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Facilitation and interference effects in a Stroop-like task: Evidence in favor of semantic processing of parafoveally-presented stimuli

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In this study we used a modified Stroop word–color task in which the target was a centrally fixated color frame and the distractor was an incompatible, compatible or non-color word. In Experiment 1 distractors were located either within (the inside condition) or outside the frame, at distances of 1.3 deg (near-outside condition) or 2 deg (far-outside condition). In Experiment 2 only the inside and the far conditions were used. The stimuli were on the screen for 150 msec (Experiment 1) or 50 msec (Experiment 2). A non-distractor condition was also included. In Experiment 1, incompatible distractors interfered with naming target colors, and this effect disappeared when the distractor was located far from the target. However, facilitation from compatible distractors was reliable in the farther location. These results were replicated in Experiment 2. The data suggest that (1) unattended items are processed semantically; (2) that facilitation and interference from words in color naming tasks can be caused by different mechanisms; and (3) that distractors are processed differently according to whether they are near or far from fixation.

1. Stroop effect and selective attention

Stroop (1935) observed that naming the ink in which a word was printed took longer when the meaning of the word mismatched the color of the ink (e.g. 'RED' printed in *blue* color), compared with a neutral condition. Since then, the Stroop interference effect has been used in several studies to assess whether selection takes place early or late in vision. An early selection view (e.g. Hock and Egeth, 1970) localizes the effect at input: because the task has

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to do with naming colors, color names would catch attention, interfering with the processing of the color of the ink. However, most studies interpret the Stroop effect as a result of response competition. That is, form and color of stimulus are processed in parallel, and when these two sources of information elicit different responses interference effects are apparent (Hintzman et al., 1972; Keele, 1972; Morton and Chambers, 1973; Posner and Snyder, 1975). This explanation localizes the effect at output, and supports a late selection view (see Deutsch and Deutsch, 1963).

In the classic case, the relevant and irrelevant stimuli are integrated. It has been suggested that selective attention is allocated to objects rather than to parts (Treisman et al., 1983), so that processing of relevant and irrelevant properties of stimuli can be facilitated. Thus, studies using the classic color-naming task assessed only processing of attended stimuli. However, when the relevant and irrelevant stimuli are physically separated, early and late selection processes can be tested by assessing whether Stroop-like effects (i.e. facilitation from compatible items, interference from incompatible items) still occur from unattended items.

2. Stroop-like interference and facilitation effects

In one variation of the typical Stroop (1935) task, one colored patch/picture (the target) can be presented simultaneously with a color name (the distractor) displayed above–below, left–right or embedded within the color frame. Subjects are required to name the color of the target. The distractor can be a color word compatible with the target color (i.e. the word RED displayed with a red patch), an incompatible word (i.e. the word RED displayed with a green patch), or neutral (a non-color word or a string of Xs). Compared with the neutral condition, incompatible words increase naming latencies to target colors (i.e. there are interference effects), whereas compatible ones shorten the time to respond (i.e. there are facilitation effects). However, such effects seem contingent upon at least two circumstances.

First, effects depend on the separation of distractors from a target (Eriksen and Eriksen, 1974; Eriksen and Hoffman, 1973; Eriksen and Schultz, 1979). As the classic study by Eriksen and Eriksen (1974) showed, reaction time to a letter appearing at a known place decreases when other letters (distractors) associated with a different response appear within 1 deg visual angle of the target. When the distractors were separated from the target by more than 1 deg visual angle, their identity had no effect. These and other results led some authors to conceive of spatial attention as the beam of a spotlight (e.g. Broadbent, 1982; Johnston and Dark, 1982, 1986; LaBerge, 1983). Within this beam, stimuli are admitted to further processing. Outside of it, stimuli receive little or no processing, except for the processing afforded to simple physical features. This viewpoint is defended by theoretical positions based on early selection (e.g. Broadbent, 1982; Johnston and Dark, 1986; Kahneman and Treisman, 1984), that assume that perception is subject to attentional modulation or top-down control.

