Evidence for early selection: Precuing target location reduces interference from same-category distractors

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In this study, we evaluated whether uncertainty about target location and category overlap between the target and the flankers played a role in recent findings (Miller, 1987) of semantic interference of irrelevant stimuli. In each of four testing conditions, subjects were required to identify a target letter surrounded by irrelevant flankers whose identity predicted the correct response. We varied (1) whether or not the target location was precued, and (2) the flanker's category (digits vs. letters). We found a substantial effect of letter flankers when subjects were uncertain of the precise target location. However, this effect was greatly attenuated when attention was pre-directed to the target location. Similarly, a reduced flanker effect was observed when the flankers (digits) belonged to a different semantic category than the target. However, when the target location was precued, no effect of the semantic congruity of target and flankers was found. Coupled with previous research, these findings converge in establishing that both failures to maintain attention on the target location and the semantic congruity of target and flankers modulate the size of the effects from irrelevant stimuli. These results are discussed in the context of early and late selection views of selective attention.

Do distractors located outside the focus of attention receive full semantic processing? Researchers have typically addressed this issue by asking subjects to identify target stimuli that appear in known locations, while they simultaneously ignore flanking distractors (see, e.g., Dark, Johnston, Myles-Worsley, & Farah, 1985; B. A. Eriksen & C. W. Eriksen, 1974; Gatti & Egeth, 1978; Kahneman, Treisman, & Burkell, 1983; Miller, 1987; Paquet & Merikle, 1988; Underwood, 1976, 1981). Of primary interest for competing theories of attention is whether or not performance is affected by the semantic relationship between the target and the irrelevant flankers.

On the one hand, late selection theorists (Allport, Tipper, & Chmiel, 1985; Deutsch & Deutsch, 1963; Miller, 1981, 1987; Neill & Westberry, 1987; Tipper & Driver, 1988; van der Heijden, 1981; van der Heijden, Hagenaar, & Bloem, 1984) argue that the target and the flankers both receive semantic processing, leading to a temporary activation of the responses associated with each stimulus. Accordingly, the meaning of irrelevant stimuli is expected to affect performance. By contrast, proponents of an early selection view claim that full semantic analysis is restricted to the attended stimuli, and that only a shallow analysis of physical features is performed on nonattended input.

Thus, the semantic relationship between targets and distractors should not affect performance.

Despite the clear-cut distinction between the theories, the issue remains unresolved, partly because both models have been able to account for observed effects from ignored stimuli. For example, early selectionists have attributed such effects to a failure to restrict attention to the target location (Broadbent, 1982; Francolini & Egeth, 1980; Johnston & Dark, 1986; Kahneman & Henik, 1981; Lambert, 1985; Yantis & Johnston, 1990). According to this argument, the flankers will be semantically processed because they are in fact "attended." A related early selection account relies on the observation that the identity of the distractors is usually task-relevant, in that it corresponds to one of the target alternatives. Thus it is argued that, by virtue of context priming, the shallower processing of the ignored material is nonetheless sufficient for semantic activation (Treisman, 1964). Clearly, this line of reasoning leads to a straightforward prediction: If experimental conditions are such that the distractors are really "unattended" and "unprimed," then no semantic effects from the flanking distractors should be found.

In an important series of studies, Miller (1987) tested this prediction, and, in line with late selectionists, he concluded that priming is not necessary for semantic processing of "unattended" distractors. Adapting the response competition paradigm of B. W. Eriksen and C. A. Eriksen (1974), Miller (1987) presented on each trial a string of three letters. Subjects were required to identify only the letter appearing in the middle (target), while ignoring distractor letters presented on either side of the tar-

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get. In order to reduce the possibility of task-relevant priming, Miller only presented as distractors letters that were never one of the target alternatives (neutral letters). Semantic processing of the flankers was assessed by varying the frequencies with which each flanker appeared with targets from a given response set. For example, an H flanker would be presented more often with the target letter T (HTH), requiring a left-handed response, and less often with the target letter S (HSH), requiring a right-handed response. Within the same block of trials, these frequencies were reversed for a different flanker (e.g., B), presenting it more often with right-response targets (BSB) and less often with left-response targets (BTB). Between blocks, the strength of the flanker-response correlation was varied such that in a high-correlation block, the flanker predicted the correct response (HTH) on 92% of the trials (valid flankers), whereas for the remaining trials (invalid flankers) the flanker was associated with an incorrect response (BTB). In a low-correlation block, valid flanker-response pairing occurred on only 58% of the trials.

