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Temporal Interactions between Target and Distractor Processing: Positive and Negative Priming Effects

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The flankers paradigm and the prime/probe paradigm for the study of positive and negative priming are based on the compatibility between relevant and irrelevant information present in the same stimuli or stimuli that are spatially or temporally contiguous. In the flankers paradigm, distractors presented at the same time as the target can produce enhanced performance for compatible flankers and impaired performance for incompatible ones. In the priming paradigm, distractors can facilitate or interfere with responses to compatible targets that are presented later. In the experiments described here we have achieved a gradual transition between these two paradigms, through the use of the Rapid Serial Visual Presentation (RSVP) procedure, by manipulating distractor compatibility and the temporal spacing between distractors and targets. With short SOAs compatible distractors facilitate and incompatible distractors interfere; but with SOAs around 400 ms performance is worse with compatible than with incompatible distractors. Similar results have been obtained either with paradigms in which participants must make a response to the stimulus that produces the effect (it is a target) or with paradigms where they do not have to make a response (it is a distractor). The present results provide strong constraints on theoretical explanations for the flanker compatibility effect and the temporal dynamics of positive and negative priming.

One of the main procedures for studying selective attention (i.e.; how we focus attention on relevant stimulus objects or information channels and ignore irrelevant stimuli or sources) is to manipulate the relationship between relevant and irrelevant material. If responses to relevant (target) stimuli depend

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on certain characteristics of accompanying distractors, then it can be inferred that these characteristics are extracted and processed despite attempts to ignore them (Botella & Barriopedro, 1999). It is upon this logic that many experimental paradigms are based, which have produced such well-known phenomena as the flanker compatibility effect (Eriksen, 1995) or the negative priming effect (Fox, 1995).

The flanker compatibility effect and the Stroop effect are particular examples of how irrelevant information can affect the speed and accuracy of responses to concurrent targets, and the nature and degree of these effects depend on characteristics of the distractors and the target-distractor relationship. Distractor effects are found even if precise advance information is provided about how to discriminate between the relevant and irrelevant information. Compatible distractors typically facilitate responses to targets whereas incompatible ones interfere with them (Eriksen, 1995; Eriksen & Eriksen, 1974; Fox, 1995; McLeod, 1991).

In negative priming (NP) it is observed that performance deteriorates when a current target stimulus had been used as a distractor on the previous trial. Responses to the target stimulus are influenced by some type of memory of the selection process, or the stimulus-response episode, that inhibits the response to the current target item when it had previously served as a distractor (Fox, 1995; Lupiañez, Rueda, Ruz, & Tudela, 2000; Milliken & Tipper, 1998; Neill, 1977; Neill & Valdes, 1996; Neill, Valdes, & Terry, 1995; Ortells, Abad, Noguera & Lupiañez, 2000; Tipper, 1985).

In order to study temporal characteristics of target-distractor similarity, other researchers have used a series of items presented in the rapid serial visual presentation (RSVP) mode. Target repetitions, rather than showing repetition priming, have sometimes shown a curious repetition blindness phenomenon (Kanwisher, 1987), in which the second target is not reported as accurately as the first. A similar phenomenon, known as the attentional blink, describes the failure to report or detect a second target or probe item in an RSVP stream, even when it differs from the first (Raymond, Shapiro, & Arnell, 1992). More important here, both of these phenomena have also been shown to depend on characteristics of the target-distractor relationship in the RSVP stream (Chun, 1997; Chun & Potter, 1995).

In general, it has been established that in tasks with simultaneous presentations of targets and distractors, distractors linked to responses compatible with those to the target have a facilitating effect, and those linked with incompatible responses lead to interference. This effect is most frequently found when the target location is known and the distractors are located physically adjacent to the target. When the target location is not known, and distractors are scattered across the visual field, target-distractor similarity has an interfering effect. In tasks with successive prime/probe trials, distractors can have a somewhat paradoxical interfering effect on a delayed target with which they are compatible. There have been some studies of changes in the flanker compatibility effect when the stimulus-onset asynchrony (SOA) between distractors and targets is manipulated. Given that the main difference between the procedures in which simultaneous vs. sequential factors in the distractor interference effect are observed is the time interval between target and distractor presentation, we might ask ourselves why, on manipulating SOA for studying the temporal course of the flanker compatibility effect, a finding similar to negative priming has not been demonstrated in long SOA conditions.

Similarly, the influence of SOA on negative priming has also been studied, although SOA has rarely been shortened enough to produce facilitation for responses to identical targets presented in the following trial. Nevertheless, there are some examples of positive priming from the distractors ignored in the previous trial, and differences between positive and negative priming results might well depend on the SOA between distractors and subsequent targets (e.g., Fuentes, & Tudela, 1992; Yee, 1991).

All those experimental results could be viewed as part of a broader concept that could be termed “context effect” (Taylor, 1977). From this perspective, processing of a target is enhanced or impaired by many factors; some of them are the number of ‘irrelevant’ stimuli and their relationships with the target, the SOA between the distractors and the target, whether a response is made to the irrelevant stimuli, and so on. In each situation the context effect is the combined effect of all these factors. Each combination is the balance between the effects of the facilitative and interfering factors. The experimental paradigms usually employed for the study of selective attention (as the flankers paradigm or the prime-probe paradigm for the study of negative priming) are particular combinations of them and, so, each phenomenon is the result of how those factors are managed in that particular experimental paradigm. As a consequence, if two paradigms only differ in one factor and a manipulation of that factor is made in the procedure then it should be possible to find a gradual transition between the phenomenon. We believe that the flankers paradigm and some versions of the prime/probe paradigm for the study of NP constitute an exemplar of this, being the SOA the differential factor.

The main goal of the present research is to study the transition between positive and negative priming effects, as parts of a more general "context effect" (Taylor, 1977), in an attempt to show the need of a theoretical continuum of the role of distractors in target processing. Specifically, it is possible that increasing SOA produces a change of the distractor effect from a "direct" effect to an "inverted" effect ("direct" referring to that of simultaneous distractors and "inverted" to that corresponding to the negative priming). It follows from such result the need for developing a unified theory to encompass all those phenomenon that are produced as part of the “context effect”.

A secondary goal is to verify, manipulating distractor compatibility, that stimuli presented with brief SOAs in the RSVP technique are processed until they are identified, even though they may not be reportable. There has been a certain controversy as to whether, in Lawrence's (1971) RSVP task, for example, stimulus features sufficient for identification are extracted in parallel before detection of the target (Botella, 1992, 1998; Botella, García, & Barriopedro, 1992; Keele & Neill, 1978; Luck, Vogel, & Shapiro, 1996) or whether they are identified only after detection of the feature that defines the target (Broadbent, 1977; Lawrence, 1971; McLean, Broadbent, & Broadbent, 1982). In the experiments described below we use a task similar to that of Lawrence, but with rapid response requirements. The fulfillment of the second goal (that is, finding evidence that stimuli presented before the target are actually identified) is a necessary condition to be able to achieve the first goal, since if the distractors presented in these conditions were not identified, neither flanker compatibility nor positive or negative priming effects should be produced.

