiment 1.

Procedure

The apparatus and procedure for this experiment were the same as those in Experiment 1. In Phase 1, subjects were instructed to read words aloud that were presented on the computer screen and to try and remember the words for a later test of recognition memory. The recognition test was given under conditions of either full or divided attention. For that test, subjects were to decide if the target of a three-word display had been presented in the earlier study list. Subjects were told to ignore the flankers and to direct their attention only to the targets.

Results and Discussion

In the divided-attention condition, subjects missed an average of 9 of 59 target sequences (17%).

Accuracy Data

An analysis of accuracy scores (see Table 2) as the probability of judging an item as old showed that old targets were more likely to be called old than were new targets, $F(1, 46) = 486.4$, $MS_e = 0.03$. The interaction of attention and target, $F(1, 46) = 7.08$, $MS_e = 0.01$, was significant. This interaction reflects the fact that subjects in the divided-attention condition were poorer at identifying old targets as old and were more likely to call a new target old (.58 vs. .18) than were subjects whose attention was fully directed to the recognition test (.64 vs. .13). No other effects were significant.

Decision Time Data

The decision times shown in Table 2 were analyzed using a 2 (attention: full vs. divided) × 2 (target: old vs. new) × 3 (flanker: presented five times vs. presented once vs. new) ANOVA with repeated measures on the last two factors. Consistent with the findings of Experiment 1, flankers produced effects under conditions of divided attention but not when subjects fully directed their attention to the recognition-memory task. This three-way interaction approached significance, $F(2, 92) = 2.98$, $MS_e = 208{,}250$, $p = .054$. Because

Table 2
Accuracy Scores (Probability of Judging an Item as Old) and Decision Times (in Milliseconds) for Recognition Memory Judgments in Experiment 2

	Flanker type					
	Presented five times		Presented once		New	
Target type	Accuracy	Decision time	Accuracy	Decision time	Accuracy	Decision time
			Full attention			
Old	.65	908	.61	953	.65	897
New	.15	1,048	.12	1,091	.13	1,030
			Divided attention			
Old	.59	1,936	.59	1,741	.55	2,157
New	.18	2,026	.19	2,257	.17	2,037

there were no flanker effects in the full-attention condition, the subsequent analyses examine results from the divided-attention condition only.

Contrary to our predictions, increasing the familiarity of a flanking word did not produce flanker effects under conditions of full attention. Rather, the decision times for targets surrounded by five-times-presented flankers were similar to those found when the targets were surrounded by new flankers. Surprisingly, the flankers that were presented only once in the study phase produced the most dramatic results. An old target that was flanked by a once-presented word produced a faster decision time (1,741 ms) than an old target flanked by a five-times-presented word (1,936 ms) or flanked by a new word (2,157 ms). Conversely, new targets were responded to more slowly when flanked by a word that had been presented once at study (2,257 ms) compared with five-times-presented flankers (2,026 ms) or new flankers (2,037 ms). Tukey post hoc tests showed that the difference between old targets flanked by once-presented words and old targets flanked by new words was significant. None of the other differences was significant.

We found this pattern of results sufficiently surprising to justify doing another experiment to see if the results could be replicated. In Experiment 2b, we further examined the effects of repeating words that served as flankers. Two changes were made from Experiment 2. First, flankers were new, were presented once, or were presented four times at study (rather than five times). As before, all old targets in the recognition-memory test were words that had been seen once at study. The second change involved the visual display. A finding in the parafoveal selective-attention literature is that higher contrast displays yield positive effects, whereas low-contrast displays may fail to produce effects (Underwood, 1986). In order to present stimuli that were of a higher contrast (white on black background) than that seen on the monochrome monitor (green on black background), we used a Zenith computer system interfaced with a Zenith virtual graphics adaptor (VGA) monitor.