The results of Miller's (1987) first experiment were particularly impressive. In the high-correlation block, responses on trials with valid flankers were 60 msec faster than responses on trials with invalid flankers, and this difference was reduced to only 4 msec in the low-correlation block. One clear implication of these data is that, contrary to early selection claims, semantic processing of unattended and unprimed flankers took place and allowed subjects to learn the flanker-response association.

Although the data above are suggestive, they are far from conclusive. First, a troublesome aspect of Miller's (1987) results is the substantial variation, across studies, in the magnitude of the flanker validity effect. For example, large effects were reported in the first study (60 and 48 msec), whereas a reliable but noticeably smaller 20-msec effect was found in Experiment 4. Although Miller attributes this range of effects to changes in the overall flanker-response correlation, other alternatives must be considered. In particular, an examination of Miller's procedures reveals that among several factors that were manipulated across studies was whether or not a fixation point was used to indicate the precise location of the target. If we assume that the fixation point used in Miller's Experiment 4 improved target selection by preventing attention shifts to flanker locations, then the modest flanker validity effect is simply seen as a further demonstration that the extent of semantic processing of distractors is modulated by the ease of target selection (Broadbent, 1982; Johnston & Dark, 1986; Lambert, 1985; Yantis & Johnston, 1990). This interpretation is completely in line with the idea that interfering effects from distractors are partly attributable to failures of selective attention.

A second methodological problem with Miller's (1987) experiment is that the flankers and the target always came from the same semantic category (i.e., letters). There are at least two reasons for suspecting that target-flankers category overlap may have played a role in Miller's study.

First, it may well be that, as several authors have suggested (Johnston & Dark, 1986; Kahneman & Treisman, 1984; Lambert, 1985; Marcel & Forrin, 1974; Taylor, 1977), the internal representations of the members of such small categories as letters are so strongly interconnected that the designation of any one member of this set as a target may be sufficient to "prime" other category members (set priming). Therefore, although Miller may have successfully reduced the likelihood of flanker priming based on task relevance, the possibility that category priming led to semantic processing of the flankers cannot be excluded. Second, if the presence of a category distinction between a target and the flankers prevents full identification of distractors (Broadbent, 1982; Gleitman & Jonides, 1976; Johnston & Heinz, 1978; LaBerge & Brown, 1989; Neumann, van der Heijden, & Allport, 1986; Pashler & Badgio, 1985; Yantis & Johnston, 1990), the large flanker effects obtained by Miller could be attributed to the fact that filtering operations were hampered by the absence of such categorical contrast. In short, the possibility remains that the semantic congruity between the flankers and the target was partly responsible for the substantial distractor effect Miller reported.

In light of the preceding criticisms, our goal was to examine the effects of prior knowledge of the precise target location and of target-flankers category overlap on the magnitude of the flanker validity effect. Accordingly, the correlational cuing paradigm developed by Miller was replicated under four testing conditions, contrasting whether or not a fixation point preceded each stimulus display (no fixation vs. fixation), and whether or not the target and the flankers were from the same category. Within each testing condition, the flanker validity effect was assessed as a function of the strength of flankers-response correlation, which was equal to .92 and .58 for the high- and low-correlation levels, respectively.

Our purpose in the first testing condition (no fixation, letter flankers) was to demonstrate that substantial flanker validity effects are obtained, under conditions identical to those prevailing in Miller's (1987) first study. Moreover, this condition served as a baseline against which the results of the other conditions were compared.

With the second testing condition (fixation, letter flankers), our aim was to establish that the flanker validity effect would be sharply curtailed if attention was previously directed to the precise target location. We reasoned that if the flanker validity effect was linked to inefficient selection of the target, then previous knowledge of its precise location may prevent spreading of attention to the flanker's location. According to this argument, early target selection based on spatial location would facilitate exclusion of flankers from full semantic processing, and consequently, a reduced flanker validity effect should be observed. On the other hand, the proposal (Miller, 1987) that the size of the validity effect is mainly affected by the correlation strength, leads to the prediction that the attention cuing manipulation should not affect the magnitude of the flanker validity effect.

