SPONTANEOUS VS DIRECTED RECOGNITION:
THE RELATIVITY OF AUTOMATICITY

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Abstract

Eight experiments are reported that examined the contrast between spontaneous and directed recognition using the flanker paradigm. The rationale was that spontaneous recognition of a flanking word would be reflected by the influence that word had on recognition of a target word. Spontaneous recognition, as indexed by flanker effects, was found but only under a restricted set of conditions. When attention was divided at test, recognition decisions for target words were faster when the flanker and target word were congruent (old flanker, old target word; new flanker, new target word) rather than incongruent (new flanker, old target word; old flanker, new target word) with regard to the decision they dictated (Exps. 1, 2, 4, 7, 8a, 8b). However, if old targets were easily identified as old, flanker effects did not emerge, even when attention was divided (Exps. 5 and 6). Surprisingly, increasing the number of prior presentations before a word served as a flanker <u>decreased</u> its likelihood to produce effects when old targets were words that had been presented once at study (Exps. 2 and 4). Words that had been presented to be solved as anagrams at study were effective as flankers, despite their change in physical characteristics from study to test (Exp. 7). Further, rather than the form of modality-specific transfer, flankers were more effective if they matched the modality in which old targets had been presented at study (Exps. 8a and 8b). In combination, the 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 flanker effects will be observed. These findings are discussed in terms of the relativity of automaticity (cf., Neumann, 1984).

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Introduction

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 and without any act of will; that is, they are reproduced involuntarily. This contrast, drawn by Ebbinghaus (1885/1964, pgs 1-2), is one that will be referred 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 past. However, outside the laboratory, spontaneous remembering seems as common and, sometimes, more important than is 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 may be more automatic than is 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., Posner & Snyder, 1975; Shiffrin & Schneider, 1977; Hasher & Zacks, 1979; Jacoby, 1991). 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 (c.f. 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, in press). To measure spontaneous recognition, recognition of an item as old must influence performance on the indirect test of memory.

A measure of distraction was used as an indirect test of spontaneous recognition. The notion is that spontaneous recognition of an item that people are told to ignore will disrupt performance of an ongoing task and, so, disruption can be used as an index of spontaneous recognition. The experimental arrangement used is very similar to the flanker paradigm introduced by Eriksen and Eriksen (1974; see also Shaffer & LaBerge, 1979) to examine the processing of unattended items. In the first phase of each of the 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. Subjects 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, recognition decisions for test words should 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.

The 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 these experiments, subjects were instructed to ignore the flankers and, consequently, might remain unaware of their influences. Indeed, only data from subjects who claimed that they had successfully ignored the flankers were used in the analyses. This criterion was employed to increase the likelihood that any flanker effects that were observed were not because of directed recognition that was contrary to instructions.

Using the flanker paradigm to investigate spontaneous recognition is similar to 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 as compared to 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 is the familiarity of flanking words that is 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, the effects of distribution of attention on spontaneous recognition was examined. 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, were examined in later experiments. To anticipate, the experiments produced some surprising results. The nature of those results leads one to question whether recognition is ever truly spontaneous. In the General Discussion, spontaneous recognition is related to automaticity, more specifically, with reference to the relativity of automaticity (cf.,Neumann,1984).

Experiment 1

The first experiment 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, so, 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 (Eriksen & Rohrbaugh, 1970; 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, the suggestion is 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 making 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 their focusing of attention to a degree of precision that is sufficient for flankers to be totally ignored. 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 as compared to 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 2 between-subject conditions defined by a manipulation of attention at test (full versus divided). Only data from 32 subjects were included in the analyses; 16 in each of the two attention conditions. Exclusion of data from the other 5 subjects was 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 absolute number of trials was questioned. 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 less 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 9 sets of 40 words each. Word sets were equated with regard to frequency in the language of words in those sets. A 200-word list presented in the study phase was constructed using 5 of those sets of words; words in one set served only as fillers. Of the other 4 sets, 2 sets served as old targets and 2 sets served as old flankers in the test phase. The remaining 4 sets of 40 words each (160 words) were used as new items in the test list; 2 sets served as new targets and 2 sets served as new flankers. The 160-item recognition test list included 40 items representing each of the 4 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, an effort was made 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 with the restrictions that not more than 3 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 3 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.

<u>Procedure</u>

A Zenith monochrome green monitor interfaced with an Apple IIe computer was mounted at near eye level and positioned approximately 55 cm from where subjects were seated. Words with a character size of 4 mm x 4 mm were presented in lower case 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 .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 (3 odd numbers in a row) and that they should make the recognition judgements 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 subject's 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, making 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 the medians of correct responses; means of medians will be reported.

For all experiments reported in this paper, the significance levels for all tests was set at $p < .05$, unless otherwise indicated. Main effects of variables that entered into significant higher-order interactions will not be 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 out of 62 target sequences (27.4%) in the listening task.

Accuracy Data

The accuracy scores (see Table 1) were analyzed as the probability of judging an item as old using a 2 (attention: full, divided) x 2 (target: old, new) x 2 (flanker: old, new) ANOVA with repeated measures on the last two factors. As would be expected, a main effect for target, F (1, 30) = 336.2, MSe = .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, MSe = .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 of the full attention condition (.67). The target x flanker interaction was not significant, F < 1.0.

Decision Time Data

Decision times were analyzed using a 2 (attention: full, divided) x 2 (target: old, new) x 2 (flanker: old, 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 (1543 ms), F (1, 30) = 24.1, MSe = 481042.4. More important, the three way interaction between attention (full vs divided), target and flanker type was significant, F (1,30) = 6.9, MSe = 42519.7. 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 (1397 ms vs 1566 ms). Conversely, when new targets were flanked by old words, decision times were slower than when they were flanked by new words (1698 ms vs 1510 ms). Tukey post hoc tests revealed that both differences were significant. No significant effects of flankers were found in the full attention condition.