At first sight, the simplest way to achieve these goals would be to desynchronize the presentation of the distractors and the target, observing the changes in the influence of the distractors on target processing as a function of the distractor/target SOA. As mentioned above, this experimental strategy has been used in the two research contexts separately (the flanker compatibility effect and negative priming), but not in a combined way. Before continuing we shall briefly review the main results found in manipulating SOA in two tasks: the flanker task and the Stroop task.

Desynchronizing the distracting information.

By desynchronizing the distractors and the target in the flanker task, researchers have attempted to discover the temporal dynamics of distractor effects on target processing (e.g., Eriksen & Schultz, 1979; Flowers, 1990; Flowers & Wilcox, 1982; Grice, Boroughs, & Canham, 1984; Miller, 1991; Taylor, 1977). The main conclusions are the following: In conditions with SOA = 0, which is the classic form of the flanker task, the results usually show a large interfering effect (cost) of incompatible flankers and a small benefit or even a null effect of compatible flankers. The interfering effect of incompatible flankers develops rapidly; although it reaches its maximum with SOA close to 0, it is still measurable when the distractors lead by 100 ms, and it disappears completely with SOA around 200 ms. The facilitative effect of compatible flankers has a slower time course. Its peak is reached when the distractors precede the target by around 100 ms. With SOA = 200, it also disappears.

As we have mentioned, significant facilitation effects of compatible flankers with a 0 ms SOA are not commonly found. What should be noted from this research is that compatible flankers do have facilitative effects on responses to targets, but these effects are relatively slow to develop, such that with SOA = 0, they sometimes go undetected. When desynchronization has consisted in presenting the target before the flankers, the flankers normally have no effect. However, in some studies a small effect has been obtained with a short negative SOA, around 50-100 ms (Eriksen & Schultz, 1979; Taylor, 1977). This could be due to a type of horse race that takes place between target and distractor processing, in which on a small proportion of trials the later-occurring distractors are processed sufficiently quickly that their identities have some effects on target processing. With increasingly negative target-distractor SOAs, the proportion of trials on which distractor processing is likely to influence the processing of a previously-presented target decreases. The main conclusion to be derived from this body of research is that the effects of compatible and incompatible flankers follow different time courses, suggesting that they are produced by different mechanisms; an argument previously made by several authors (e.g., Flowers, 1990; Grice & Gwynne, 1985; Yeh & Eriksen, 1984).

Desynchronization has also been carried out in several versions of the Stroop task, although in this case desynchronization forces the modification of the original stimuli (colored words). A typical procedure has used words presented inside colored frames and to present the two components of the stimulus with different SOAs (Glaser & Düngelhoff, 1984; Glaser & Glaser, 1982; Kornblum, Stevens, Whipple, & Requin, 1999; MacLeod, 1991; Schooler, Neumann, Caplan, & Roberts, 1997; Sugg & McDonald, 1994). The results indicate that in the color naming task, when the words are to be ignored, there are also asymmetries between the time courses of interference and facilitation, similar to those observed in the flanker task (e.g., Glaser & Glaser, 1982).

In sum, what these studies tell us is that (1) the "direct" effects of irrelevant information are observed only when this information is presented in close temporal proximity to the target, and (2) the time course of interfering effects of incongruent information is different from that of the facilitating effects of congruent information.

Methodological problems with simple target-distractor desynchronization.

From our point of view, simple desynchronization of targets and distractors might not be a good procedure for studying the time course of the effects of irrelevant on relevant information for two reasons. First, manipulating SOA introduces an experimental confounding with the activation produced by any warning stimulus, especially one potentially relevant for the task (Jonides & Mack, 1984; Posner & Boies, 1971). The different levels of performance observed when the distractor-target SOA is manipulated could be due in part to different levels of participant readiness at the time of target presentation. There are many experiments with such findings; e.g., Elliott, Cowan and Valle-Inclán (1998), who found that RT was shorter with SOA = 500 in a condition with neutral distractors than in a condition without distractors (an activating effect of the appearance of any warning stimulus). In general, desynchronizing distractors and targets causes RTs to decrease globally in all compatibility conditions (e.g., Flowers, 1990; Flowers & Wilcox, 1982). The same occurs with Stroop-like stimuli; in a condition with neutral distractors, changes are observed in RT as a function of SOA (e.g., Glaser & Glaser, 1982; Schooler, Neumann, Caplan, & Roberts, 1997).

The second reason for discarding the methodology based on simple manipulation of SOA is that it has been customary to keep the distractors present until the target appears (e.g., Eriksen & Schultz, 1979; Flowers, 1990; Flowers & Wilcox, 1982). In this way greater SOAs are accompanied by longer exposure times of the distractors, producing another type of confounding. Some of the inconsistencies observed in the literature reviewed above are undoubtedly due to these factors.

The experimental solution to these two problems should include the presentation, in all SOA conditions to be compared, of the same number of stimuli, with the same exposure times and the same time schedules. The experimental manipulation should exclusively affect the nature or identity of these stimuli. In the experiments described below we have combined the RSVP technique with the paradigm of distractor compatibility. The time sequence of stimulus presentation is always the same. The only aspect that changes is the identity of the stimuli presented. Consequently, when effects are observed in response times (RTs) these will have to be attributed to changes in the position of critical distractors in the sequence of items relevant to the target identification task. In the present studies, a series of black letters is presented, using the RSVP technique, and among them is inserted a single red letter. The participants had to discriminate rapidly the identity of the single red letter using a choice-RT task. Also included in various positions in the series, in black, are some of the letters defined as critical letters. We have observed effects, on target discrimination times, from the critical distractor letters in the series (in black) which depend on their categorical (compatible versus incompatible) and temporal relationships to the target.[1]

EXPERIMENT 1

The task was to discriminate whether the only red letter in an RSVP series of 16 letters was an S or an H. The other letters in the series were in black, and on most trials one of the critical letters (S or H) was presented between four positions before and four positions after the red target letter as a critical distractor. In a control condition the only critical letter was the red target. Since all trials included the same number of stimuli in the same temporal series (RSVP), no case can be made for effects due to abrupt onsets or variable foreperiod duration. We expected that by manipulating the delay between two critical letters, one a black distractor and the other a red target, we could explore the temporal course of distractor effects. For example, if an H is presented in black, it should facilitate the response to a subsequent red H if it is presented in sufficient temporal proximity for distractor processing to be still active when the target letter is presented. On the other hand, if the black

[1] Readers will probably ask themselves why flankers are not used as distractors. The reason for this is that the first experiment was designed not for the first goal we have presented but for the second one: to verify through the procedure of compatibility of distractors that the stimuli presented with the RSVP technique are identified even though they cannot be reported (Botella, Garcia & Barriopedro, 1992). However, the incidental observation of NP in the first experiment provided the motivation for the series of experiments we describe, and which we present in the order in which they were carried out.