Second, effects depend on the size of the distractors (Holender, 1986; Merikle and Gorewich, 1979). Some studies have shown that distractors separated from the target by 3 degrees or more are able to decrease response latencies to the target (e.g. Gatti and Egeth, 1978; Underwood, 1981). For example, Gatti and Egeth (1978) required subjects to identify the color of a target patch in the center of a briefly exposed display and to ignore color names presented above and below the patch at distances of 1, 3, and 5 deg of visual angle. Results showed interference even with a 5-deg separation between target and distractor. Since the identity of the color word can disrupt the response to the color patch, it seems that words can activate identity unintentionally. That contention is defended by theoretical positions based upon late selection (e.g. Deutsch and Deutsch, 1963; Duncan, 1980; Keele and Neill, 1978; Posner, 1978; Posner and Snyder, 1975; Schneider and Shiffrin, 1977; Shiffrin and Schneider, 1977; Van der Heijden, 1981), where perception is considered as a data-driven or bottom-up process in nature. According to this view, irrelevant stimuli could undergo complete perceptual processing, even when attention appears to be focussed on relevant stimuli.

Although Gatti and Egeth's results apparently give some support to the idea that stimuli presented on the parafovea are semantically processed without attention, an alternative explanation based upon visual acuity may also be held (see Merikle and Gorewich, 1979, for a similar explanation of Gatti and Egeth' study). The letters used by Gatti and Egeth (1978) were so large (each letter subtended 1.2×1.2 deg) that it could compensate for reduced acuity due to their peripheral location on the visual field. In order to test the visual acuity hypothesis, Merikle and Gorewich (1979) replicated Gatti and Egeth's (1978) experiment but some details were modified. Each letter subtended either 0.24 or 0.57 deg of visual angle. Also, color names were presented at distances of either 0.5 or 2.5 deg of visual angle, above and below the target. Relative to a comparable neutral distractor, the large distractor decreased color-naming reaction times at both target–distractor separations, but the small distractor only affected reaction times when the target–distractor separation was 0.5 deg. As Holender (1986) has pointed out, the size of stimuli used in several studies reporting interference from parafoveal stimuli, could lead to them being attended (on at least some occasions).

Hagenaar and Van der Heijden (1986) also tested the visual acuity hypothesis. These authors criticized Gatti and Egeth's (1978) and Merikle and Gorewich's (1979) results because increasing target–distractor separation was confounded with decreasing retinal acuity for the parafoveal stimuli.

When unequal retinal acuity was prevented by using a circular display, interference was found from both near and far distractors (Hagenaar and Van der Heijden, 1986; see also Experiment 2 for a clearer demonstration), supporting a late selection view of performance. In an other study, Humphreys (1981, Experiment 1) showed that interference produced by a foveal distractor on response to a target presented simultaneously to the parafovea at different degrees of eccentricity, was due to subjects attending to the distractor rather than differences in retinal acuity, since the effect did not change as targets were displaced further from fixation (up to 2 deg).

So far, the issue concerning the processing of parafoveal unattended stimuli is far from clear.

The above criticisms about the confounding effects of separation and retinal acuity, might cast doubts about the usefulness of horizontal arrangements of stimuli to study the effects of parafoveal words on foveal targets. Nevertheless, a common property of the aforementioned studies is that processing of parafoveal distractors is mainly evaluated through interference effects. Interference seems to be the most common effect reported by different authors, when subjects have to focus their attention on the target and to ignore the irrelevant parafoveal stimuli (Eriksen and Eriksen, 1974; Gatti and Egeth, 1978; Merikle and Gorewich, 1979; Underwood, 1976, 1981; Underwood and Thwaites, 1982; Underwood et al., 1983). Thus interference has been considered as the most important evidence telling us that parafoveal stimuli have been processed.