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Insert Table 1 about here

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The processing of the flankers was not generally accompanied by awareness. Following 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 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 (c.f., Broadbent, 1982; 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 have also influenced the basis used for recognition-memory decisions. Jacoby (1991) has presented evidence to show that divided, as compared to 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 primarily based on recollection, as is made possible when full attention is devoted to the recognition-memory test.

In the General Discussion, 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 are considered further. The experiments that are to be reported next 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.

Experiment 2

Dual-process theories of recognition memory (eg. 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 & Gathercole (1990) reported that the meaning of flanking words affected decisions to targets only when words were frequently repeated and, thus, became extremely familiar. Theories of automaticity typically hold that repeated exposure to a stimulus is required for its processing to become automatic (eg., Logan, 1988; Shiffrin & Schneider, 1977). Based on 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 their repetition during study, flanker effects might even be found under conditions of full attention at test. To examine this possibility, the number of prior presentation of words that later served as flankers was varied in Experiment 2.

In Exp. 2, words that served as flankers were new, presented once or presented 5 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 5 times rather than only once.

Method

Subjects

Fifty-nine students enroled in a psychology course participated in the experiment for course credit. Subjects were randomly assigned to a full attention or divided attention condition. Of the 59 subjects, 3 were dropped from data analysis because they reported attending to flankers and 8 were dropped due to their performance in the listening task. Consequently, data analysis included 24 subjects that were tested under conditions of full attention and 24 in the divided attention condition.

<u>Materials and Design</u>

Two hundred and forty words were selected from the pool of words used in Experiment 1. These 240 words were divided evenly into 12 sets of 20 words. Word sets were equated with regard to frequency in the language of words. A 300-word study list was constructed using seven of the 12 sets of words. Of the seven sets, three sets served as targets and four sets as flankers. For the flankers, two sets were presented throughout the study list five-times and two sets were presented once. For the 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 flanker, old target/once-presented flanker, old target/new flanker, new target/five-times flanker, new target/once-presented flanker, new target/new flanker. Other details of materials and list construction were the same as in Exp. 1.

<u>Procedure</u>

The apparatus and procedure for this experiment were the same as that in Exp. 1. Subjects were instructed in the first phase to read words aloud that were presented on the computer screen and to try and remember the words for a test of recognition memory that would follow. 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. The target items were only words that had been presented once in the study phase, whereas flankers were words that had been presented five-times, once, or not at all (new). Subjects in the divided-attention test performed the above while simultaneously engaged in the listening task.

Results and Discussion

In the divided attention condition, subjects missed an average of 9 out 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 the highest probability occurred for targets that were old (.61) as compared to new targets (.16). The interaction of attention and target, $\underline{F}$ = 7.08, $\underline{MSe}$ = .01 was significant. This interaction is a product of subjects being poorer at identifying old targets as old (.58) and being more likely to incorrectly identify a new target as old (.18) in the divided attention condition than when their attention is fully directed to the task (.64 and .13). No other effects were significant.

Decision Time Data

The decision times shown in Table 2 were analyzed using a 2 (attention: full, divided) x 2 (target: old, new) x 3 (flanker: five-times, once-presented, new) ANOVA with repeated measures on the last two factors. Consistent with the findings of Exp. 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 with p = .054, F (2,92) = 2.98, MSe = 208250.0. Due to a lack of effects in the full attention condition, the subsequent analyses examined results from the divided attention condition only.

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Insert Table 2 about here

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Contrary to the predictions, increasing the familiarity of a flanker 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 once-presented words had a faster decision time (1741 ms) than when it was surrounded by either a five-times presented flanker (1936 ms) or a new flanker (2157 ms). Likewise, a new target that was flanked by a once-presented word had a slower decision time (2257 ms) than if it was flanked by a five-times presented flanker (2026 ms) or a new flanker (2037). Tukey post hoc tests showed that the condition of old targets flanked by once-presented words was significantly different from old targets flanked by new words. No other means were significantly different from each other.

Automatic influences of memory for unattended flanking words were revealed again. Verbal reports from the subjects continued to support the assertion that the processing of flankers was not accompanied by awareness. However, the predictions that words that were repeated at study would give rise to larger flanker effects, and that effects would be observed in the full attention condition, were not realized. Instead, larger effects were found when flankers were words that had been presented once at study and only under conditions of divided attention. The nature of these findings was very surprising. The purpose of the next experiment was determine if this pattern of results would replicate. For that experiment, the visual display was changed in the hopes of increasing the size of the flanker effects.

Experiment 3

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). Underwood (1986) stated that given the sensitivity of the parafovea, high-contrast viewing conditions may be a necessity for effective results with displays such as that used in the flanker paradigm. Indeed, in the preceding experiments the between subject variability was very high, suggesting that the display used here (green on black background) may not be of high enough contrast to yield consistent positive effects. Consequently, it was decided to transfer the experimental procedures to a Zenith computer system that was interfaced with a Zenith virtual graphics adaptor (VGA) monitor. This served to present stimuli that were of a higher contrast (white on black background) than that seen on the monochrome monitor (green on black background). By having a higher contrast display it was expected that more subjects would show positive effects, thus reducing the between subject variability. A second change in this experiment involved the number of repetitions of items that served as flankers. In this experiment, flankers were new, presented once or <u>four-times</u> at study (rather than five-times). Once again, all old targets in the recognition memory test were words that had been seen once at study.

Method

Subjects

Subjects were 30 volunteers from an introductory psychology course at McMaster University who served in the experiment for course credit. Of these 30, 1 reported attending to the flankers on greater than 5% of the trials and 5 were not able to perform the listening task to criterion. Thus, only the data from the remaining 24 subjects were used for analyses.

Materials and Design

The materials and design used for this experiment were identical to those of Experiment 2 with the exception that repeated words at study were now presented four times instead of five times and cell size of the six experimental test conditions was increased to 25. These two changes resulted in a study list of 325 words and a 150-trial recognition test. Flankers were words that had been presented at study four-times, once, or not at all (new). Targets in the recognition test were words that have been presented once in the study list.