With the third testing condition (no fixation, digit flankers), our purpose was to show that the large flanker effect found in the first condition (no fixation, letter flankers) was partly due to category congruity between the target and the flankers. Therefore, our prediction was that an attenuation of flankers' interference would result from a reduction in the category overlap. In contrast, if subjects learn the flanker-response correlation regardless of distractor category, then similar digit-flankers and letter-flankers interference effects should be found.

Finally, the fourth condition (fixation, digit flankers) was intended to explore whether or not the flanker category would influence performance when early selection of the target was possible. In order to answer this question, a comparison of the flanker validity effects obtained in the fourth and second (fixation, letter flankers) testing conditions was of special interest.

METHOD

Subjects

The subjects were 96 students from Carleton University, who were individually tested in one session, which lasted 45 min. They participated in the experiment either in return for course credit or for money. Twenty-four subjects were assigned to each testing condition.

Apparatus and Stimuli

Each stimulus display consisted of a string of three alphanumeric characters, each measuring 1.52° vertically and 1.2° horizontally. As in Miller's study, the angular separation between characters was 0.3° . The stimuli were displayed on a Zenith ZVM-1230A monitor viewed from a distance of 60 cm. A three-button response box was placed in front of the subject. In the fixation-present groups (fixation, letter flankers; fixation, digit flankers), the subject initiated the trials by pressing, with the thumb, the center key located at the bottom of the box. All subjects provided their responses by pressing, with the index finger, one of two keys placed side by side at the top of the box (one finger was assigned to each key).

Design

The design of the experiment was a $2 \times 2 \times 2 \times 2$ mixed factorial. Location precuing (fixation present vs. absent) and flanker category (letter vs. digit) were the between-subjects variables; flanker-response correlation strengths (.92 or .58) and flanker validity (valid or invalid) were the within-subjects factors.

As mentioned above, there were four between-subjects testing conditions: no fixation, letter flankers; fixation present, letter flankers; no fixation, digit flankers; and fixation present, digit flankers.

Procedure

All subjects were tested in two blocks of 192 trials. In the letter-flankers groups, six letters were randomly selected (without replacement) from the set A-W, for each subject and each block. Of these letters, four were designated as targets (two assigned to the left response, two to the right response), and two were designated as flankers (one being displayed more often with left-response targets, the other with right-response targets). This procedure was also followed in the digit-flankers groups, with the exception that for each subject and each correlation block, four letters were randomly selected as targets while the flankers were two digits randomly selected from 1-9.

In the high-correlation (.92) block, one flanker was presented on 88 trials (valid flankers) with the two targets assigned to the left response (44 trials with each target; e.g., HTH-HAH or 3T3-3A3) and on only 8 trials (invalid flankers) with the two targets assigned to the right response (4 trials with each target; e.g., HLH-HRH or 3L3-3R3). These frequencies were reversed for the second flanker, which was displayed more often with targets assigned to the right response (e.g., BLB-BRB or 5L5-5R5) and less often with targets assigned to the left response (e.g., BTB-BAB or 5T5-5A5). In the low-correlation block, 56 valid and 40 invalid trials were presented for each flanker. Half of the subjects participated in the high-correlation block first, and the other half participated in the low-correlation block first.

At the beginning of each block, the four target letters were displayed on the monitor. The target letters were also displayed on tags, which were taped to the left and right response keys. The subjects were told that a row of three characters would be presented on each trial, and that only the middle character would be one of the targets. They were instructed to identify only the middle character and to ignore the flankers. In the groups for which no fixation point was provided, each trial began with the presentation of a blank screen for 1.5 sec, followed by the appearance of the stimulus display, which remained exposed until the subject responded or a 10-sec deadline expired. At the end of a trial, accuracy feedback was displayed for 1 sec. For the fixation-present groups, each trial began with a fixation cross presented at the location of the target. When the subject pressed the start key, fixation was replaced by the stimulus display, which remained on until a response was emitted or a 10-sec deadline had passed. At the end of a trial, accuracy feedback was displayed for 1 sec and was replaced by the fixation point. For all subjects, instructions stressed both speed and accuracy.

RESULTS

The results section is divided into three parts. The first part is an overall description of the data. The second part presents the results for each of the four between-subjects testing conditions. In the third part, comparisons of the magnitude of the flanker validity effect across testing conditions are presented.