While Stroop interference has proved to be a robust effect, Stroop facilitation has not. Most studies have failed to observe facilitation effects in Stroop-type tasks in which the target is the to-be-attended stimulus, and the distractor is the to-be-ignored one. Also, when facilitation effects have been obtained their size is much less than the interference shown in the incompatible conditions (see MacLeod, 1991, for a recent review of these studies). However, facilitation does not seem to be the only counterpart of interference. Using different varieties of the Stroop task, some authors have reported qualitative differences in the behavior of both facilitation and interference as a function of several variables. For instance, La Heij and Vermeij (1987) varied the size of the stimulus set from two to eight. When subjects were engaged in a picture-naming task, interference decreased and facilitation increased relative to the neutral condition when the stimulus set increased from two to eight. Glaser and Düngelhoff (1984) used a picture-naming task with irrelevant word distractors, in which the SOA between the picture and the word was varied. When subjects were told to name the picture, both facilitation and interference effects were observed with SOA values within the 100 msec. When the word preceded the picture by more than 100 msec, facilitation remained strong but interference decreased. Results reported by Gatti and Egeth (1978) suggest that interference de-

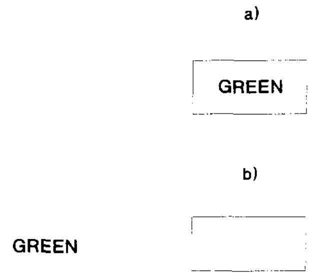

Fig. 1. Examples of stimulus displays used in the experiments: (a) inside condition; (b) outside condition (far or near). See text for more details.

creases drastically with eccentricity, but facilitation does not. Thus, it seems that facilitation is smaller and more fragile than interference, but over and above this, they may be driven by different mechanisms.

In the present research, we examined whether facilitation from unattended compatible stimuli could still occur even when interference from incongruent stimuli decreased. We used a modified Stroop word–color task in which the target was a centrally fixated color rectangular frame, and the distractor was a compatible, incompatible or non-color word printed either inside or outside the color frame (randomly left or right at different distances; see Fig. 1). We took special care with the size of distractors to try to make the present study comparable to those in which interference effects have been shown to disappear with distractor eccentricity (see method section below).

From previous results, we can expect interference effects to decrease at greater distractor–target distances; the question is: does this also hold true for facilitation effects?

3. Experiment 1

In this experiment we attempted to replicate Merikle and Gorewich's (1979) results with 'small distractors'. As mentioned above, these authors showed that, when presented 2.5 deg from fixation (at the 'far' distractor location), incompatible distractors did not interfere with responses to targets. In addition, we extended their result by also using compatible distractors and targets on some trials.

3.1. Method

Subjects

Sixteen undergraduates (8 female, 8 male) from the University Campus of Almeria aged 18–23 years participated. They were tested individually and received course credits for their participation. All had normal or corrected-to-normal vision.

Apparatus and materials

A Scientific Prototype three channel tachistoscope (S-1000) was wired in circuit with a microphone and a timer to obtain vocal RTs.

A deck of 240 stimulus cards was constructed by coloring a rectangular frame (the target stimulus) subtending 0.44×1.33 deg in the center of each card. Three colors were used: blue, green, and red. A word printed in black ink (the distractor stimulus) was arranged horizontally within the visual field. When viewed through the tachistoscope, each letter subtended a width of about 0.20 deg and a height of about 0.13 deg. The word could be a color name (AZUL 'blue', VERDE 'green' or ROJO 'red'), which was nominally the same as the color of the frame (compatible distractor condition), nominally different from it (incompatible distractor condition), or a non-color word (e.g. MANO 'hand', CASA 'house', GATO 'cat', see the Appendix). Special care was taken that non-color words were not associated with a specific color.

For each of the compatible, incompatible, and non-color word conditions, there were three different distractor locations: within the frame (inside), 1.33 deg (near) or 2 deg (far) to the left or right of the frame. Distances were measured from the center of the frame to the inner edge of the word.

In addition, 8 cards with each of the color frames alone were constructed (the non-distractor condition).

Procedure

Subjects were told that the experiment investigated how fast individuals could identify colors. A trial was initiated by a warning signal (a 500 msec tone), followed by a lasting 500 msec fixation dot at the center of the screen. Subjects were instructed to maintain their gaze at fixation until the trial had been finished. Following the fixation dot the screen was blank for 500 msec and after that a stimulus card appeared for 150 msec. Subjects were encouraged to name the color of the frame as quickly as possible, trying not to make any errors. Subjects were also warned of the deleterious effect of words, which would appear simultaneously with the frame in most trials. They were advised that their performance would be faster and more accurate if they looked only at the target. Vocal responses were registered and 4 seconds after responding a new trial was initiated.