Procedure

A Zenith VGA monitor interfaced with a Zenith data systems computer was mounted at near eye level and positioned approximately 55 cm from where a subject was seated. The character size of the stimuli was approximately 4 mm x 2.5 mm. The angular separation between the words was approximately .42 . The total visual angle of the three word display subtended about 2.0 vertically and 1.6 horizontally. Less than 3% of the three item displays had the same first letter for both the flankers and target. On the table directly in front of the subject was a keyboard. During the recognition test, the subject was to press the "A" key for an "old" decision and the "L" key for a "new" decision. The computer recorded both the subjects' judgement and latency.

The same procedure was used as that of Experiment 2. Once again, half the subjects performed the recognition judgements while engaged in a listening task and the other half performed it under conditions of full attention.

Results and Discussion

Subjects in the divided attention condition missed an average of 14.3 sequences out of 54.7 sequences (26.1%).

Accuracy Data

The accuracy scores were analyzed as the probability of judging an item as old using a 2 (attention: full, divided) x

2 (target: old, new) x 3 (flanker: 4X, 1X, new) ANOVA with repeated measures on the last two factors. A main effect for target, F (1, 34) = 361.1, MSe = .02, showed that old targets had a higher probability of being judged as old (.55) than did new targets (.16). No other effects were significant, all F's >1.0.

Decision Time Data

The decision times were analyzed using a 2 (attention: full, divided) x 2 (target: old, new) x 3 (flanker: 4X, 1X, new) ANOVA with repeated measures on the last two factors. Consistent with previous findings, subjects were faster to respond under conditions of full attention (1503.8 ms) than under conditions of divided attention (2535.0 ms). This difference was supported by a main effect of attention, F (1, 34) = 22.5, MSe = 271373925.4. In addition, subjects responded faster when the target was old rather than new (1898.3 ms vs 2140.4 ms), F (1, 34) = 8.95, MSe = 14952605.6. Although this portion of the results were similar to the first two experiments, the three way interaction for attention, target and flanker did not emerge, F > 1.0.

However, as referenced in the materials and design section, the visual angle of the entire display, as well as the angular separation between the target and the flankers, differed from that of the Apple system. The visual display on the apple system created an angular separation of approximately .2, whereas the Zenith display for this experiment was approximately .42. Various experiments that have used the flanker paradigm have demonstrated that as the spatial separation between the targets and flankers increase, flanker effects decrease (Broadbent & Gathercole, 1990; Eriksen & Eriksen, 1974). In the Eriksen and Eriksen (1974) study, only stimuli that were within .06 of the target produced significant interference effects. As the spatial separation increased to .5 and further to 1 , a marked decrease in the amount of interference was noted. This may also be the case with respect to this experiment. The spatial separation changing from .2 to .42 may have been sufficient to eliminate the previously obtained effects.

Experiment 4

The purpose of this experiment was to determine whether the lack of flanker effects in Experiment 3 was due to the change in display from that of Experiments 1 and 2. To investigate this, the text display of the Zenith VGA monitor was changed from an 80 column to a 40 column text (the Apple IIe computer system also had a 40 column text). Decreasing the column size increases the size of the words while minimally affecting the total visual angle of the display, and, consequently, reduces the angular separation. It was expected that creating the same angular separation between the target and flanker items on the VGA monitor, as that of the Zenith monochrome monitor, would allow for a replication of Exp. 2's findings. All other variables in the experiment remained the same.

Method

Subjects

Subjects were 55 psychology students who performed the experiment for course credit. Twenty-four subjects were tested in the full attention condition and 31 in the divided attention condition. However, for the divided attention condition, 7 subjects were discarded. Six subjects were dropped because they performed the listening task below criterion and one subject reported attending to the flankers.

Materials and Design

The materials and design used for this experiment were identical to those of Experiment 3.

Procedure

The same procedure was used as that of Experiment 3 with the exception of the change in character size of the letters used in the visual display. Words with a character size of approximately 3 mm x 4.5 mm were presented in lower case letters in the center of the screen. For the recognition test display, the angular separation between the target and flankers was approximately .2 and the entire display subtended 1.25 vertically and 3.1 horizontally.

Results and Discussion

Subjects in the divided attention task missed an average of 15.1 sequences out of 54.5 sequences (28.4%).

Accuracy Data

Accuracy scores, analyzed as the probability of judging an item as old, revealed that old targets were judged with a higher probability as being old (.51) than were new targets (.13), F (1, 46) = 10.3, MSe = .008 (see Table 3). No other effects were significant, all F's > 1.0.

Decision Time Data

Decision times were analyzed using a 2 (attention: full, divided) x 2 (target: old, new) x 3 (flanker: four-times, once-presented, new) ANOVA with repeated measures on the last two factors. With the changed display, the three way interaction of attention, target, and flanker type, F (2,92) = 4.2, MSe = 211772.7 was significant; the interaction of target and flanker was found in the divided attention condition but not in the full attention condition (see Table 3). In the divided attention condition, old targets flanked by once-presented words were responded to faster (1391.0 ms) than were old targets flanked by either four-times presented words or new words (1775 ms and 1712 ms respectively). Conversely, new targets flanked by once-presented words were responded to slower (1803 ms) than when they were flanked by either four-times presented or new words (1623 ms and 1469 ms respectively). Tukey post hoc tests revealed that old targets flanked by once-presented words differed significantly from old targets flanked by both four-times presented and new words, which did not differ significantly from each other. As well, new targets flanked by once-presented words differed significantly from new targets flanked by new words. No other differences were significant.