The results of Experiment 2b are shown in Table 3. The accuracy scores revealed that old targets were more likely to be judged as old than were new targets (.51 vs. .13), $F(1, 46) = 10.3$, $MS_e = 0.01$. More important, as found previously, analysis of the decision times revealed a significant three-way interaction of attention, target, and flanker type, $F(2, 92) = 4.2$, $MS_e = 211{,}772$; the interaction of target and flanker was found in the divided-attention condition but not in the full-attention condition. In the divided-attention condition, old targets flanked by once-presented words were responded to faster (1,391 ms) than were old targets flanked by either four-times-presented words or new words (1,775 ms and 1,712 ms, respectively). Conversely, new targets flanked by once-presented words were responded to more slowly (1,803 ms) than were new targets flanked by either four-times-presented words or new words (1,624 ms and 1,469 ms, respectively).

These results replicate those of Experiment 2. Surprisingly, increasing the number of presentations of an item does not increase the likelihood of its later being spontaneously recognized. Flankers that had the most influence on directed-recognition judgments were not those that had been seen more frequently at study but were those that had been presented once. Such findings contrast with Broadbent and Gathercole's (1990) finding that words have to be from a familiar set in order for flanker effects to emerge. However, differences in methodology between the two experiments may account for the discrepancy. Despite these methodological differences, it is important to note that a single prior processing episode was sufficient to result in spontaneous influences of memory. That a word that had been made more familiar by repetition did not produce flanker effects leads us to reconsider the possible factors responsible for spontaneous recognition.

One factor that is eliminated, however, concerns the possibility that flanker effects arose because subjects were more likely to fixate on a flanker in the divided-attention condition than in the full-attention condition. Yet if this had been the case, then flankers that had multiple presentations at study should have shown flanker effects. As mentioned, no flanker effects were evidenced for these sets of flankers. This finding makes it highly unlikely that the flanker effects observed here were due to a less stable fixation pattern during the divided-attention condition than in the full-attention condition.

The finding that incongruent flankers led to slowed decision times compared with congruent flankers is similar to results from B. A. Eriksen et al.'s (1986) memory search experiments. They interpreted their results in terms of response priming by the familiarity of the flanking letters. The frequency and recency of a particular stimulus were said to

Table 3
Accuracy Scores (Probability of Judging an Item as Old) and Decision Times (in Milliseconds) for Recognition Memory Judgments in Experiment 2b

	Flanker type					
	Presented four times		Presented once		New	
Target type	Accuracy	Decision time	Accuracy	Decision time	Accuracy	Decision time
			Full attention			
Old	.53	917	.55	967	.50	968
New	.12	1,040	.14	989	.12	1,005
			Divided attention			
Old	.51	1,775	.48	1,391	.50	1,712
New	.14	1,624	.14	1,803	.12	1,469

set the familiarity value of the flanking items; the greater the frequency, the higher the familiarity value. In turn, the "stronger" the familiarity value, the more likely that the flanking item contributed to flanker effects. According to our findings, however, the absolute familiarity of flankers was not the critical factor. Rather, the relationship between the target and the flanker may be what is critical for spontaneous influences of memory. Indeed, the pattern of the results can be interpreted as showing that automatic influences of memory in the form of flanker effects are largest when the processing history of the flanker is the same as that of old target words. According to this interpretation, spontaneous recognition of flankers would result only under conditions where the flankers possess the same processing history as old targets.

Although it is not the primary purpose of this research, the results also address the question of whether the latency differences found for the congruent and incongruent flanker conditions can be attributed to response priming or to recognition processes. If the locus of the effect is at the response selection stage, then flankers that produce a response contrary to targets should show longer response times than flankers that are congruent with the response for target words, regardless of the number of prior presentations. However, the number of prior presentations at study was a determinant of the observed flanker effects. That flanker effects are not fully accountable by response-button selection suggests that recognition processing is a critical factor in the latency differences.

An alternative explanation for the effects seen in Experiments 2 and 2b could be proposed on the basis of Johnston et al.'s (1990) findings of a novel pop-out effect. Their results showed that a novel item in a field of familiar items enhances localization of that item and can inhibit localization of familiar items. With respect to our experimental conditions, this would suggest that our effects resulted as a function of the novel target's (once-presented item) inhibiting processing of the familiar flankers (repeated items). However, we propose that the effect is due to the relative similarity of processing between the flankers and the target and not to the novel pop-out effect. A prediction made by our relativistic account is that if all the targets had been study items presented four times, then four-times-presented flankers would have produced the larger effects. In the next experiment we tested this prediction by using words that had been presented four times at study as old targets in the recognition-memory test.