There were 24 practice trials followed by 240 experimental trials: 24 trials (8 for each type of color) in which the color frame was presented alone (the non-distractor condition) and 216 trials with a word appearing along with the frame (the distractor conditions). There were 72 trials for each distractor location (inside, near or far). Each of these three 72-trial sets, was divided into three compatibility conditions, 24 for the compatible distractor condi-

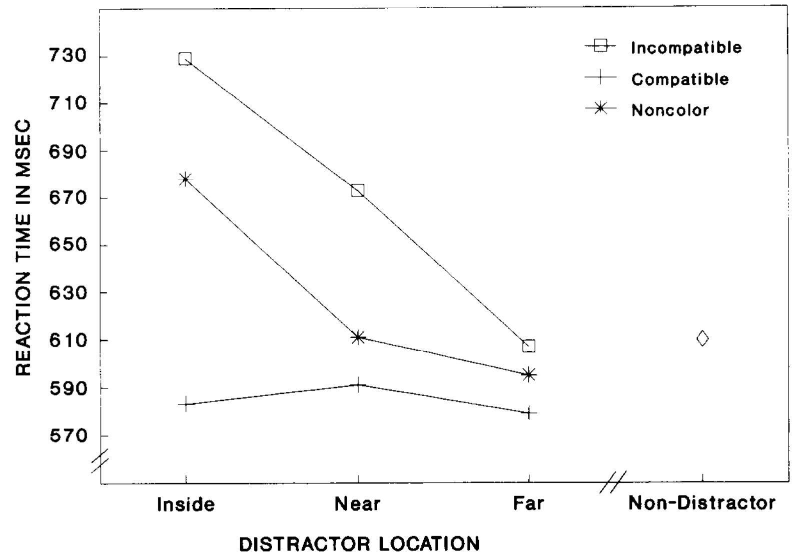

Fig. 2. Experiment 1: Mean reaction time (RT) for the three compatibility conditions (incompatible, compatible and non-color words) as a function of target–distractor location (inside, near, or far). Mean latency for non-distractor condition has also been included.

tion, 24 for the incompatible distractor condition and 24 for the non-color condition. In each of these compatibility conditions, there were 8 trials for each of the color frames (blue, green and red). For the distractor conditions with the word appearing separated from the frame, the word was located on the left visual field on half the trials, and on the right visual field on the other half. Each subject received a different random sequence of trials.

Trials on which the response was wrong were discarded and rerun randomly later.

The main dependent variable was the vocal reaction time (RT) to the color frame. Errors were also registered in order to examine possible trade-off effects between latency and accuracy.

3.2. Results and discussion

Fig. 2 shows the results for each experimental condition. A previous analysis including the visual field of the distractor as a factor, failed to show any reliable effect of this factor. Thus, the data were collapsed over the field factor.

A two-way within subject analysis of variance (ANOVA) on mean RTs was performed. There was a reliable effect of conditions (incompatible, compatible, or non-color) ($F(2,30) = 89.5$, $MSe = 974.9$, $p < 0.001$; the mean RTs for compatible, incompatible and non-color words were 584, 669, and 628 msec respectively). The overall effect of distractor location (inside, near, or far) and the condition × location interaction were also reliable ($F(2,30) = 58.7$, $MSe = 995.09$, $p < 0.001$; and $F(4,60) = 27.8$, $MSe = 587.19$, $p < 0.001$ respectively; the mean RTs for inside, near and far locations were 663, 625, and 594 msec respectively). Error rates were too low to analyze.