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Insert Table 3 about here

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These results are a replication of those of Experiment 2. Surprisingly, increasing the number of presentations of an item does not appear to increase spontaneous recognition of that item. Flankers that had the most influence on directed recognition judgements were <u>not</u> those that had been seen more frequently at study, but were those that had been presented once. Such findings are in contrast with Broadbent and Gathercole's (1990) finding that words had to be from a familiar set in order for flanker effects to emerge. However, differences in methodology (i.e. divided attention and a recognition memory task) 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 presented more frequently did not produce flanker effects leads us to reconsider the possible factors responsible for spontaneous recognition.

A possible explanation for the effects seen in Exps. 2 and 3 could be proposed based on 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 (once-presented item) inhibiting processing of the familiar flankers (repeated items). The design of the next experiment allows us to investigate this possibility.

The finding that incongruent flankers led to slowed decision times as compared to congruent flankers is similar to Eriksen et al's (1986) memory search experiments. They interpreted their pattern of results in terms of response priming by the familiarity value of the flanking letters. The frequency and recency of a particular stimulus was said to 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 the flanking item contributed to flanker effects. According to the findings reported here, however, the absolute familiarity of flankers was not the critical factor. Rather, the relationship between the target and 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 of items presented as old targets. The results support this "relativistic" interpretation of spontaneous recognition memory.

A prediction made by this 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. The next experiment tests this prediction by using words that had been presented four-times at study as old targets in the recognition memory test.

Experiment 5

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). Based on the "relativity" hypothesis, it was expected that flankers that had been presented four times in the study list would produce the most dramatic effects. In comparison, however, the results would be expected to show a different pattern based on Johnston et al's (1990) novel pop-out effect. An old target surrounded by a once-presented flanker would be expected to show the largest flanker effects because the relatively novel flankers should "capture" attention and slow decision times for the recognition judgements.

Method

Subjects

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

Materials and Design

The same materials and design was used as that of the previous experiment with the following modifications. 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, once, or were new.

Procedure

All of the previous experiments employed a between subject factor of attention; half of the subjects performed the recognition test while engaged in a listening task and the other half under conditions of full attention. Consistently across all experiments, subjects in the full attention condition did not show flanker effects. This experiment started out testing a group of subjects in the full attention condition but after 12 subjects it was apparent that, once again, subjects were not affected by distractors in this 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 this experiment and the remaining experiments to be reported. Data are reported only for subjects in the divided attention condition.

Results and Discussion

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

Accuracy Data

Analysis of accuracy scores as the probability of judging an item as old demonstrated that subjects judged old targets as old with a higher probability than new targets (.82 vs .15 respectively), F (1, 138) = 16.2, MSe = .02 (see Table 4). No other effects were significant.

Decision Time Data

Analysis of decision times (see Table 4), using a 2 (target: old, new) x 3 (flanker: four-times, once-presented, new) ANOVA with repeated measures on the last two factors, revealed a main effect for target, $\underline{F}$ (1, 23) = 11.0, $\underline{MSe}$ = 394822.5. 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 were analyzed in terms of the probability of judging an item as old using a 2 (Experiment: 5 vs 4) x 2 (target: old, new) x 3 (flanker: four-times, once-presented, new) ANOVA with repeated measures on the last two factors. Subjects in Experiment 5 were more accurate in their judgements of identifying an old target as old (.82) than were subjects in Experiment 4 (.50). This difference was supported by an experiment x target interaction, $\underline{F}$ (1, 46) = 81.2, $\underline{MSe}$ = .02.

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Insert Table 4 about here

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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 possibility that novel items inhibited the localization of familiar flankers. By that account, flanker effects were expected to occur for a display that had a familiar target (i.e. four-times presented) 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 decisions to targets when a person's ability to focus their attention on the target is decreased (e.g. performing a secondary task). As well, it seems that if target words are easily identified as old, flanking words lose their effectiveness.

Experiment 6

Indirect measures of memory are very sensitive to changes in perceptual characteristics from study to test. Jacoby and colleagues (e.g. Jacoby & Dallas, 1981; Kelley, Jacoby, & Hollingshead, 1989), among others, have interpreted such findings in terms of a perceptual fluency hypothesis. In this hypothesis, the feeling of familiarity is said to serve as one basis for recognition memory and is described as relying on the physical characteristics of an item. 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. The next series of experiments examined whether superficial characteristics of an item, such as physical similarity, is a factor affecting spontaneous recognition. Because familiarity of a flanker is expected to be important for spontaneous recognition, the match in perceptual similarity between the earlier presentation of a word and its presentation as a flanker may be important for a flanker's effectiveness.

Earlier experiments have demonstrated that reading a word does more to benefit its later identification than does solving it earlier as an anagram (Allen & Jacoby, 1990). This experiment takes advantage of this finding. Words were presented to be read or to be solved as anagrams (e.g., stump vs ptsmu; only letters that are not underlined were to be rearranged to form a word) in the first phase. During the recognition test, old targets were the solution words to items that had been presented as anagrams at study. Flankers were identified with reference to their presentation at study. Flankers were either solutions to words that had been presented as anagrams at study (anagram-solution flankers), words that had been read at study (read flankers), or words that had not been presented (new flankers). If perceptual similarity is important for spontaneous recognition, read flankers should affect recognition memory judgements more than anagram-solution flankers.

The findings of Exps. 2 and 4, however, were interpreted as showing that the similarity in processing history between the old targets and the flankers may influence the extent to which flankers affect memory processing of the targets. This hypothesis can be contrasted with the perceptual similarity hypothesis. By the relativity account, because old targets were those that had been solved as anagrams at study, the anagram-solution flankers should be more effective than flankers that had been read at study.

Method

Subjects

Twenty-one students from a first year psychology course participated in the experiment for course credit. Of these 21 subjects, three performed the listening task poorly and were discarded from analysis, leaving data from 18 subjects for analysis.