H triggers a response tendency that must be suppressed because it is not the target (red) item, then this suppression (or other components of the traditional negative priming effect) could linger and produce a delay in responding to the target.

METHOD

Participants. Fourteen students from the Universidad Autónoma de Madrid participated as volunteers. Their vision was normal or corrected to normal.

Apparatus and materials. Two-hundred fifty-six lists of 16 uppercase letters were prepared. The target letter (H or S, equiprobably) appeared in red in a central position in each list (in positions 6, 7, or 8, equiprobably). The rest of the list included 15 different consonants shown in black. Once the lists had been constructed, one non-critical letter between positions –4 and + 4 (with 0 defined as the target position) was replaced by one of the critical letters; either the same letter as the target for that list (Compatible distractor condition), or the opposite one (Incompatible distractor condition). Also, some lists were unchanged, with no critical letters presented in black (Control condition).

Procedure. All letters were uppercase and presented in black in the center of a computer terminal screen except the target letter, which was presented in red (see Figure 1 for a schematic representation of the trial sequence). The background remained gray throughout the experiment. The participants' task was to discriminate rapidly whether the red letter was an H or an S, using two keys on the computer keyboard to make their responses. An asterisk appeared in a central position on the screen to begin each trial. When ready, the participant then pressed the spacebar, and 500 ms later the asterisk was replaced by the first letter of the series. Each letter stayed on the screen for 116 ms and was immediately replaced by the following one. The last letter was replaced by the central asterisk. Independent variables were Compatibility of the critical distractor with the target and relative Position in which the critical distractor was presented. There were 17 experimental conditions, 16 with critical distractors and one Control, without a critical distractor. The conditions with critical distractors included equal numbers of trials with distractors Compatible with the target (the critical distractor and the target were the same letter - SS or HH) or Incompatible with it (the critical distractor and target were different - SH or HS). The distractor could appear in either one of the four positions prior to the target or one of the four subsequent positions (positions –4 to +4).

Participants carried out a practice block of 40 trials and two experimental blocks of 216 trials each with a short break between blocks. Each experimental block contained 12 trials in each experimental condition and 24 control trials.

Position	C-3	I-1	C+1
+ 9	R	L	Z
+ 8	L	M	T
+ 7	F	D	F
+ 6	K	C	P
+ 5	D	P	D
+ 4	P	B	X
+ 3	X	F	G
+ 2	C	X	V
+ 1	G	Q	S
← T A R G E T	H	S	S
- 1	J	H	B
- 2	R	T	J
- 3	H	G	C
- 4	T	J	K
- 5	V	K	Q
- 6	B	Z	L

Figure 1. Examples of the series used in Experiment 1. The first is from the condition with the Compatible distractor in the third position counting back from the target (C-3). The second includes an Incompatible distractor in the position just before the target (I-1). In the third there is a Compatible distractor in the position just after the target (C+1).

RESULTS

RT data. Mean RTs were calculated for each condition for each participant (see Table 1 and Figure 2). A 2 X 8 ANOVA (distractor Compatibility versus Position) found no significant effects of Position [$F(7,91) = 1.74$, $p < .12$], a marginal effect of Compatibility [$F(1,13) = 4.32$, $p < .06$] and a clear effect of the interaction of Compatibility X Position [$F(7,91) = 13.52$, $p < .001$]. In *a posteriori* multiple comparisons using the Bonferroni t-test, a significant and expected facilitative effect of compatibility was found when the distractor was presented in position –1 and, at a marginal level ($p < .10$), in position +1. In order to check the reliability of this effect, a replication is necessary. No compatibility effects were found for position –2, nor for positions +2 onwards.

The most noteworthy result, however, is the inverted compatibility effects for distractor positions –3 and –4; that is, mean RT was significantly shorter on trials with incompatible distractors than on those with compatible distractors, in positions –4 ($p < .05$) and –3 ($p < .01$).

In order to separate positive from negative effects we have tested significant differences with the control condition. Whereas the facilitative and interfering effects from distractors in position –1 were both significant (p <

.05) those from distractors in position –3 are not clearly observed (p<.10 in both cases). The only significant effect from distractors in position +1 is the facilitation of compatible distractors (p<.05).

Table 1. Mean response times (RT) and error percentages (%E) for Incompatible and Compatible (identical) critical distractor conditions, as functions of their positions relative to the target letter (position = 0) in the RSVP stream, and for the Control condition (Experiment 1).

	Critical Distractor Position								
	-4	-3	-2	-1	0	+1	+2	+3	+4
Incompatible									
RT	421	416	434	453	-	430	428	428	438
%E	3.3	1.8	4.2	20.2	-	11.0	0.9	3.3	3.3
Compatible (identical)									
RT	439	442	426	385	-	415	429	435	433
%E	5.4	5.4	3.6	2.1	-	3.6	3.3	2.7	3.0
Control									
RT	429								
%E	6.0								

Error data. Mean proportions of errors were calculated for each condition for each participant (see Table 1). A 2 X 8 ANOVA (distractor Compatibility versus Position) found significant effects of Compatibility [$F(1,13) = 5.33$, $p = .038$], Position [$F(7,91) = 5.98$, $p < .001$], and, as in the RT data, a highly significant interaction of Compatibility X Position [$F(7,91) = 7.81$, $p < .001$]. These results are mainly due to the relatively high error rates for incompatible distractors at positions –1 and +1. In *a posteriori* multiple comparisons, the error rates for compatible distractors were found to be lower than those for incompatible distractors at positions –1 ($p < .01$), and +1 ($p < .05$), whereas the reversed effect (a higher error rate on compatible than on incompatible distractor trials) was significant at position –3 ($p < .01$).

DISCUSSION

As expected, we obtained a clear effect of distractor compatibility for position –1. Mean RTs were 44 ms shorter and error rates were 3.9% lower for Compatible trials at position –1 than for Control trials. Also, RTs were increased by 24 ms and errors rates by 14.2% relative to Control trials for Incompatible trials at position –1. In Experiment 1 there is no replication as such of the flanker compatibility effect, since at each moment only one stimulus appears, and there were no simultaneous presentations of targets and distractors. The much smaller effects of the critical distractor presented in position +1 are probably due to the fact that there are at least some trials in which target processing and distractor processing overlap, even though the distractor is presented 116 ms later. Distractors presented with greater delays (positions +2 to +4) had no effect on target processing, as by then the response had presumably been determined. Similarly, there are no compatibility effects for critical distractors presented two positions before the target.