As Jonides and Mack (1984) have pointed out, it is difficult to identify a true neutral condition to observe facilitation and interference effects unambiguously. Thus we considered both non-color word and non-distractor data as baselines for comparisons, contending that to observe similar results for both of them will avoid problems due to the choice of baseline (see the General Discussion for a more extensive comment on neutral conditions)

As expected, the influence of incompatible distractors on target responses depended critically on distractor location. Response latencies decreased as the incompatible distractor was separated from the target. In contrast, the pattern shown by compatible distractors was completely different. As interference from incompatible distractors decreased, and even when it was eliminated, compatible words still produced facilitation. To provide good support for these observations we carried out pairwise comparisons in which both non-color and non-distractor RTs were considered as the baseline. Fisher's tests (LSD) were calculated for post-hoc comparisons between means, and the 0.05 level was used as criterion for statistical significance in these analyses.

At the inside location, there was a reliable effect of the conditions on RT, $F(3,45) = 52.4$, $MSe = 1332.26$, $p < 0.001$, (compatible = 583 msec, incompatible = 729 msec, non-color = 678, and non-distractor = 610 msec). Post-hoc comparisons (LSD = 26 msec) showed that all pairwise differences were reliable.

At the near location, there was again a main effect of conditions, $F(3,45) = 23.1$, $MSe = 881.6$, $p < 0.001$ (compatible = 591 msec, incompatible = 673 msec, non-color = 611, and non-distractor = 610 msec). Comparisons (LSD = 21 msec) showed that latencies with incompatible words were significantly longer than in any of the other three conditions, which did not differ.

At the far location, the effect of conditions remained reliable, $F(3,45) = 9.1$, $MSe = 351.76$, $p < 0.001$ (compatible = 579 msec, incompatible = 607 msec, non-color = 595, and non-distractor = 610 msec). Comparisons (LSD = 13 msec) showed that responses were faster with compatible words than with any of the other conditions, among which there were no reliable differences.

The interference effect found in this experiment replicates that of Merikle and Gorewich (1979) with small distractors. However, even though the interference disappeared with distractors presented at the far location, facilitation for compatible distractors was still observed. These results suggest that Stroop-like facilitation and interference effects can show different patterns.

Several studies (Gatti and Egeth, 1978; Hagenaar and Van der Heijden, 1986; Merikle and Gorewich, 1979) have shown separate effects of spatial separation and visual acuity, concluding that acuity loss was probably responsible for any decrease in interference from incompatible stimuli in Stroop-like conditions. Even so, distractors presented 2 deg away facilitated the target responses. This suggests that processing of parafoveal words does not depend completely upon visual acuity, at least within the degree of eccentricity that we have explored here (see also Humphreys, 1981). The size of the distractors also cannot explain the facilitation effect in the far condition. For instance, it is highly unlikely that subjects attended to these items because of their size (cf. Holender, 1986); indeed they were rather small in comparison with items used in other experiments (e.g. Gatti and Egeth, 1978; Merikle and Gorewich, 1979).

The results in the far location condition support the claim that unattended distractors are processed semantically. Further, unattended items lead to facilitation when compatible to targets, but fail to produce interference when they are incompatible. In contrast, in the near and inside location conditions, distractors may attract attention, and so exert their effects by virtue of being attended. Hence both facilitatory (in the compatible condition) and interfering effects (in the incompatible condition) are apparent. These results extend to a Stroop-like paradigm what Fuentes and Tudela (1992) observed using a lexical decision task. In their study, the prime display consisted of two words, one at fixation (the foveal attended word) and the other displaced from it (the parafoveal unattended word), followed by a target display containing only one word (or nonword) presented at fixation. Fuentes and Tudela found that when there was a long interval between the prime and target, both foveal primes and parafoveal primes displaced from fixation by 4.3 deg produced semantic priming. However, when the parafoveal prime was presented nearer to the foveal prime, semantic priming from the former was eliminated and semantic priming from the latter was reliably reduced. Thus near distractor effects must be mainly explained in terms of interference.

The results of Experiment 1 agree with the idea of semantic processing of parafoveal unattended stimuli, in line with late selection positions. Nonetheless, the pattern of facilitation without interference at the far location is rather unusual (though, Miller, 1991, has recently reported a similar result; see his Experiment 1). In order to allow definitive conclusions to be drawn, the data were replicated in Experiment 2, using only the inside and far location conditions.