Materials and Design

Three hundred words were selected from the pool of words used in Experiment 1. These 300 words were divided evenly into 12 sets of 25 words, each with word frequency equally balanced. A 175 word study list was constructed with seven sets of 25 words, three sets of which words served as targets in the test phase and four sets as flankers. For the flankers, two sets were presented that had been solved as anagrams throughout the study list and two sets were read at study. For the targets, all three sets of words were presented to be read at study. The remaining five sets of words were used as new words in the recognition test list, three sets of 25 to be used as targets and two sets as flankers.

The 150-trial recognition test included 25 trials from each of the following six experimental conditions; old target/anagram solution flanker, old target/read flanker, old target/new flanker, new target/anagram solution flanker, new target/read flanker, new target/new flanker. Other details of materials and list construction were the same as in Experiment 1.

To construct anagrams, words were presented with the second and fourth letters in their proper positions and underlined (e.g., elsmi). The remaining letters were randomly rearranged. Constraining the order of the letters served two purposes. First, the constraints made the anagrams easier to solve. More importantly, it also resulted in only one solution per anagram.

Procedure

The procedure was similar to those used in the previous experiments with the exception of the study phase conditions. In the study phase, subjects were required to solve anagrams and to read words. The subjects were informed that words would sometimes be presented in their normal form, and that those words were to be read aloud as quickly as possible. Other items, however, would sometimes be presented as anagrams with the second and fourth letters underlined and in their proper position, with respect to the positions in the solution word. It was emphasized that this meant that only the three other letters needed to be rearranged to solve the anagram. Once subjects had the solution, they were to report the word aloud. If the word said aloud was the correct solution, the experimenter pressed a key and the next item appeared on the screen. Otherwise, subjects were informed of their errors and were allowed to continue to try to solve the anagram. A maximum of 20 sec was allowed for each anagram. Once that time elapsed, a beep sounded and the subject was given the correct solution for the anagram. Subjects were told that response times were recorded for both the reading and the solving of the anagrams, and that the reading times were to be used as a baseline for interpreting the solving times of the anagrams. In actuality, times were not recorded.

As before, subjects were told to try to remember each word for the recognition memory test that would follow. The recognition test was run only under the divided attention condition. Old targets were the solutions to words that had been presented as anagrams at study. Flankers were anagram-solutions of anagrams that had been presented at study, words that had been read at study, or new words.

Results and Discussion

During the study phase, subjects were able to solve an average of 81.7 % of the anagrams. Subjects missed an average of 12.1 sequences out of 42.1 sequences (28.7%) while performing the listening task.

Accuracy Data

Analysis of the accuracy scores as the probability of judging an item as old showed that old targets were judged as old with a higher probability (.76) than were new targets (.15), F (1,17) = 252.5, MSe =.04 (see Table 5). No other effects were significant; all F's > 1.0.

Decision Time Data

Decision times (shown in Table 5) were analyzed using a 2 (target: old, new) x 3 (flanker: anagram-solution, read, new) ANOVA with repeated measures on the last two factors. A main effect for target, F (1, 17) = 5.4, MSe = 304295.0, indicated that old targets were responded to faster than new targets. Analyses showed no other significant effects.

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Insert Table 5 about here

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Again, flanker effects were not found even under conditions of divided attention when old targets were easily identified. Subjects were fairly accurate at identifying an anagram-solution target as old (.76)-- more so than that seen in the preceding experiments, when targets were items that had been earlier read (M = .55). This finding supports the "ease of recognition" interpretation advanced in Exp. 5. If targets are easily identified as old, spontaneous recognition will not occur. The advantage in recognition memory performance for targets that had been presented as anagrams at study over those that were read is consistent with the results of other experiments (Allen & Jacoby, 1990; Jacoby, 1983; Slamecka & Graf, 1978). Unfortunately, however, the absence of flanker effects effectively prohibits the testing of the perceptual similarity hypothesis. To ratify this problem, the next experiment uses words that had been read at study as the old targets.

Experiment 7

This experiment used the same procedure as Exp. 6, however, old targets were words that had been read at study. The logic here is that the previous experiments that have shown flanker effects had old targets as those that had been read at study. By using words that had been read at study, instead of those that had been presented as anagrams, it was expected that targets would be more difficult to identify, and, consequently, flanker effects more likely to occur. Given the occurrence of flanker effects, testing the perceptual similarity hypothesis is possible. If the hypothesis is viable, read flankers should affect recognition memory judgements more than anagram-solution flankers because of their greater match in perceptual characteristics between study and test. Coincidentally, the relativity hypothesis makes the same prediction.

Method

Subjects

Subjects were 32 students enroled in an introductory psychology course who participated in the experiment for course credit. Six of these subjects were not able to meet the criterion set for the divided attention task and were discarded prior to data analysis. Two subjects reported attending to the flankers. Consequently, analysis included data from 24 subjects.

Materials and Design

Two hundred and forty words were selected from the pool of words used in Experiment 5. These 240 words were divided evenly into 12 sets of 20 words, each with word frequency equally balanced. A 140-word list presented in the study phase was constructed with seven sets of 20 words. Of the seven sets, three served as targets in the test phase and four as flankers. For the flankers, two sets were presented that had been solved as anagrams throughout the study list and two sets were read at study. For the targets, all three sets of items were words that had been read at study. The remaining five sets of 20 words were used as new items in the recognition test list; three served as new targets and two sets served as new flankers.

The 120-trial recognition test included 20 trials from each of the following six experimental conditions; old target/anagram solution flanker, old target/read flanker, old target/new flanker, new target/anagram solution flanker, new target/read flanker, new target/new flanker. Other details of materials and list construction were the same as in Experiment 6.

Procedure

The same apparatus and procedure were used as Exp. 6 with the exception that old targets during the recognition test were words that had been read at study.

Results and Discussion

During the study phase, subjects solved an average of 86% of the anagrams. Subjects missed an average of 15.8 out of 57.9 target sequences (27.3%) in the listening task.