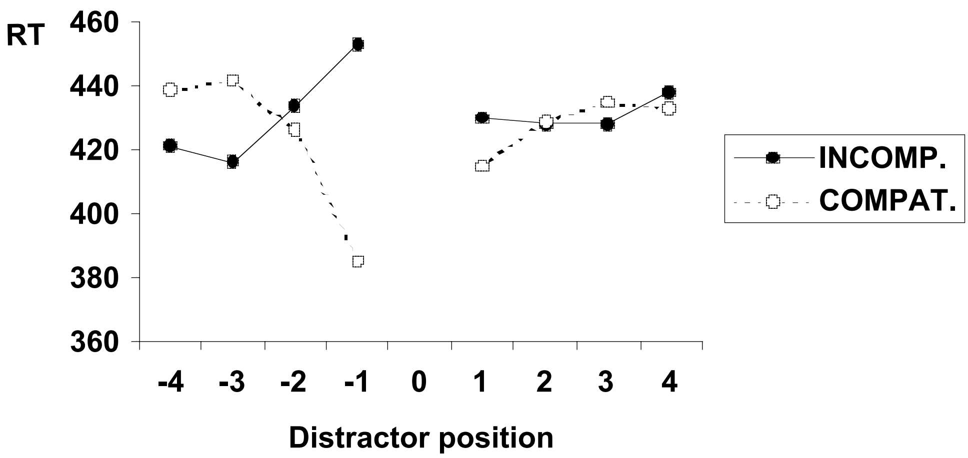

Figure 2. Mean RTs obtained in Experiment 1, as a function of the relationship between the critical distractor and the target (Incompatible, Compatible) and the position of the distractor with respect to the target (4 positions before and after the target).

Clearly the most interesting result, however, is the inverted effect for distractor positions –3 and –4. It appears that if the target is presented 3 or 4 positions (around 400 ms) after the critical distractor, then the priming effect is inverted. Put in simple terms, compatible distractors produce significantly poorer performance than incompatible ones. This may be due to the fact that compatible distractors produce interference, that incompatible ones produce facilitation, or to both phenomena operating at the same time.

From a theoretical point of view, interference by compatible distractors in positions –3 and –4 could be explained in the following way. When the visual system detects a critical distractor letter it is processed to some level high enough to promote recognition and the development of a response tendency. However, since the distractor does not include the key response feature of redness, this response tendency must be suppressed. If that same letter is presented in red when inhibition is still operating, responses to it are impaired. This is clearly a type of negative priming effect (Fox, 1995;

Milliken & Tipper, 1998; Neill & Valdes, 1996; Neill, Valdes, & Terry, 1995).

Somewhat less clear is the interpretation of possible facilitation produced by an incompatible distractor. C. W. Eriksen's interpretation of the flanker compatibility effect, in terms of competition of responses, may provide the key. According to this interpretation (Coles, Gratton, Bashore, Eriksen, & Donchin, 1985; Eriksen, Coles, Morris, & O'Hara, 1985), the presentation of any multi-character stimulus produces the progressive activation of all associated responses, though to different extents. The race is usually won by the response associated with the attended target, but the time taken to win is greater the less favorable the balance of activations. In the present experiment, the inhibition associated with incompatible distractors presented several positions before the target should make the balance more favorable to the correct alternative at the moment of target presentation.

Both influences (facilitation in the Incompatible distractor condition and interference in the Compatible distractor condition) might be present. One way to determine their relative contributions would be to see whether incompatible distractors produce significantly shorter RTs than those in the control condition and whether compatible ones produce significantly longer RTs. However, although RT in the compatible distractor condition was significantly longer than that in the incompatible distractor condition, neither of their RTs differed significantly from the intermediate mean RT in the control condition. Thus, with the present data we cannot resolve the ambiguity of whether the reversed compatibility effects are due to inhibitory or excitatory processes, or to both. We shall return to this issue when we have more data to consider after reporting two additional experiments.

Whatever the correct interpretation, what is clear is that characters presented in the present RSVP conditions are not filtered by color, but rather are identified completely enough to exert an influence over 400 ms after their presentation, despite the fact that participants were not aware, in general, that some of the stimuli relevant to the task were sometimes presented in black (Botella, Barriopedro, & Suero, 2001).

We considered the fact that in the compatible distractor condition a repetition of the same letter might have some undesired effect. Specifically, in the present task the distractors and the target have the same physical form and they share the same response. We would like to separate both factors. We know that the flanker compatibility effect is also usually obtained when the distractors are different from the target but are associated with the same response (e.g., Eriksen & Eriksen, 1974; Miller, 1991). We decided to run a new experiment introducing additional distractors with compatible and incompatible responses.

EXPERIMENT 2

According to the above, we did a new experiment with two goals: replicate the effects found in experiment 1 and test whether the effects with compatible distractors are the same when they are physically different but share the same associated response. Experiment 2 differed in two ways from the first study. First, we used two sets of letters, one for each response (C&S vs. A&N). We included trials with identical compatible stimuli and trials with non-identical compatible stimuli as critical distractors in order to make a direct comparison between repeated items associated with the same response, while at the same time either repeating or not repeating the same stimulus. We expect to find once again the inverted effect in the Identical Compatible distractor condition but not necessarily for Different Compatible distractors. This is predicted from most theories of negative priming, but it would be informative to check it here. Second, we included digits among non-critical distractor items in order to expand the set of distractors (consonants and the digits 1-9) that could be used in this and the following studies. The goal of Experiment 2 is twofold: to replicate the inverted priming effect of positions –3 and –4, which showed up in Experiment 1, and to confirm whether this effect is linked to memory representations of the stimuli, to the responses associated with them, or to both. Given the results of the previous experiment, and those of a similar pilot study that we have reported elsewhere (Botella & Barriopedro, 1995), we expected to find an inverted effect with Identical Compatible distractors, and a smaller or no inverted effect with Different Compatible distractors.

METHOD

Participants. Fourteen students from the Universidad Autónoma de Madrid participated as volunteers. All had normal or corrected to normal vision.

Apparatus and materials. Five hundred four different lists containing 16 digits and uppercase letters were prepared. In a central position of each list was placed (equiprobably) the target letter C, S, A or N. For the rest of the list the other letters and digits were randomly used, but without repetition within a list.

Procedure. There were 25 experimental conditions, 24 with one critical distractor and one Control condition, without critical distractors. In the critical distractor conditions, the distractor could be the same letter as the target (Identical Compatible), the other letter from the same set as the target for that trial (Different Compatible), or a letter from the other set (Incompatible). Thus, if in any trial the red target letter was C, the critical distractor in the Identical Compatible condition was also the letter C, in the Different Compatible condition it was the letter S, and in the Incompatible condition it could be, equiprobably, A or N. The critical distractors appeared in the same positions of the list as in Experiment 1, and no critical distractors appeared in the Control condition.

Participants carried out a practice block of 96 trials and two experimental blocks of 204 trials each with a short break between them. Each experimental block was made up of six trials of each possible distractor/target pair. At each position there were 12 Incompatible, 6 Different Compatible and 6 Identical Compatible trials. There were also 12 trials in the Control condition.