Overall Description

Mean correct reaction times (RT), for each flanker validity level at each correlation block, were calculated for each subject in each testing condition. The mean latencies and percentage error rates for each testing condition are given in Table 1.

Error rate was very low for all testing conditions. The only significant effect was that of flanker validity [$F(1,92) = 4.99$, $MS_e = .0009$, $p < .05$]; subjects were less accurate on invalid trials. The error data showed no evidence of speed-accuracy tradeoff.

A mixed-design analysis was carried out on the RT data to examine the effect of location precuing, flanker category, correlation block, and flanker validity. The statistical analysis showed that the only significant main effect was that of the flanker validity [$F(1,92) = 54.40$, $MS_e = 568$, $p < .001$]; latency was shorter for valid trials than for invalid trials. There was also a significant interaction effect between correlation block and flanker validity [$F(1,92) = 27.56$, $MS_e = 545$, $p < .001$]. Overall, larger

Table 1
Mean Reaction Times and Percent Error Rates for Each Testing Condition ×
Correlation Block (High or Low) and Flanker Validity (Valid or Invalid)

		Flankers				
Condition	Correlation	Valid		Invalid		Difference
		RT	% Error	RT	% Error	
Letters						
No fixation	high	540	2.6	590	4.1	50
	low	560	2.6	562	2.8	2
Fixation	high	543	3.2	568	2.6	25
	low	555	3.3	561	3.0	6
Digits						
No fixation	high	537	2.7	560	3.1	23
	low	526	2.7	529	4.6	3
Fixation,	high	520	3.2	543	5.2	23
	low	516	3.4	528	3.2	12

flanker validity effects were observed in the high-correlation blocks. The latter pattern was more evident on conditions with no fixation and conditions with letters as flankers; the three-way interaction of correlation block × flanker validity × fixation presence was significant [$F(3,92) = 3.98$, $MS_e = 545$, $p < .05$], and the three-way interaction of correlation block × flanker validity × flanker category was marginally significant on RT [$F(1,92) = 3.63$, $MS_e = 545$, $p < .06$].

Individual Testing Conditions

No fixation, letter flankers. Analysis of correct RT data revealed that Miller's (1987) original results were replicated. The main effect of flanker validity [$F(1,23) = 18.79$, $MS_e = 864$, $p < .01$] and the interaction of correlation block × flanker validity [$F(1,23) = 14.49$, $MS_e = 1,009$, $p < .001$] were highly significant. As is shown in Table 1, no effect of flanker validity was apparent in the low-correlation block, where invalid responses were only 2 msec slower than valid responses [$F(1,23) = .07$, $MS_e = 398$, $p > .1$]. On the other hand, in the high-correlation block, a substantial flanker validity effect (50 msec) was found [$F(1,23) = 20.77$, $MS_e = 1,474$, $p < .001$].

Fixation, letter flankers. The analysis of correct RT data showed that subjects were slower (565 msec) for invalid than for valid trials (549 msec) [$F(1,23) = 20.90$, $MS_e = 283$, $p < .01$]. The interaction between flanker validity and correlation strength was also significant [$F(1,23) = 8.02$, $MS_e = 286$, $p < .01$]. Planned comparisons revealed that the small flanker effect (6 msec) observed in the low-correlation block was not significant [$F(1,23) = 2.63$, $MS_e = 157$, $p > .1$]. On the other hand, in the high-correlation block, there was a reliable (25-msec) flanker validity effect [$F(1,23) = 18.88$, $MS_e = 413$, $p < .001$].

No fixation, digit flankers. The statistics performed on the correct RT data showed a main effect of flanker validity [$F(1,23) = 9.03$, $MS_e = 443$, $p < .01$] and an interaction between flanker validity and correlation strength [$F(1,23) = 5.50$, $MS_e = 455$, $p < .05$]. In addition, planned contrasts revealed effects of flanker va-

lidity (23 msec) in the high-correlation block [$F(1,23) = 9.71$, $MS_e = 650$, $p < .01$], but not in the low-correlation block ($F < 1$).

Fixation, digit flankers. The analysis carried out on the correct RT data uncovered a main effect of flanker validity [$F(1,23) = 10.34$, $MS_e = 681$, $p < .01$]. However, the analysis failed to show an interaction between flanker validity and correlation strength [$F(1,23) = 1.83$, $MS_e = 431$, $p > .1$]. Contrary to what occurred in the previous conditions, there was a reliable 12-msec flanker validity effect in the low-correlation block [$F(1,23) = 8.24$, $MS_e = 189$, $p < .01$]. However, in agreement with previous findings, a significant flanker validity effect (23 msec) was also observed in the high-correlation block [$F(1,23) = 6.8$, $MS_e = 923$, $p < .05$].