Accuracy Data

The accuracy scores in Table 6 were analyzed as the probability of judging an item as old using a 2 (target: old, new) x 3 (flanker: anagram, read, new) ANOVA with repeated measures on both factors. A main effect for target revealed that old targets had a higher probability of being judged as old (.51) than did new targets (.19), $F(1, 23) = 200.7$, $MSe = .02$. In addition, there was a significant interaction of target and flanker, $F(2, 46) = 10.9$, $MSe = .008$; the accuracy scores for identifying old targets were affected by the presence of flankers but accuracy scores were not affected when targets were new. Old targets surrounded by flankers that had been read at study had a higher probability of being judged as old (.56) than did the anagram-solution flankers (.50) and new flankers (.48). Tukey post hoc tests showed that when targets were old, subjects judged the targets to be old more accurately when read flankers surrounded the target than when new words flanked the target. No other differences were significant.

This is the only experiment throughout the series that yielded significant effects in the accuracy data. The pattern of the results support that which both the relativity and perceptual similarity hypotheses would have predicted. When an old target was surrounded by flankers that had been read, and, thus, had the same processing history, as well as a match in perceptual characteristics, recognition judgements were the most accurate.

Decision Time Data

The decision times were analyzed using a 2 (target: old, new) x 3 (flanker: anagram, read, new) ANOVA with repeated measures on both factors. Analysis revealed a significant two way interaction of target and flanker, F (2, 46) = 5.0, MSe = 780038.8; faster decision times were observed for congruent flankers than for incongruent flankers (see Table 6). Read and anagram-solution flankers surrounding an old target showed speeded response times (1716 ms and 1692 ms respectively) as compared to new flankers surrounding an old target (2123 ms). Conversely, read and anagram-solution flankers surrounding a new target showed slower decision times (2125 ms and 2100 ms respectively) than when a new target was surrounded by new flankers (1924 ms). Tukey post hoc tests showed that the time to respond to read targets flanked by new words was significantly slower than when they were flanked by read or anagram-solution words. No other differences were significant.

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Insert Table 6 about here

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Familiarity is typically described as greatest when the perceptual characteristics of a test item match those of its prior presentation (e.g. Atkinson & Juola, 1974; Jacoby & Dallas, 1981; Mandler, 1980). Words that were earlier read had a greater match in perceptual characteristics than were words that had earlier been solved as anagrams. The prediction, then, was that read flankers would be more familiar and thus have larger flanker effects. However, anagram-solution flankers had the same effect on the memory processing of targets as did read flankers, suggesting that perceptual characteristics alone do not account for spontaneous recognition. This finding is similar to effects found by Jacoby (1991). In that set of recognition memory experiments, words that were presented earlier as anagrams were later more familiar than words that were read. Jacoby (1991) interpreted the results as showing that familiarity may not rely on the perceptual characteristics of an item alone, but, also reflect other processing factors. The results here are in line with that interpretation and will be discussed in more detail in the General Discussion.

Experiments 8a and 8b

Perceptual identification experiments have shown that earlier reading a word enhances subsequent visual identification to a substantially larger degree than does earlier hearing a word (e.g. Jacoby & Dallas, 1981; Morton, 1979). Some researchers have used such findings to argue that indirect tests are mediated by modality-specific representations (Kirsner & Dunn, 1985; Weldon & Challis, 1989). The significance of such interpretations is that flanker effects may be specific to the modality in which the flanking word was previously presented.

In Exps. 8a and 8b the modality of prior presentation of words that served as flankers was varied. Words were presented for study by means of both the auditory and visual modality. Following the study list, subjects made recognition judgements on targets. Essentially, the two experiments differed only by which items were used as old targets. In Experiment 8a, old targets were words that had been heard at study, whereas in 8b old targets were words that had been read. During the recognition test 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 flanker), read at study (read flanker), or were new words.

If modality-specific effects are a factor here, then flankers that had been earlier read at study should show larger flanker effects in both experiments. Further, an advantage of using modality of presentation as the differentiating factor in the study list is that it eliminates the processing confounds noted in Exps 5 and 6. That is, studies indicate that manipulations of modality generally produce no effects on recognition memory performance (eg., Kirsner, Milech, & Standen, 1983). This feature of the design enables the testing of the relativity hypothesis. If old targets set the context for those words which will be effective as flankers, then flankers that had been heard at study should be more effective as flankers in Exp. 8a and flankers that had been earlier read should be more effective in Exp. 8b.

Method

Subjects

Thirty-four subjects participated in each of the two experiments in return for course credit in an introductory psychology course. In Exp. 8a, 8 subjects had trouble with the divided attention task and 2 reported attending to the flankers. In Exp 8b, 7 subjects performed the listening task below criterion and 3 subjects reported attending to flankers. Thus, each of the experiments included twenty-four subjects in the statistical analysis.

Material and Design

An additional 95 five-letter nouns were combined with the original pool of words used in Exp. 1, creating a pool of 455 words balanced for medium and low frequency as scaled by Thorndike and Lorge (1944). The materials and design were similar to 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. For both experiments, this resulted in a study list consisting of 280 words and a recognition test of 210 trials. In Exp. 8a 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, new target/new flanker. Similarly, Exp. 8b 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, new target/new flanker.

<u>Procedure</u>

The procedure of these experiments were 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 him/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 a 800 ms rate.

For the recognition test, 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 Exp. 8a old targets were words that had been heard at study, whereas, in Exp. 8b, old targets were words that had been read at study. Subjects were tested only in the divided attention condition during the recognition task.

Results and Discussion

In Experiment 8a, subjects missed an average of 21.4 sequences out of 81.3 target sequences (26.3%) in the listening task. In 8b, subjects missed an average of 22.4 out of 76.4 target sequences (29.3%) in the listening task.

Accuracy Data

In both experiments, an analysis of accuracy scores as the probability of judging an item as old revealed a main effect for targets; F (1,23) = 79.7, MSe = .02 (Exp 8a) and F

(1,23) = 131.8, MSe = .01 (Exp. 8b) (see Tables 7 and 8). Old targets were judged as old with a higher probability (.50 in 8a; .51 in 8b) than that of new targets (.32 in 8a; .30 in 8b). No other effects were significant.