4. Experiment 2

Experiment 1 showed facilitation with distractors widely separated from the target. However, the exposure duration of the stimulus display (150 msec) may have been long enough to allow the subjects to process the color of the frame and to shift their attention onto the parafoveal stimulus. Considerable evidence indicates that visual features such as color and orientation are processed in parallel across the visual field. Furthermore, the time course for attention shifts is in the range of 50–100 msec following the presentation of the peripheral target (cf. Posner, 1980; Tsal, 1983). Hence, 150 msec presentations may be sufficiently long to allow both responses to the color of the frame, and attention shifts to distractors. In order to minimize the probability of such shifts, in Experiment 2 the exposure time of the stimuli was shortened to 50 msec.

The reduction in stimulus duration may also have two additional effects. First, it increases the difficulty of identifying parafoveal words, even when subjects are deliberately told to do so (Underwood, 1981). Second, it narrows the flexible beam of spotlight (LaBerge et al., 1991; only one subject out of four was given a duration of less than 50 msec in their Experiment 3). Thus by means of reducing exposure time of stimuli, we expect to prevent possible spilling over of attention onto the parafovea from occurring in this experiment.

4.1. Method

Subjects

Ten undergraduates (5 female and 5 male) from the Campus Universitario of Almeria, aged 18–22 years, participated in this experiment. They were tested individually and received course credits for their participation. None of the subjects had been tested in the previous experiment. All had normal or corrected-to-normal vision.

Apparatus and stimuli

The same laboratory equipment and experimental stimuli were used as in Experiment 1.

Procedure

Stimuli were displayed for 50 msec. Only two levels of target–distractor separation were manipulated: distractor was either within the frame (inside) or separated from the frame by 2 deg (far).

In all other respects, the method was the same as for Experiment 1.

4.2. Results and discussion

Fig. 3 shows the mean RTs for each experimental condition. A two-way within-subject analysis of variance (ANOVA) showed a reliable overall effect of condition ($F(2,18) = 89.4$, $MSe = 327.85$, $p < 0.001$; the mean RTs for

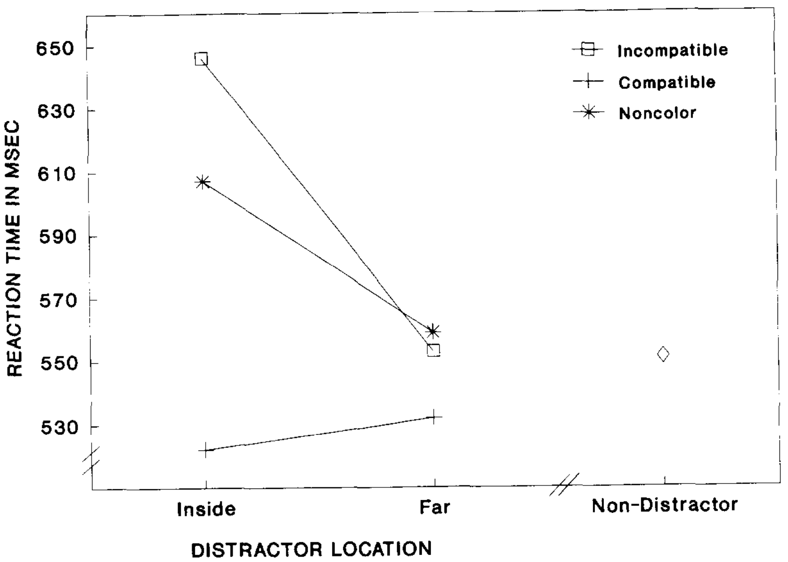

Fig. 3. Experiment 2: Mean reaction time (RT) for the three compatibility conditions (incompatible, compatible and non-color words) as a function of target–distractor location (inside, or far). Mean latency for non-distractor condition has been also included.

incompatible, compatible and non-color words were 547, 619, 603 msec respectively). The main effect of location and the condition × location interaction were also statistically significant ($F(1,9) = 55.17$, $MSe = 516$, $p < 0.001$, and $F(2,18) = 23.4$, $MSe = 567.3$, $p < 0.001$ respectively; the mean RTs for inside and far distractors were 612 and 568 msec respectively). Error rates were too low to analyze.

As in Experiment 1, both non-color and non-distractor RTs were used as the baseline.