RESULTS AND DISCUSSION

RT data. Mean RTs were calculated for each condition for each participant (see Table 2 and Figure 3), and were subjected to a 3 X 8 ANOVA (distractor Compatibility versus Position). No significant effects of Position were obtained [$F(7,91) = 1.05$, $p < .40$], but a marginally significant effect of Compatibility [$F(2,26) = 2.82$, $p < .08$] was found, as was a clear effect of the interaction between critical distractor Position and target-distractor Compatibility [$F(14,182) = 2.27$, $p < .01$]. *A posteriori* multiple comparisons found a significant difference, in the expected direction, between the RTs in the Incompatible condition and those in the Identical Compatible and Different Compatible conditions in position –1 ($p < .001$, and $p < .01$, respectively). The only additional significant effect was a longer RT in the Identical Compatible condition than in the Incompatible condition (inverted effect of compatibility, difference equals 16 ms) in position –3 ($p < .03$). The 12 ms difference in the same direction in position –4 was not significant.

When compared with the control condition, only the facilitative and interfering effects, respectively, of the compatible identical and the incompatible distractors in position –1 are significant ($p < .01$).

Error data. Mean error proportions were calculated for each condition for each participant (see Table 2), and were subjected to a 3 X 8 ANOVA (distractor Compatibility versus Position). A significant effect of Position [$F(7,91) = 2.45$, $p < .03$] was found, but the Compatibility effect was not significant [$F(2,26) = 1.67$, $p < .21$]. As in the RT data, their interaction was significant [$F(14,182) = 3.58$, $p < .001$]. *A posteriori* multiple comparisons found significantly higher error rates in the Incompatible condition than in the Identical Compatible and Different Compatible conditions in position –1 ($p < .02$, and $p < .05$, respectively). The only additional significant effect was a higher error rate in the Identical Compatible condition than in the Different Compatible condition (inverted effect of compatibility, difference equals 6 percent) in position –3 ($p < .04$).

Table 2. Mean response times (RT) and error percentages (%E) for Incompatible, Compatible (different), and Compatible (identical) critical distractor conditions, as functions of their positions relative to the target letter (position = 0) in the RSVP stream, and for the Control condition (Experiment 2).

	Critical Distractor Position								
	-4	-3	-2	-1	0	+1	+2	+3	+4
Incompatible									
RT	482	484	489	500	-	496	490	488	487
%E	6.3	7.4	12.5	22.0	-	9.2	6.3	6.5	7.1
Compatible (different)									
RT	494	484	482	481	-	493	489	491	485
%E	7.1	7.1	7.1	7.7	-	6.5	6.0	6.5	9.5
Compatible (identical)									
RT	494	500	489	447	-	485	484	482	484
%E	8.3	13.1	6.0	4.8	-	7.1	7.1	6.5	8.3
Control									
RT	481								
%E	6.3								

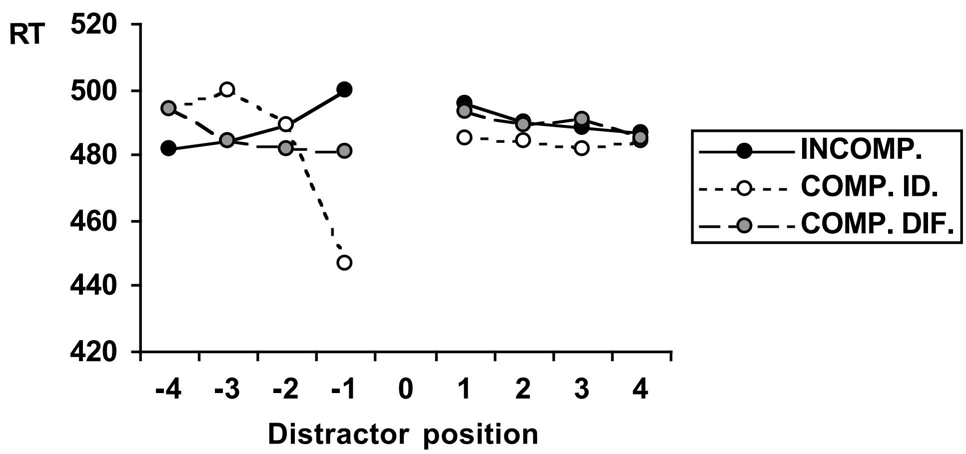

Figure 3. Mean RTs obtained in Experiment 2, as a function of the relationship between the critical distractor and the target (Incompatible, Different Compatible, Identical Compatible) and of the position of the distractor with respect to the target (4 positions before and after the target).

We replicated the inverted effect of the distractors presented in position –3, but only with identical distractors. Therefore, this effect is not due to an inhibition of the responses associated with the distractors presented, but to an inhibition associated with the particular identity of a critical distractor, an effect similar to that predicted by the episodic trace theory of negative priming (Neill & Valdes, 1992, 1996; Neill, Valdes, Terry, & Gorfein, 1992).

The results for position –4 were not completely consistent across the first two experiments, although the trends in the data are the same. Given that we do not know whether this incongruence is due to variable persistence over time for the inverted effect, we decided to carry out another experiment in which this effect was tracked backwards, looking for its presence in the immediately previous time period. On the other hand, and as expected, the distractors presented two positions or more after the target had no effect on the responses, so it was not necessary to include these positions in subsequent experiments.

EXPERIMENT 3

The main goal of the present experiment was to check the consistency of the effects in position –4. Perhaps random fluctuations on the latency of the inverted effect makes that it appears in some experiments but not in others. Experiment 3 is very similar to the previous one. The only difference is that the positions used for inserting the critical distractors varied from –6 to +2, rather than from –4 to +4 as in the previous study. Another goal was to increase the power of the design (increasing the sample size) as an attempt to discriminate differences against the control condition. The experiment had three goals: (1) to track further backwards other possible effects of the presence and/or identity of the distractors; (2) to replicate once again the inverted effect associated with the identical distractors at position –3, and (3) to increase the power of the design.

METHOD

Participants. Twenty-one students from the Universidad Autónoma de Madrid volunteered to participate. All had normal or corrected to normal vision.

Apparatus and materials. These were identical to those used in the previous experiment, the only difference being that the positions of the critical distractors were varied from –6 to +2 in the present study.

Procedure. The procedure was identical to that of the previous experiment, with exceptions as indicated.

RESULTS AND DISCUSSION

RT data. Mean RTs were calculated for each condition for each participant (see Table 3 and Figure 4), and were subjected to a 3 X 8 ANOVA (distractor Compatibility versus Position). Significant effects were obtained for Position [$F(7,140) = 6.09$, $p < .001$], Compatibility [$F(2,40) = 3.70$, $p < .05$] and their interaction [$F(14,280) = 5.16$, $p < .001$]. *A posteriori* multiple comparisons found, again, a significant difference, in the expected direction, between Incompatible and Identical Compatible and Different Compatible conditions in position –1. In position +1 a significantly shorter RT was obtained in the Identical Compatible condition than in the other two conditions. In position –3 a significantly larger RT was obtained in the Identical Compatible condition than in the Incompatible and Different Compatible conditions (inverted effect of compatibility). No other significant differences were found.