Experiment 3

In this experiment, all old targets were words that had been presented four times in the study list. Flankers were words that had been presented once, four times, or not at all (new). On the basis of the "relativity" hypothesis, we expected flankers that had been presented four times in the study list to produce larger effects than flankers that had been presented only once. In comparison, however, the results would be expected to show a different pattern on the basis of Johnston et al.'s (1990) novel pop-out effect. By that account, an old target surrounded by a once-presented flanker would be expected to show the largest flanker effects because the relatively novel flankers would "capture" attention and slow decision times for the recognition judgments.

Method

Subjects

Thirty-one psychology students performed the experiment for course credit. The data from 24 of these subjects were used in the analysis; subjects not included in the data analysis (7) did not meet the criterion set for the divided-attention task.

Materials and Design

The materials and design were the same as in Experiment 2b with the following exceptions: The sets of words used as old targets were presented four times at study rather than once, and the cell size for each of the experimental conditions was reduced to 15. These changes resulted in a study list of 390 words and a 90-trial recognition-test list. Targets were words that had been presented four times at study, and flankers were words that had been presented four times, words that had been presented once, or new words.

Procedure

In all of the previous experiments we used a between-subjects manipulation of attention; half of the subjects performed the recognition test while engaged in a listening task, and the other half performed the recognition test under conditions of full attention. Across all experiments, subjects in the full-attention condition did not show a flanker effect. In this experiment, we began by testing a group of subjects in the full-attention condition, but after we tested 12 subjects it became apparent that, once again, subjects were not affected by flankers in that condition. The consistent failure to obtain flanker effects in the full-attention condition and the similar results produced at the start of this experiment led us to drop the full-attention condition in Experiment 3 and the remaining experiments to be reported. Data are reported only for subjects in a divided-attention condition.

Results and Discussion

Subjects missed an average of 8.6 of 31.8 sequences (27%).

Accuracy Data

Analysis of accuracy scores as the probability of judging an item as old showed that subjects judged old targets as old with a higher probability than they judged new targets as old (.82 vs. .15), $F(1, 138) = 16.2$, $MS_e = 0.02$. No other effects were significant.

Decision Time Data

Analysis of decision times, using a 2 (target: old vs. new) $\times$ 3 (flanker: presented four times vs. presented once vs. new) ANOVA with repeated measures on the last two factors, revealed a main effect for target, $F(1, 23) = 11.0$, $MS_e =$

394,823. Old targets were responded to faster than new targets. Analyses showed no other significant effects.

Flanker effects were not found even under conditions of divided attention when targets had been presented four times for study. This absence of flanker effects may reflect the greater ease of recognizing words that have been repeated. Results from a cross-experiment analysis did show that repetition enhanced recognition. In that analysis, accuracy scores (only those from the divided-attention condition in Experiment 2b) were analyzed in terms of the probability of judging an item as old using a 2 (Experiment: 3 vs. 4) $\times$ 2 (target: old vs. new) $\times$ 3 (flanker: presented four times vs. presented once vs. new) ANOVA with repeated measures on the last two factors. Subjects in Experiment 4 were more accurate in their judgments of identifying an item as old (.82) than were subjects in Experiment 3 (.50). This difference was supported by an Experiment $\times$ Target interaction, $F(1, 46) = 81.2$, $MS_e = 0.02$.

That increased exposure to an item affects recognition accuracy is well documented. This is evidenced by the robustness of repetition effects on recognition-memory tests (Feustal, Shiffrin, & Salasoo, 1983; Jacoby & Dallas, 1981; Ste-Marie & Lee, 1991). With this in mind, obtaining a null effect does not make the relativity hypothesis implausible. Instead, it may be more prudent to say that targets that are made easy to recognize by their repetition are less likely to be susceptible to the influences of spontaneous recognition. The null effect, however, does undermine the alternative explanation offered by the novel pop-out effect—that novel items inhibited the localization of familiar flankers. By that account, slower response times were expected to occur for a display that had a familiar target (i.e., presented four times) surrounded by novel stimuli. However, flanker effects were not found under such conditions.