Decision Time Data

Decision times were analyzed using a 2 (target: old, new) x 3 (flanker: read, heard, new) ANOVA with repeated measures on both factors. A curious finding in Exp. 8a was that decision times for new targets surrounded by new flankers (congruent condition) were longer than the condition which had heard targets surrounded by new flankers (incongruent condition). In all other experiments reported here, that showed flanker effects, the congruent condition was faster than 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 of the old targets between 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, thereby, causing longer decision times for new targets than previously attained in the other experiments. Indeed, a main effect for target, F (1,23) = 22.7, MSe = 237286.9 was evident for Exp. 8a but not for Exp. 8b, 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 earlier heard were slower than when new targets were surrounded by new flankers.

The finding of main concern, however, is the significant interaction of target and flanker for both experiments (see Tables 7 and 8). In Experiment 8a, F (2,46) = 5.1, MSe = 159569.3, old heard targets surrounded by heard flankers were responded to faster (1585 ms) than were old heard targets surrounded by read flankers (1867 ms) and new (2029 ms) flankers. Conversely, new targets flanked by heard items showed slower decision times (2265 ms) as compared to read (2166 ms) and new (2212 ms) flankers. Tukey post hoc tests showed that a heard target surrounded by heard flankers was significantly different than when surrounded by read or new flankers. The two latter conditions were not significantly different from each other.

In Experiment 8b, F (2,46) = 5.9, MSe = 251001.5, when old targets were those that had been read at study, results showed faster decision times for old targets flanked by words that had also been read at study (1486 ms) as compared with flankers that had been heard at study (1852 ms) or were not seen (new; 1843 ms). In addition, the slowest times to respond for new targets were when the flankers were words that had been previously read (1951 ms) as compared to heard

(1790 ms) or new flankers (1643 ms). Tukey post hoc tests showed that the condition of old targets 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.

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Insert Tables 7 and 8 about here

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The combined results of Experiment 8a and 8b 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.

The flanker experiments reported here show that spontaneous influences of memory only under a restricted set of conditions. When attention was divided at test, subjects' decision times for making recognition memory judgements were affected by flankers despite subjects' self reports of having successfully ignored the flankers. Recognition decisions were made more rapidly when flanker and target words were congruent, rather than incongruent, with regard to the response they dictated. However, if old targets were easily identified as old, such flanker effects did not occur, even under conditions of divided attention.

Perhaps the most remarkable finding was that factors that were expected to influence spontaneous recognition--repetition and physical similarity between study and test--were found to have little effect on their own. Increasing the number of prior presentations of a word before it served as a flanker decreased its effectiveness as a flanker when old targets were words that had been presented once at study. Words that had been presented to be solved as anagrams at study were effective as flankers, despite their change in physical characteristics from study to test. Further, rather than the form of modality-specific transfer, flankers were more effective if they matched the modality in which old targets had been presented at study. In combination, the findings suggest that the relation between the processing history of the target and the flanking words, rather than the absolute history of the flanking word, is a determinant of whether flanker effects will be observed.

Why was it necessary to divide's subjects' attention at test to observe flanker effects? It may be that dividing a subject's attention widens the "breadth of attention" as compared to that which occurs when a subject's attention is fully directed to the recognition task (cf., Yantis & Johnston, 1990). Thus, when attention is divided, flankers that subjects are attempting to ignore actually appear within the portion of the visual field that is "illuminated" by attention. On the other hand, subjects are able to successfully ignore flankers in the full attention condition, as evidenced by no flanker effects, because of their ability to selectively attend to the target. By this <u>selective processing</u> view, the encoding of spatial location is computed at a very early stage and later, "semantic" processing is restricted to words presented in the selected location.

Another possibility, however, relates to parallel effects of dividing attention as found in effects on temporal selection. Jacoby (1991) presented words in two temporally separate lists and subjects were later required to selectively respond to items in one list. Similar to our results, when attention was divided at test, subjects were less able to localize the event in time and make an accurate recognition memory judgement. Jacoby argued that while a subject's attention is divided they are less likely to engage in conscious recollection, and, consequently, rely on the use of familiarity as a basis for recognition memory judgements. That change in the basis for recognition-memory judgments is likely 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 <u>selective-cueing</u> account of performance in perception experiments such as the flanker paradigm. Selective-cueing is the process by which task-relevant information is specified for control of a particular response. In contrast to the selective-processing view, Allport holds 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 is made poor and the semantic content of the stimulus is correlated with their 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 these experiments, old targets were always of a specific set identified by their presentation in the study list (i.e. once-presented items; heard items). In this sense, the spatial location of target items were correlated with that attribute which identified them as old. If, in the divided attention condition, subjects are relying on such attributes to serve as a spatial cue, then in situations where flankers and targets are incongruent, localization of a target would be disrupted. Conversely, flankers and targets that are congruent with regard to the response they dictate may assist in restricting the information needed to localize the target to make the necessary recognition judgement. Arguably, dividing attention during the recognition test interfered with the computing of spatial location and, thereby, made the subjects more reliant on the use of correlated attributes.

Allport's selective-cueing view can be used to highlight the similarity between "perception" experiments and "memory" experiments. In that vein, 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, as shown here. 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 judgements. 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 important for familiarity are different than those held by most theoretical accounts. Familiarity of an item is generally described as reflecting its number of prior presentations and the match in perceptual characteristics between study and test. In contrast, to explain the flanker effects evidenced here, it can be argued that neither of these factors were important. Rather, the familiarity of an item appeared to depend on the <u>similarity</u> of its characteristics to that of the target words. It seems that recognition of target words resulted in the adoption of an "unconscious set" that determined the type of flanker that would influence responding. This set is referred to as unconscious because, in general, subjects stated that they had ignored flankers and remained unaware of a their identity throughout the recognition test. As well, when asked, none of the subjects claimed to have noticed the homogeneity of the old target words (e.g., that they were all words that had earlier been read). Support for the proposal of an unconscious set comes from investigations of "release from proactive interference" in short-term memory. Subjects' awareness of a change in the dimensions of words that are to be remembered is not required to produce release from proactive interference (Wickens, 1970, 1972; Turvey, 1974).