Table 3. Mean response times (RT) and error percentages (%E) for Incompatible, Compatible (different), and Compatible (identical) critical distractor conditions, as functions of their positions relative to the target letter (position = 0) in the RSVP stream, and for the Control condition (Experiment 3).

	Critical Distractor Position								
	-6	-5	-4	-3	-2	-1	0	+1	+2
Incompatible									
RT	501	491	484	480	507	510	-	494	488
%E	9.3	8.7	6.3	9.3	12.9	34.3	-	16.1	7.1
Compatible (different)									
RT	503	495	489	482	497	469	-	491	492
%E	8.3	7.5	7.1	8.7	11.1	5.2	-	6.0	11.5
Compatible (identical)									
RT	497	495	488	500	498	441	-	475	486
%E	7.1	10.7	13.5	5.2	4.4	3.6	-	9.9	6.7
Control									
RT	494								
%E	10.5								

When compared with the control condition, both the facilitative and interfering effects, respectively, of the compatible identical and the incompatible distractors in position –1 are significant ($p < .01$). Similarly, the interference from the identical compatible distractor in position –3 and the facilitation from the incompatible distractor in position –3 are now significant ($p<.05$).

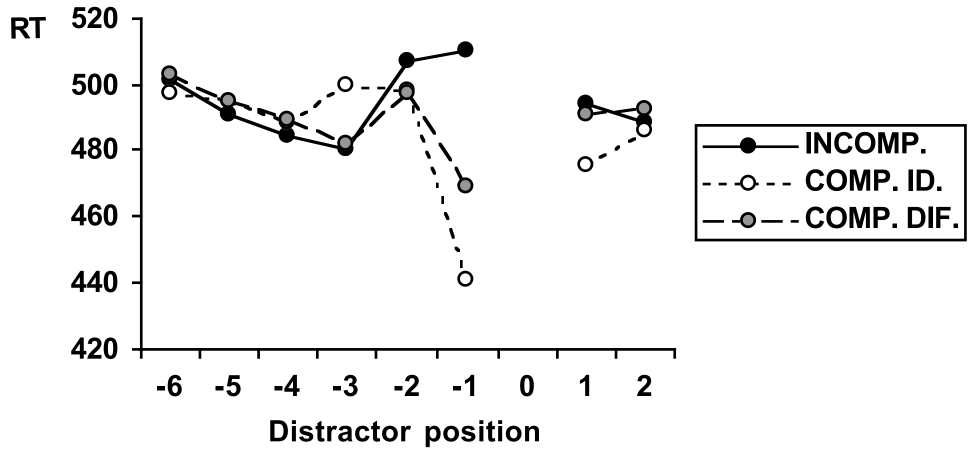

Figure 4. Mean RTs obtained in Experiment 3, as a function of the relationship between the critical distractor and the target (Incompatible, Different Compatible, Identical Compatible) and of the position of the distractor with respect to the target (6 positions before and 2 after the target).

Error data. Mean error proportions were calculated for each condition for each participant (see Table 3), and were subjected to a 3 X 8 ANOVA (distractor Compatibility versus Position). Significant effects were obtained for Position [$F(7,140) = 3.24$, $p < .01$], Compatibility [$F(2,40) = 12.74$, $p < .001$] and their interaction [$F(14,280) = 11.10$, $p < .001$]. *A posteriori* multiple comparisons found that the error rates were significantly greater in the Incompatible condition than in the Identical Compatible and Different Compatible conditions at position –1 (both ps < .001) and also at position +1 ($p < .04$ and $p < .001$, respectively). In addition, the error rates were lower in the Identical Compatible condition than in the Different Compatible condition at position –1 ($p < .02$). The higher error rate in the Incompatible condition persisted over that for the Identical Compatible condition in positions –2 ($p < .005$) and –3 ($p < .03$), and this difference reversed its direction at position –4, although the inverted effect did not reach significance ($p = .13$).

GENERAL DISCUSSION

The main results are that we have found the "natural" compatibility effect of distractors in position –1 and we have also replicated the inverted effect of distractors presented in position –3 for Identical Compatible distractors. This result reinforces the idea that the inverted effect is not due to an inhibition of the associated responses, but to an inhibition associated with the identity of the target. The trend for position –4 is not reliable across experiments. On exploring the positions before –4, we did not find differential effects associated with the type of critical distractor.

We should consider once more a point raised in the introduction and ask why, in the time course of distractor effects, no previous evidence has been found for reversed priming effects with an SOA around 350 ms, as we have found. In the flankers paradigm and in the prime trial of the usual negative priming paradigm, the distractors are to be ignored. With respect to a simultaneous target, the influence of these incompatible ignored distractors is one of interference (both in the flankers paradigm and in the prime trial in negative priming studies). With respect to a delayed target, like the one presented in the probe trial of the negative priming paradigm, the effect of a distractor identical to the target is one of interference, whereas in the flankers paradigm, the delay typically eliminates any influence of the distractor on the target. A major difference between the two situations is that in the negative priming paradigm there is real selection (selection for action) in the prime trial, whereas in the flanker task with delayed presentation, there is no selection for action during the presentation of the distractors. This "selection against" process has been highlighted as having a crucial role in negative priming (DeSchepper & Treisman, 1996; Neill, Valdes, Terry, & Gorfein, 1992). In the delayed flanker task we are dealing with a distractor that can appear later in the same trial as a target. In the negative priming task there is also a distractor that later appears as a target, but in a separate, probe trial. Moreover, in negative priming a target appears with an incompatible distractor during the prime trial, but during the presentation of the distractor in the flankers task, no imperative stimulus is present. Are these differences important enough to explain the discrepancy?

Perhaps the answer to this question lies in the procedure. In the introduction we said that a source of confusion, when studying the time course of priming effects in the flankers task, has been the fact that exposure time has varied as a function of SOA. This implies that the distractors remain until the target appears and the response is made. According to Houghton and Tipper (1994), negative priming is produced by a kind of rebound effect generated by the inhibitory inertia that occurs when the distractor disappears. While the distractor is present, an equilibrium is maintained between the activation produced by the distractor stimulus and the inhibition exerted on it. However, when the stimulus disappears there is an inhibitory inertia which, until it vanishes, produces the well-known negative priming effect. Thus, in experiments in which SOA is manipulated, but the distractor remains until the response to the target is made, the rebound effect cannot take place. Of the experiments we reviewed, only those of Taylor (1977) used a procedure in which exposure time was fixed, despite variation in SOA. This is also the only study (as far as we are aware) that found a negative facilitation (interference) effect for compatible distractors with an SOA = 250 ms. Since the reversed facilitation effect was not the object of Taylor's study, we are not informed as to whether or not the effect is statistically significant (see Taylor, 1977, Figure 2, p. 413). The inhibitory inertia interpretation is also consistent with the results of Houghton, Tipper, Weaver and Shore (1996), who obtained negative priming when the prime stimuli remained on the screen for only 150 ms, whereas if they remained until the probe trial stimuli appeared, negative priming was not obtained. In the second case there is no opportunity for the inhibitory rebound to take place. Yee (1991) has also shown that the effect of semantic priming in a lexical decision task can depend on the SOA used, with negative priming generally being found at SOAs longer than 500 ms, and facilitation found at shorter SOAs in her research.