Although the results leave the relativity-of-automaticity hypothesis untested, they do further our understanding of the conditions that encourage spontaneous recognition. At this stage, spontaneous influences of memory appear to affect responses to targets when a person's ability to focus his or her attention on the target is decreased (e.g., by performing a secondary task). As well, it seems that if target words are easily identified as old, flanking words lose their effectiveness.

Experiments 4a and 4b

Indirect measures of memory are very sensitive to changes in perceptual characteristics from study to test. For example, perceptual identification experiments have shown that earlier reading of a word enhances its later visual perceptual identification to a substantially larger degree than does earlier hearing of a word (e.g., Jacoby & Dallas, 1981). Findings such as these have led researchers to argue that indirect tests are mediated by modality-specific representations (e.g., Kirsner & Dunn, 1985). Emphasis on perceptual characteristics is also central to the systems view of memory. Tulving and Schacter's (1990) perceptual representation system, for example, is described as reflecting only the perceptual characteristics of an event. On the basis of such arguments, the effects of a flanker would be expected to be specific to the modality in which the flanking word was previously presented.

In Experiments 4a and 4b we varied the modality of prior presentation of words that served as flankers. Words were presented for study by means of both the auditory and visual modalities. After presentation of the study list, subjects made recognition judgments on targets. Essentially, the two experiments differed only in which items were used as old targets. In Experiment 4a, old targets were words that had been heard at study, whereas in Experiment 4b old targets were words that had been read. During the recognition test, all flankers were presented visually and were defined with reference to the processing experienced at study. Thus, flankers were words that had been heard at study (heard flankers; but they were presented visually at test), words that had been read at study (read flankers), or new words. For both experiments, a view that emphasized modality specificity would predict larger flanker effects when flankers had been read earlier at study. However, the relativity-of-automaticity hypothesis proposed earlier suggests that the processing history of the old targets may set the context for those words that will be effective as flankers. If the relationship between old targets and flankers is crucial, then larger effects would be expected for the heard flankers in Experiment 4a and for the read flankers in Experiment 4b.

Method

Subjects

Thirty-four subjects participated in each of the two experiments in return for course credit in an introductory psychology course. In Experiment 4a, 8 subjects performed the listening task below criterion and 2 reported attending to the flankers. In Experiment 4b, 7 subjects performed the listening task below criterion and 3 subjects reported attending to flankers. Discarding data from those subjects, we included 24 subjects in the statistical analysis for each of the experiments.

Materials and Design

An additional 95 five-letter nouns were combined with the original pool of words used in Experiment 1 to create a pool of 455 medium- and low-frequency words, as scaled by Thorndike and Lorge (1944). The materials and design were similar to those of the previous experiments with the following exceptions: First, words at study were presented visually and aurally. For the recognition test, all words were presented visually. In addition, the cell size for each of the experimental test conditions was increased to 35. For both experiments, this resulted in a study list consisting of 280 words. Of these 280 words, 35 fillers were presented. In Experiment 4a fillers were presented visually (to be read), and in Experiment 4b fillers were presented aurally (to be heard). This served to more equally balance the proportion of the stimuli that were heard and read in each of the two experiments. Despite this constraint, there were a higher proportion of heard words in Experiment 4a and, conversely, a higher proportion of read words in Experiment 4b. However, this 25% difference was not expected to have created a bias in the way in which stimuli were encoded at study.

A recognition test of 210 trials was given after presentation of the study list. In Experiment 4a, the recognition test included 35 trials from the following six experimental conditions: heard target, heard flanker; heard target, read flanker; heard target, new flanker; new target, heard flanker; new target, read flanker; and new target, new flanker. Similarly, Experiment 4b included the 35 trials of the following experimental conditions: read target, heard flanker; read target, read flanker; read target, new flanker; new target, heard flanker; new target, read flanker; and new target, new flanker.

Procedure

The procedure for these experiments was the same as that of the previous experiments with the exception of the presentation of the study list. In the study phase, a word or series of dashes appeared on the screen in a random order. If a word appeared, the subject read it silently to himself or herself. If a series of dashes appeared, the experimenter, who was sitting beside the subject, read the word aloud to the subject (heard words). A tone sounded before each presentation of a word to be read aloud by the experimenter. This tone served to alert both the subject and the experimenter that the upcoming word was one to be heard. Words were presented at an 800-ms rate.