For the inside location, there was a reliable effect of condition on RT, $F(3,27) = 66.8$, $MSe = 465.6$, $p < 0.001$, (compatible = 542 msec, incompatible = 666 msec, non-color = 627 msec, and non-distractor = 571 msec). Post-hoc comparisons (LSD = 19 msec) showed that all pairwise differences were reliable.

The effect of condition was also reliable at the far location, $F(3,27) = 3.7$, $MSe = 389.8$, $p < 0.025$, (compatible = 552 msec, incompatible = 573 msec, non-color = 579 msec, and non-distractor = 571 msec). Comparisons (LSD = 18 msec) showed that responses with compatible words were significantly faster than in any of the other three conditions, among which there were no reliable differences.

These results nicely replicate those obtained in Experiment 1. When distractors are located far from the target, they did not interfere with target responses. In contrast, compatible distractors still facilitated responses. The reduction in stimulus exposure time in Experiment 2 should prevent attention being switched from the target to the distractor. In spite of this, these stimuli appear to have been semantically processed, thus facilitating responses to compatible color frames. The replication of the results from the first experiment gives serious support for the claims that (1) unattended items are processed semantically; (2) that facilitation and interference from words in color naming tasks can be caused by different mechanisms; and (3) that distractors are processed differently according to whether they are near or far from fixation.

5. General discussion

We have divided the general discussion into 2 main sections. The first is concerned with the choice of the neutral condition; and the second is concerned with the implications of the present study regarding the processing of unattended stimuli.

5.1. Non-color words and non-distractor conditions as the neutral baseline

Most studies using Stroop-like tasks have been concerned with interference from incompatible distractors, usually measured relative to an XXXX control (MacLeod, 1991). When compatible trials have been included either no or only small facilitation effects have been reported (cf. Gatti and Egeth, 1978). In contrast, several studies that have used an unrelated-word condition as the baseline have reported both interference and facilitation (e.g. Hintzman et al., 1972). Thus, one could argue that facilitation depends upon the choice of the baseline. In other words, a non-color word condition could interfere with color-naming responses and therefore overestimate facilitation at the expense of interference. However, just the opposite could be said regarding the use of a string of Xs as the baseline. In this condition the baselines differ in so many aspects from color words (structural differences within the string, string lexicality and spelling, etc.) that interference could be overestimated at the expense of facilitation (cf. Jonides and Mack, 1984). Further, the contention that facilitation is contingent on the use of non-color words as controls is not true. Dyer (1973) found both facilitation and interference effects with respect to the XXXX control using a task in which, as in the present experiments, words and color patches were separated.

The choice of a non-distractor condition [1] as baseline is also controversial. While Gatti and Egeth (1978) did not find any facilitation effects with respect to this condition, Ehri (1976) did so in a picture-naming task.

So far, the choice of the best baseline condition in Stroop-like tasks is an unresolved question. The strategy followed for the present research was to choose two different baselines with the reasoning that, if similar patterns of results were observed with both baselines, confidence could be extended that facilitation effects were not due solely to a decreased baseline in the non-color word condition (which itself causes interference) since there can be no interference in the non-distractor control. Non-color words were preferable to a row of Xs because the former differ from the color words just in meaning, the critical aspect; while the latter differ in many aspects (structure, lexicality, spelling, etc.) other than meaning (cf. Jonides and Mack, 1984).

5.2. Processing of stimuli displayed outside the attention focus

The interference effects from incompatible distractors obtained in our experiments replicate those reported in a number of previous studies. Distractors located either inside or near the target produced interference. When they were displaced from the target by 2 deg, interference disappeared. Such a result has previously been taken to support an early selection account of processing.

However, the major finding of the present research was the pattern observed with compatible distractors. Facilitation was observed irrespective of the distractor location. This result favors a late-selection view of performance, since it suggests that distractor words were processed semantically, thus facilitating color naming. The result also indicates that the absence of interference from far distractors cannot be due solely to reduced retinal acuity (Hagenaar and Van der Heijden, 1986).