Comparisons Across Testing Conditions

In order to determine whether target location precuing and flanker category influenced the size of the flanker validity effect, planned contrasts were performed using only the high-correlation block data. For each subject and each testing condition, a flanker validity score was computed by subtracting the valid trials' mean latency from the invalid trials' mean latency.¹ The results are displayed in Figure 1. As can be seen in Figure 1, the data confirm that positional uncertainty (fixation vs. no fixation) had a large effect on letter-flankers' interference. Inspection of Figure 1 also reveals that, in the absence of the fixation point, the flanker category modulated the size of the validity effect. Furthermore, one striking feature of Figure 1 is that although the digit-flankers versus letter-flankers distinction was obtained in the no-fixation conditions [$F(1,92) = 9.49$, $MS_e = 1,730$, $p < .01$], no such effect was apparent for the fixation conditions ($F < 1$).

Planned comparisons confirmed that the validity effect obtained under the fixation-letter-flankers condition (25 msec) was smaller than the effect obtained under the no-fixation-letter-flankers (50 msec) condition [$t(92) = 2.08$, $MS_e = 1,730$, $p < .025$]. This finding indicates that an attenuation in the letter-flankers effect resulted from predirecting attention to the target location. Furthermore, as predicted, under conditions of spatial uncertainty

Figure 1. Flanker validity effect for the high correlation (.92) block, for each testing condition.

(no fixation), digit flankers were easier to ignore than letter flankers [$t(92) = 2.25$, $MS_e = 1,730$, $p < .025$]. However, planned comparisons of the fixation-letter-flankers and fixation-digit-flankers validity scores failed to reveal any significant effects associated with flankers category [$t(92) = .005$, $MS_e = 1,730$, $p > .25$].

DISCUSSION

There is considerable evidence that people experience some difficulty when trying to ignore irrelevant stimuli (B. A. Eriksen & C. W. Eriksen, 1974; Glaser & Glaser, 1989; Shaffer & LaBerge, 1979; Smith & Magee, 1980; Stroop, 1935; Underwood, 1976). Although such effects may be taken as evidence for automatic semantic processing of unattended stimuli (Allport, 1980; Deutsch & Deutsch, 1963; Hirst, 1986; Shiffrin, 1988), a number of investigators (Broadbent, 1982; Johnston & Dark, 1986; Lambert, 1985; Yantis & Johnston, 1990) have criticized this account by linking interfering effects from distractors to failure of selective attention and/or to priming of the irrelevant stimuli. The present experiment was undertaken to investigate whether or not the flanker validity effect, which has been interpreted as evidence of semantic processing of unattended and unprimed distractors (Cowan, 1988; Miller, 1987), is subject to the preceding criticisms.

The experiment produced four main findings. First, the results confirm that considerable processing of letter

flankers takes place when subjects are not informed in advance of the precise target location. Although this pattern of results can be taken as evidence of semantic processing outside the focus of attention, it is more likely that, under positional uncertainty, subjects experience difficulty in restricting their attention to the target location. Accordingly, the letter flankers had a large impact on performance because attentional resources were distributed over the spatial location of the flankers.

In accordance with the above hypothesis, the second major finding in the present research established that the letter-flanker effect was considerably lessened when a fixation point informed subjects in advance of the location of the target. This finding is to be expected if subjects can more successfully filter the flankers when the target location is precued. This result indicates that little semantic processing of distractors takes place when an early spatial filtering of the flankers is possible. Essentially the same point was made recently by Yantis and Johnston (1990), who also employed a target location precuing procedure but, unlike the authors of the present study, used flankers that were target alternatives. In line with the present findings, these investigators found only minimal interference effects from the flankers when the target location was precued. At the theoretical level, such converging demonstrations that the magnitude of flanker effects is influenced by the ease of target selection are of special interest because they imply that early selection based on spatial location is a highly efficient selection mechanism that appears to facilitate exclusion of the flankers from full semantic processing.