For the recognition test, all words were presented visually, and flankers were defined with reference to their processing history; heard flankers had been presented aurally, read flankers had been presented visually, and new flankers had not been seen. The key difference between the experiments was the processing history of the old targets. In Experiment 4a old targets were words that had been heard at study, whereas in Experiment 4b old targets were words that had been read at study. Subjects were tested only in the divided-attention condition during the recognition task. At the end of a testing session, subjects were asked whether they noticed the homogeneity of the old target words. This question was included to determine whether subjects were aware of this factor in the design of the experiments.

Results and Discussion

In Experiment 4a, subjects missed an average of 21.4 of 81.3 target sequences (26.3%) in the listening task. In Experiment 4b, subjects missed an average of 22.4 of 76.4 target sequences (29.3%).

Accuracy Data

In both experiments, an analysis of accuracy scores (see Tables 4 and 5) as the probability of judging an item as old revealed a main effect for targets: $F(1, 23) = 79.7$, $MS_e = 0.02$ for Experiment 4a, and $F(1, 23) = 131.8$, $MS_e = 0.01$ for Experiment 4b. Old targets were judged as old with a higher probability (.50 in Experiment 4a; .51 in Experiment 4b) than were new targets (.32 in Experiment 4a; .30 in Experiment 4b). No other effects were significant.

Decision Time Data

Decision times were analyzed using a 2 (target: old vs. new) × 3 (flanker: read vs. heard vs. new) ANOVA with repeated measures on both factors. The finding of main concern is the significant interaction of target and flanker for both experiments (see Tables 4 and 5). In Experiment 4a, old heard targets surrounded by heard flankers were responded to faster (1,585 ms) than were old heard targets surrounded by read flankers (1,867 ms) or new flankers (2,029 ms), $F(2, 46) = 5.1$, $MS_e = 159{,}569$. Conversely, new targets flanked by heard items showed slower decision times (2,265 ms) than new targets flanked by read items (2,166 ms) or new items (2,212 ms). Tukey post hoc tests showed that a heard target surrounded by heard flankers was significantly different from a heard target surrounded by read or new flankers. The two latter conditions were not significantly different from each other.

In Experiment 4b, when old targets were those that had been read at study, results showed faster decision times for old targets flanked by words that had been read at study (1,486 ms) than for old targets with flankers that had been heard at study (1,851 ms) or that were new (1,846 ms), $F(2, 46) = 5.9$, $MS_e = 251{,}002$. In addition, slower times were observed for new targets surrounded by read flankers (1,951 ms) than for new targets surrounded by heard flankers (1,788 ms) or new flankers (1,643 ms). Tukey post hoc tests showed that the condition in which old targets were flanked by previously read words was significantly different from both the heard and new flanker conditions, which in turn, were not significantly different from each other. No other means were significantly different from each other.

A curious finding in Experiment 4a was that decision times for new targets surrounded by new flankers (congruent condition) were longer than decision times in the condition in which heard targets were surrounded by new flankers (incongruent condition). In all other experiments reported here that showed flanker effects, decision times were faster in the congruent condition than in the incongruent condition. However, in those experiments, old targets were always words that had been read at study. Perhaps the difference, then, is related to the lack of physical similarity between the old

Table 4
Accuracy Scores (Probability of Judging an Item as Old) and Decision Times (in Milliseconds) for Recognition Memory Judgments in Experiment 4a

	Flanker type					
	Heard		Read		New	
Target type	Accuracy	Decision time	Accuracy	Decision time	Accuracy	Decision time
Heard	.51	1,585	.52	1,867	.48	2,029
New	.30	2,265	.33	2,166	.32	2,212

Note. Data are for divided attention only.