It is unlikely that subjects did attend to distractors under the present exposure conditions. In Experiment 2, 50 msec target exposures were used, minimizing the possibility that subjects might switch attention from targets to distractors. Further, evidence from our two baseline conditions confirms that distractors were unattended. Using conditions similar to the present baselines, Kahneman et al. (1983) found that, when subjects attended to both targets and distractors, there was a reliable RT cost when the distractor was an irrelevant word relative to when no distractor appeared (Kahneman et al. term this a filtering cost). Our failure to find such a difference in the far and near conditions indicates that distractors were not attended. Note further that a 'filtering cost' (a difference between the non-color word baseline and

[1] An anonymous reviewer has suggested that some slowing down may be caused in this condition because subjects expect frame + distracting word in most trials. If this is true, one should expect this effect to be present in other related studies. That is not the case. Gatti and Egeth (1978) found that this condition produced the fastest reaction time as can be inferred from their figure. Other studies have also included a non-distractor condition as the only baseline (e.g. Kahneman et al., 1983; Treisman et al., 1983).

the non-distractor baseline) was present in the inside condition, compatible with distractors being attended. Thus the experiments are sensitive to such an effect.

An alternative explanation is that the identity of color names is task-relevant and might be highly primed. In this case even shallow processing of parafoveal distractors would be sufficient for semantic activation (Treisman, 1964). However, this explanation does not account for why incompatible color words did not yield interference at the far location whereas compatible color words did yield facilitation. It could be argued that facilitation is an overall more sensitive measure of distractor processing, and therefore less affected by eccentricity than interference is. However, that does not fit with the previous studies as mentioned in the introduction. Nor does it fit with the fact that in Experiment 1 the interference effect was greater than the facilitation effect at the near location (62 msec and 20 msec respectively).

Instead, our results agree with the idea of semantic processing of unattended parafoveal stimuli in line with late selection views. In both the near and the inside conditions distractors may be attended, with the result that both target and distractor compete for the response. The interference and facilitation produced by incompatible and compatible distractors, respectively, is in this case due to effects on response selection. In contrast, in the far location condition distractors are not attended. We suggest that, under these circumstances, response processes are not contacted by primes and, as a consequence, interference effects are eliminated. Nevertheless, primes may still affect performance by activating the semantic representation contacted by the target. By activating this representation, over and above the activation created in the baseline conditions, target responses are enhanced. In other words, while response competition can bring about interference effects, facilitation effects may reflect enhanced perceptual processing (e.g. preactivation of the target's representation) and may not be contingent on stimuli being attended.

To summarize, the present experiments show that lack of Stroop-like interference is not sufficient to determine whether or not unattended parafoveal stimuli have been processed semantically. Even when this is the case, facilitation from compatible primes can still be observed. We attribute these differences to facilitation and interference effects from primes arising from contrasting causes: facilitated access to semantic representation of targets and response competition respectively. We interpret the data in favor of a late selection account of performance. In line with the conclusion that the absence of interference effects is not sufficient to favor early selection is evidence from research on negative priming. Distractors which do not interfere with responses to a concurrent target can produce longer RTs when they are presented as targets in the next trial (Allport et al., 1985; Tipper, 1985; Yee, 1991).

In tasks where target and distractors are displayed simultaneously, interference effects have been useful for studying the span of the attention focus (Eriksen and Eriksen, 1974; Humphreys, 1981; LaBerge, 1983; LaBerge et al., 1991). However, in order to understand the nature of processing afforded to distractors appearing at different locations, both facilitation and interference should be taken into account.

Appendix

Non-color words used in the present experiments

BARBA	'chin'	GORRO	'hat'	PISO	'flat'
BESO	'kiss'	LAZO	'loop'	RELOJ	'watch'
CASA	'house'	LLAVE	'key'	RUEDA	'wheel'
CEJA	'eyebrow'	MANO	'hand'	SACO	'bag'
CUBO	'cube'	MONO	'monkey'	TARDE	'afternoon'
DURO	'hard/coin'	PASO	'passage'	TAZA	'cup'
GATO	'cat'	PATA	'leg'	TELA	'cloth'
GOMA	'gum'	PELO	'hair'	VINO	'wine'

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