In our experiments we obtained negative priming in the RT data when a distractor identical to a subsequent target was presented three positions before the target, because this is the apparent time interval (about 350 ms) needed for the inhibitory rebound to reach its maximum. Distractors presented in other positions did not consistently produce significant negative priming. In the discussion of Experiment 1, we commented that the data did not yield sufficient power to decide whether the inverted priming effects were due to significant costs for Identical Compatible distractors, significant benefits for Incompatible distractors, or both. By combining the data from positions –4 to +2 for Exps 1, 2, and 3, we can achieve a greater degree of statistical power to solve the inconsistencies observed. These combined data are shown in Table 4 and Figure 5. Here the data show that there is a clear cost (like negative priming), at least in the RT data, for Identical Compatible distractors centered at position –3. Also, there is a significant benefit (a type of positive priming) present in the RT data for Incompatible distractors, also centered about at position –3. These mirror-image effects occurring at about the same point before the target presentation hint at the operation of a common mechanism, such as the development of response tendencies for critical distractors advanced by Eriksen and his colleagues (Coles, Gratton, Bashore, Eriksen, & Donchin, 1985; Eriksen, Coles, Morris, & O'Hara, 1985). It is the suppression of these response tendencies that could lead to the inverted priming effects for both compatible and incompatible distractors. The typical priming effects are found in both the RT and error data at position –1, showing large positive priming effects for Identical Compatible distractors and large interference effects for Incompatible distractors. An ANOVA of the RT data across all three experiments showed a significant difference between the results for Incompatible and Identical Compatible conditions [$F(1,46) = 26.50$, $p < .001$] at position –3, with no interaction across experiments [$F < 1$].

What do these experiments tell us about the 'context effect'.

We have found sufficient proof that stimuli presented within the present RSVP procedures are analyzed until identification (including those that do not fulfill the selection criteria of color that define the target) even though participants are unaware of this identification. Our results add to an increasing body of research supporting this conclusion (Botella, Barriopedro, & Suero, 2001; Juola, Duvuru, & Peterson, 2000; Luck, Vogel, & Shapiro, 1996; Maki, Frigen, & Paulson, 1997; Shapiro, Driver, Ward, & Sorensen, 1997).

Table 4. Mean costs (positive values) and benefits (negative values) in the RT and error data collapsed across Exps 1-3. Only the data from the Identical Compatible and Incompatible distractor conditions across distractor positions –4 to +2 are shown.

	Critical Distractor Position						
	-4	-3	-2	-1	0	+1	+2
Incompatible							
RT	-6	-8	+8	+19	-	+5	0
%E	-2	-2	+2	+18	-	+4	+1
Compatible (identical)							
RT	+6	+13	+3	-44	-	-10	-2
%E	+2	0	-3	-4	-	-1	-2
Difference (Incompatible – Compatible))							
RT	-12	-21	+5	+63	-	+15	+2
%E	-4	-2	+5	+22	-	+5	+3

The identification of distractors influences responses to the target, although the degree and direction of this influence depends on the distractor/target relationship and on the time interval between them. With a short distractor/target interval, compatible distractors facilitate target processing, whereas lengthening the SOA causes them to interfere. Both roles are part of what can be called the "context effect" (Taylor, 1977). Let us look at how we believe these events develop.

When the participant has to give a rapid response with respect to the only stimulus in red, the stimuli in black that he/she perceives are not filtered in terms of color, but are preattentively identified. Let us suppose that one of the black stimuli in the series is one of the critical stimuli defined in the task. A representation of this identity is activated, along with the subsequent incipient activation of its associated response (Eriksen & Schultz, 1979). Let us now see what happens as a function of the temporal separation between distractor and target.

Delay 0 – Had the target been presented simultaneously with the distractors, as in the flanker compatibility paradigm, then the usual flanker effect would be produced. Since the interference produced by incompatible flankers develops rapidly, while the facilitation produced by compatible ones is slower, the flanker compatibility effect usually consists of a large cost and a small benefit (Eriksen, 1995).

Delay 1 - Let us now suppose that the distractor and the target are not presented simultaneously, but that the target appears in a position following the distractor and is the same stimulus that has been presented as distractor or one compatible with it. Its identification and the response execution will be facilitated. In contrast, if an incompatible stimulus were to appear, interference, albeit only a small amount, would occur, probably due to competition between distractor and target processing (Botella, 1995), giving rise to the direct effect that we observed in conditions with distractors in position –1. As enough time has passed for the mechanism underlying facilitation to develop, while the processes associated with interference are already declining, what is obtained is a smaller cost and a larger benefit than that obtained with simultaneous presentations.

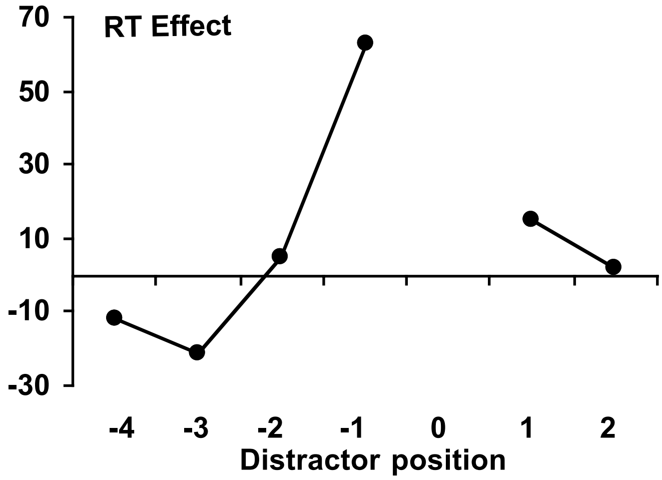

Figure 5. Mean RTs and error rates collapsed across Experiments 1-3. The data are for Incompatible and Identical Compatible conditions only, plotted as the compatibility effect (incompatible minus compatible identical) against the relative positions of the critical distractor.

Delay 2 - If instead of a critical letter, what appears after the distractor is a neutral letter, then activation of distractor identity and its associated response continue to decrease, at the same time as inhibition begins to increase. Thus, if the critical stimulus appears in the next position in the series, it appears that the balance between decreasing activation and increasing inhibition could result in the null effect empirically observed. Inhibition is produced because of an active attempt to prevent a potential target from occupying focal attention and gaining access to the response control system. Inhibition is triggered when the system identifies a potential target that does not contain the critical response feature (e.g., color in our experiments).