Table 5
Accuracy Scores (Probability of Judging an Item as Old) and Decision Times (in Milliseconds) for Recognition Memory Judgments in Experiment 4b

	Flanker type					
	Heard		Read		New	
Target type	Accuracy	Decision time	Accuracy	Decision time	Accuracy	Decision time
Read	.52	1,851	.51	1,486	.48	1,846
New	.30	1,788	.30	1,951	.29	1,643

Note. Data are for divided attention only.

targets at study and test. Benefits of perceptual fluency, normally found for items that match in perceptual characteristics between study and test, were not available, and subjects' discrimination between old and new targets may have been more difficult and thereby caused longer decision times for new targets than were previously attained in the other experiments. Indeed, a main effect for target, $F(1, 23) = 22.7$, $MS_e = 237{,}287$, was evident in Experiment 4a but not in Experiment 4b, $F < 1.0$. This artifact may have contributed to this otherwise anomalous finding. Nonetheless, decision times for new targets that were surrounded by words that had been heard earlier were slower than decision times for new targets that were surrounded by new flankers.

The combined results of Experiments 4a and 4b provide strong support for the relativity hypothesis. The effectiveness of flanking words was dependent on their relationship to the processing history of the old targets. Flankers with the same processing history (i.e., heard target, heard flanker; read target, read flanker) were spontaneously recognized, whereas those with a different history were successfully ignored. Spontaneous recognition, then, is not a function of the flanking stimulus alone; the automatic influences of memory were automatic only in the context set by the intentional processes required for the recognition-memory task.

General Discussion

Under what conditions does spontaneous recognition memory occur? In an attempt to answer that question, we examined flanker effects in recognition-memory performance. Our reasoning was that spontaneous recognition of a flanking word would be reflected by the influence that word had on recognition of a target word. Flanker effects were observed, but only under a very restricted set of circumstances. When attention was divided at test, recognition decisions were made more rapidly when flanker and target words were congruent, rather than incongruent, with regard to the response they would dictate. Such flanker effects were not observed when subjects devoted full attention to the test of recognition memory.

Even under conditions of divided attention, flanker effects were not observed when recognition of the target word was made easy by increasing its number of prior presentations. Furthermore, factors that would be expected to influence spontaneous recognition of flankers—repetition and physical similarity between flankers at study and test—were found to have little effect on their own. Increasing the number of presentations of a word decreased its later effectiveness as a flanker when old target words had been presented only once during study. Rather than the form of modality-specific transfer that was expected from the results of experiments that used indirect tests, flanker effects were largest when words serving as flankers had been presented in the same modality as old target words. In combination, these results show that it is the relation between the processing history of the target and flanking words, rather than the absolute history of the flanking word, that determines whether flanking effects will be observed.

Why was it necessary to divide subjects' attention at test to observe flanker effects? Two possibilities exist that may account for this finding and, because we cannot currently select between the two, both are discussed. First, it may be that dividing attention has its effects by reducing subjects' ability to focus their processing on the spatial location of the target word. The notion is that breadth of attention is greater under conditions of divided, compared with full, attention (cf. Yantis & Johnston, 1990). By this *selective processing* view, the encoding of spatial location and spatial relationships is computed at a very early stage, and later "semantic" processing is restricted to words presented in the selected location. An implication is that words presented as flankers are more fully processed when attention is divided, which makes spatial selection less precise, than when full attention is devoted to the recognition-memory test.

An alternative account of the reliance of flanker effects on dividing attention implicates the effects of dividing attention on the basis used for recognition-memory judgments. Jacoby (1991) presented words in two temporally separate lists and later required subjects to selectively respond to items in one list. When attention was divided at test, subjects were less able to localize events in time to make an accurate recognition-memory judgment. Jacoby argued that dividing attention made subjects less able to engage in conscious recollection and, consequently, made them rely more heavily on the use of familiarity as a basis for recognition-memory judgments. That change in the basis for recognition-memory judgments is likely to be important for explaining the dependence of flanker effects on dividing attention at test. Only recognition-memory decisions based on familiarity may be open to flanker effects.