However, the results of Exp. 7 appear to contradict the importance of the similarity of characteristics between the flankers and the targets. When targets were items that had been read, anagram-solution flankers were effective as flankers despite the differences in processing that had been encountered at study between targets and anagram-solution flankers. Perhaps these results are best explained in terms of the level of similarity. In this vein, it is argued that the difference in processing between solving an item as an anagram and reading an item once is less than if the item had been presented in a different modality, or even that of being presented four times. While the latter case may seem somewhat questionable, the accuracy data lends support to the notion. Targets that had been presented four-times were judged as old more accurately (.82) than were anagram-solution targets (.76). As well, in all cases, two letters, and in many cases, three letters, were in the same position for a word to be solved as an anagram as that seen in its normal form. The combined similarities in processing characteristics and physical characteristics may account for the finding that anagram-solution flankers were as effective at disrupting performance as that of read flankers. By this explanation, the absolute familiarity of the flanking stimulus is also playing a role, albeit an arguably minor one. With this said, however, the accuracy data in Exp. 7 can not be ignored. When targets were items that had been earlier read, they were judged to be old more accurately when surrounded by read flankers as compared to anagram-solution flankers or new flankers. These results can be interpreted as demonstrating, to some extent, that flankers that are similarly processed from study to test are more effective at influencing recognition memory judgements.

The rediscription of familiarity as reflecting the similarity between flankers 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 for 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.

Returning 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 the activity in which a person is engaged.

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Footnotes

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

Table 1.

Accuracy Scores (probability of calling a target old) and Decision Times (msec) for Recognition Memory Judgements in Experiment 1.

		FLANKER TYPE			
TARGET TYPE		Old		New	
		Prob. Old	Decision Time	Prob. Old	Decision Time
FULL ATTN	Old	.67	860	.67	869
	New	.17	1008	.17	1025
DIVIDED ATTN	Old	.65	1396	.64	1565
	New	.26	1698	.24	1510

Table 2.

Accuracy Scores (probability of judging an item as old) and Decision Times (msec) for Recognition Memory Judgements in Experiment 2.

TARGET TYPE		FLANKER TYPE					
		Five-Times		Once-Presented		New	
		Prob. Old	Decision Time	Prob. Old	Decision Time	Prob. Old	Decision Time
FULL ATTN	Old	.65	908	.61	953	.65	897
	New	.15	1048	.12	1091	.13	1030
DIVIDED ATTN	Old	.59	1936	.59	1741	.55	2157
	New	.18	2026	.19	2257	.17	2037

Table 3.

Accuracy Scores (probability of judging an item as old) and Decision Times (msec) for Recognition Memory Judgements in Experiment 4.

TARGET TYPE		FLANKER TYPE					
		Four-Times		Once-Presented		New	
		Prob. Old	Decision Time	Prob. Old	Decision Time	Prob. Old	Decision Time
FULL ATTN	Old	.53	917	.55	967	.50	968
	New	.12	1040	.14	989	.12	1005
DIVIDED ATTN	Old	.51	1775	.48	1391	.50	1712
	New	.14	1624	.14	1803	.12	1469

Table 4.

Accuracy Scores (probability of judging an item as old) and Decision Times (msec) for Recognition Memory Judgements in Experiment 5.

TARGET TYPE		FLANKER TYPE					
		Four-Times		Once-Presented		New	
		Prob. Old	Decision Time	Prob. Old	Decision Time	Prob. Old	Decision Time
DIVIDED ATTN	Four-Times	.83	1790	.81	1748	.83	1745
	New	.13	2167	.18	2030	.14	2153

Table 5.

Accuracy Scores (probability of judging an item as old) and Decision Times (msec) for Recognition Memory Judgements in Experiment 6.

TARGET TYPE		FLANKER TYPE					
		Ang-Solution		Read		New	
		Prob. Old	Decision Time	Prob. Old	Decision Time	Prob. Old	Decision Time
	Ang-Sol'n	.78	1636	.77	1597	.74	1557
DIVIDED ATTN							
	New	.17	1903	.15	1795	.14	1832

Table 6.

Accuracy Scores (probability of judging an item as old) and Decision Times (msec) for Recognition Memory Judgements in Experiment 7.

TARGET TYPE		FLANKER TYPE					
		Ang-Solution		Read		New	
		Prob. Old	Decision Time	Prob. Old	Decision Time	Prob. Old	Decision Time
DIVIDED ATTN	Read	.50	1692	.56	1716	.48	2123
	New	.23	2100	.17	2125	.17	1924

Table 7.

Accuracy Scores (probability of judging an item as old) and Decision Times (msec) for Recognition Memory Judgements in Experiment 8a.

	TARGET TYPE	FLANKER TYPE: Heard		Read		New	
		Prob. Old	Decision Time	Prob. Old	Decision Time	Prob. Old	Decision Time
DIVIDED ATT	Heard	.51	1585	.52	1867	.48	2029
	New	.30	2265	.33	2166	.32	2212

Table 8.

Accuracy Scores (probability of judging an item as old) and Decision Times (msec) for Recognition Memory Judgements in Experiment 8b.

TARGET TYPE		FLANKER TYPE					
		Heard		Read		New	
		Prob. Old	Decision Time	Prob. Old	Decision Time	Prob. Old	Decision Time
DIVIDED ATT	Read	.52	1851	.51	1486	.48	1846
	New	.30	1788	.30	1951	.29	1643