In fact, our third main finding lends further support to this notion by showing that letter flankers and digit flankers have the same reduced impact on performance when the target location is cued in advance. This result is completely in line with the argument that when it is possible to select the target early, semantic processing of the flankers is limited.

Our fourth main finding in the present experiment is that when spatial filtering of the flankers was not optimal (i.e., under condition of spatial uncertainty), digit flankers had only a modest influence on subjects' performance. This result provides support for our argument that category congruity contributed to the large flanker validity effect reported by Miller (1987). There are at least two possible explanations for this finding. The first account rests on the notion that there is a category priming contribution to the letter-flankers effects found under positional uncertainty. According to this account, the reduced digit-flankers effect reflects the fact that, without priming, irrelevant stimuli are not semantically processed. This explanation is consistent with the early selection argument that interfering effects from irrelevant stimuli are often dependent on the likelihood of flanker priming. On the other hand, a second account attributes the diminished digit-flankers effects to a late selection mechanism based, perhaps, on categorical filtering of the flankers. One interesting implication of this account is that when early selection is suboptimal, late selection performs the func-

tion of removing the distraction produced by irrelevant flankers. This interpretation is in line with numerous suggestions (Broadbent, 1982; Johnston & Heinz, 1978; LaBerge & Brown, 1989; Pashler & Badgio, 1985; Yantis & Johnston, 1990) that attentional selection may occur at various stages. According to this argument, selection may occur early if the target and the distractors are distinguished by some basic physical properties (e.g., spatial location, color, orientation, featural differences). However, efficient target selection is also possible at later stages if the target can be discriminated from the flankers on the basis of a semantic distinction, such as the category to which it belongs (Broadbent, 1982; LaBerge & Brown, 1989). In addition, our finding that the target-flankers category had no effect on performance when the target location was precued suggests that the semantically based selection mechanism may only be operative if there is failure of the earlier physically based selection mechanism.²

However, it would be premature, on the sole basis of these results, to draw firm conclusions concerning the involvement of either category priming or categorical filtering in the present study. It is clearly essential to evaluate the possibility that factors other than category contrast contributed to the reduced digit-flankers effect. For example, it has been argued (Cardosi, 1986; Duncan, 1983; Krueger, 1984) that the physical resemblance between targets and flankers of the same category (both letters or both digits) is higher than the similarity across categories (letters vs. digits). Since differences in visual features between a target and distractors may be detected early, this featural information may have served as a basis for improved target selection when the target was surrounded by digit flankers rather than by letter flankers. However, our study was not designed to distinguish between these possibilities. A fruitful direction of subsequent research would involve replicating the present study, using a procedure in which physical differences between the target letters and the digit flankers would be minimized (Dixon & Shedden, 1987). This direction of research would help clarify whether the category effect is dependent on detection of distinctive features or on conceptual differences. Until further work is done, the possibility remains that the only selection mechanism that was operative in the present study was an early selection based on the spatial location and the featural characteristics of the target.

One other notable feature of the present results deserves comment. Why were we unable to completely eliminate the flanker validity effect, despite the fact that our precuing procedure should have promoted efficient selective processing of the target? On the one hand, the presence of such residual effects may be interpreted as evidence in favor of the view that unattended items undergo semantic analysis leading to full identification. However, a viable alternative is that our procedure did not permit complete focusing of attention. In particular, the residual flanker effects could be due to the small (.3°) character

spacing that we used. In fact, there have been several suggestions (see C. W. Eriksen & Hoffman, 1972, 1973; C. W. Eriksen & St. James, 1986; Johnston & Dark, 1986; Yantis & Johnston, 1990) that it may not be possible to filter out noise stimuli that are located within 1° of a target stimulus. To evaluate this properly, however, a systematic manipulation of the flanker-target spacing would be needed.

In summary, the major thrust of the present research is to limit the empirical argument that the flanker validity effect constitutes decisive evidence of semantic processing of "unattended" and "unprimed" distractors. Although no definite answer can yet be provided concerning the nature of the category effect, the present study points to the importance of category overlap as a determinant of flanker interference. More critically, the present results confirm the findings of other investigators (Yantis & Johnston, 1990) that flanker effects are modulated by the efficiency of target selection. Finally, our present findings, as well as recent arguments by Yantis and Johnston (1990) and Johnston and Dark (1986), suggest that distractor stimuli have limited impact on the processing of attended stimuli, if early selection of the target is possible.

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NOTES

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