This alternative to the selective processing view can be described in terms of Allport's (1989) *selective cuing* account of performance in perception experiments such as the flanker paradigm. Selective cuing is the process by which task-relevant information is specified for control of a particular response. In contrast to the selective processing view, Allport held that semantic content of a stimulus is computed early and that spatial selection can follow at a later stage of processing. Presumably, spatial selection could sometimes be assisted by the use of semantic content. This would most likely occur in a situation where spatial selectivity was made poor and the semantic content of the stimulus was correlated with its spatial location. Perhaps dividing attention makes people more reliant on the use of attributes of an item that are correlated with its location as a basis for spatial selection. In our experiments, old targets were always of a specific set identified by their presentation in the study list (i.e., once-presented items or heard items). In this sense, the spatial location of target items was correlated with that attribute that identified them as old.

Allport's selective cuing view can be used to highlight the similarity between "perception" experiments and "memory" experiments. In that vein, we think it is important to note that effects of dividing attention in the flanker experiments are paralleled by effects in memory experiments. That is, dividing attention reduces the ability to localize an event in time (e.g., Jacoby, 1991) as well as in space. The source of this reduction can be related to analytic versus nonanalytic processing (cf. Jacoby & Brooks, 1984). In memory experiments, dividing attention induces people to adopt a nonanalytic approach for making recognition judgments. Subjects will rely on feelings of familiarity rather than conscious recollection. Similarly, dividing subjects' attention when they are attempting to localize an item may lead them to use a nonanalytic strategy—that of relying on correlated attributes.

If it is to be argued that flanker effects are unique to the use of familiarity as a basis for recognition, the factors that are important for familiarity are different from those held in most theoretical accounts. The familiarity of an item is generally described as reflecting its number of prior presentations and the match in its perceptual characteristics between study and test (e.g., Mandler, 1980). In contrast, to explain flanker effects, it must be argued that the familiarity of an item depends on the similarity of its characteristics to those of target words. It seems that the recognition of target words results in the adoption of an "unconscious set" that determines the type of distractor items that will influence responding. We refer to the set as unconscious because subjects generally claimed to be unaware of the flankers. Also, when asked, none of the subjects claimed to have noticed the homogeneity of old target words (e.g., that they were all words that had earlier been read) although that homogeneity created the set for the particular class of items.

The results that lead us to propose the operation of an unconscious set are similar to ones observed in investigations of release from proactive interference in short-term memory. Subjects' awareness of a change in a dimension of words that are to be remembered is not required for the change to produce release from proactive interference (Turvey, 1974; Wickens, 1970, 1972). In the case of release from proactive interference, attributes of words that are correlated with their occurrence in time are used to aid temporal selection in restricting responding. Similarly, in the flanker paradigm, correlated attributes are used to aid spatial selection in restricting the information used as a basis for recognition-memory judgments. Arguably, dividing attention at test interferes with the computing of spatial location and thereby makes subjects more reliant on the use of correlated attributes.

The redescription of familiarity as reflecting the similarity between distractors and targets is in line with recent changes in theorizing about automaticity. Indeed, the results of our flanker-effect experiments can be interpreted as providing evidence of the relativity of automatic influences of memory. That task context is influential for producing flanker effects seriously challenges notions that automatic processing is driven entirely by external stimuli (e.g., LaBerge & Samuels, 1974; Posner & Snyder, 1975; Schneider & Shiffrin, 1977). Others have also criticized the notion that automaticity reflects stimulus-driven processing (Isen & Diamond, 1989; Logan, 1989; Neumann, 1984). For example, Neumann (1984) argued that automatic processes are dependent on a person's current intentions and direction of attention.

One piece of evidence used by Neumann to support his arguments was a finding by Keren, O'Hara, and Skelton (1977). Keren et al. (1977) used Posner and Mitchell's (1967) letter-matching task combined with the flanker paradigm to investigate the level of processing to which distractors were processed. The results revealed that the ability of distractors to disrupt performance depended on their relationship with the targets in terms of the required letter-matching task (i.e., physical, name identity, or category match). That is, the level of processing of distractors was dictated by the processing required of targets. The results of our experiments join those of Keren et al. in showing the relativity of automatic processing. Both automatic processes and familiarity are best seen as context dependent and thus as changing across tasks and situations.

To return to the issue of spontaneous recognition, our results lead us to question whether recognition is ever truly spontaneous. Recognition may never be spontaneous in the sense of being fully divorced from intention or from the activity in which a person is engaged.

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