Delay 3 - If the target letter does not appear in either of the two following positions (or after about 350 ms has elapsed), maximum inhibition is reached. This inhibitory process is associated with the identity of the distractor, and appears to take place in the way Houghton and coworkers have described (Houghton & Tipper, 1994; Houghton et al., 1996). It is manifested in the response if the target appears in the third position after the distractor, or, more generally, between about 300 to 400 ms after the critical distractor has been presented. This is the "rebound effect" described theoretically by Houghton and Tipper (1994), the temporal course of which is well traced in our experiments. According to these authors, the rebound effect of inhibition produces negative priming.

Delay 4 - The rebound effect produced by the inhibitory inertia has a short life, so that the representation of the identity involved quickly recovers the activation base line characteristic of the resting level. Therefore, when three complete positions have already passed and the target appears in the fourth position after the distractor (or more than about 500 ms), it no longer has any influence on target processing. However, the duration of the rebound effect is variable, and it may sometimes remain even though four positions separate the distractor from the target (Experiment 1). The fact that observable inhibition does not remain over longer periods of time as in the typical negative priming experiment is probably due to the unique aspects of the RSVP paradigm. That is, there is no selection for action for any but the target items in the series, and each potential priming item is quickly supplanted by the next even after the target occurs.

Negative delays - In some of the trials no relevant distractor appears before the target. In these cases, when the target appears, it is identified and the normal processes that lead to the response take place. What is the effect of the appearance of a critical distractor once these processes have begun? If the target/distractor interval is sufficiently long, the distractor has no effect on the responses to the target. However, if the interval is short, it may be that distractor processing overlaps in time with the early phases of target processing, in which it is still vulnerable to distractor influence. We only found indications of this influence with a delay of +1, and even then inconsistently across the experiments. When we did obtain it, the effect of the distractors presented in the position following the target was direct, that is, RT was significantly longer with incompatible distractors than with compatible distractors.

In short, the role of distractors depends on their temporal asynchrony with the target and on their relationship to it. When they are simultaneous with the target they act synergistically with it: they facilitate target processing if they are identical or have a compatible response, and they interfere if they are incompatible. As SOA increases, their role depends on the stage of development of their processing when the target appears. There is a certain critical interval in which identical distractors produce interference, which we have linked to the phenomenon of negative priming. Incompatible distractors produce little or no effect in this position, although we have some evidence for a facilitative effect for incompatible distractors presented 300 to 400 ms before the target (Exps. 1-3). We can state, therefore, that we have fulfilled our main goal; obtaining a gradual transition from the "direct" role of distractors to the inverted role of compatible distractors. At least with our experimental paradigm, the flankers' (natural) effect and negative priming (reversed effect) are two frames of the same movie. The traditional flanker and negative priming paradigms provide isolated cross sections of distractor effects which preclude their systematic examination. At any moment we are influenced not only by concurrent information present in a stimulus array, but also by preceding information. Further, the relative influences exerted by current and previous information are modulated by selective attention as well as by the spatial and temporal limits of perceptual integration.

What do these experiments tell us about the flanker compatibility effect.

It has been customary to find in the flankers paradigm small or even null effects of compatible distractors, and the weight of the flanker compatibility effect has fallen, mainly, on the interference effect of incompatible flankers (small benefit, large cost). We do not have in our experiments conditions with simultaneous distractors to replicate this. However, when the distractor appears in position –1 (before the target) we have obtained benefits of compatible distractors that are greater than the costs of the incompatible distractors. It is clear that the temporal development of the facilitation effects is slower than the development of interference. The reason why facilitation effects have not been found in many experiments with simultaneous flankers may be that they have not been given enough time to occur. With simultaneous distractors there are greater costs than benefits. With distractor/target SOAs around 100 ms there are greater benefits than costs.

The inevitable temptation is, of course, to postulate that interference and facilitation are produced by different mechanisms. Several researchers have suggested that the effects exerted by distractors on target processing are multi-level, acting both on identification and on decision-making and response execution (Botella, 1995; Coles, Gratton, Bashore, Eriksen, & Donchin, 1985; Fournier, Scheffers, Coles, Adamson, & Vila, 1997; Gratton, Coles, Sirevaag, Eriksen, & Donchin, 1988; Kornblum & Stevens, 1998). The final effect observed in the RT data would be the combination of all of these influences, and the weight of each one on RT would be different in each experimental condition (identical, different compatible, neutral or incompatible distractors); thus, for example, the mere competition of responses and the reciprocal inhibition of alternative responses (e.g., Eriksen, Coles, Morris, & O'Hara, 1985) would have greater weight with incompatible distractors than with other types of distractors. The fact that the time courses of the distractor effects in two experimental conditions are different allows us to infer that the composition of influences acting on them are different. For instance, benefits of similar size (small or null) have frequently been obtained with identical or different compatible flankers. Although similar effects might suggest that both facilitation effects are produced by the same mechanisms, our analyses of their time courses demonstrates that this is not so. Identical flankers produce far greater facilitation than non-identical ones when they appear in position -1.

Moreover, identical flankers produce the interference that we have linked to negative priming, whereas non-identical compatible ones do not.

What do these experiments tell us about negative priming, repetition blindness, and the attentional blink.

As we have emphasized, our experiments show that the inhibition we have obtained is associated with the identity of the target, and not specifically with the response associated with it (this interference does not appear with distractors that are compatible but different from the target). In this sense, it is inconsistent with the general findings in the attentional blink literature in that any item which attracts attentive processing (as any potential target would) should produce interference of proportional magnitude with subsequent target processing. Theoretical explanations of the attentional blink phenomenon cannot account for the inverted effects we describe here. Repetition blindness is another matter, as it should lead to particular difficulties in responding to a repeated target in the Identical Compatible conditions. However, neither the error data nor the recent theoretical analyses of the repetition blindness phenomenon suggest that the second target is not perceived. Rather it is the separation of the second target as a new episode that lies at the heart of the failure to report a second item in the repetition blindness paradigm (Chun, 1997; Fagot & Pashler, 1995)

At a methodological level, it has sometimes been pointed out that negative priming is not an effect that directly reflects what happens during the prime trial, but rather it reflects to some extent the mechanisms involved in the probe trial (Milliken & Tipper, 1998; Pashler, 1998). Our procedure minimizes this source of confusion, since it is not necessary to make two different responses; there is a single trial in which the SOA is manipulated.

Various theoretical interpretations of negative priming have been made (see the review by Fox, 1995). Some highlight inhibitory mechanisms that start during the prime trial. These inhibitory mechanisms might affect the ease with which representations of a recently ignored stimulus are developed (Neill & Westberry, 1987; Tipper, 1985), or influence the connection of these representations to the response systems (Tipper & Cranston, 1985). Other interpretations are based on retroactive effects that take place during the probe trial. Specifically, the representation of the target would have certain discrepancies with respect to a recent episodic memory with different features (Park & Kanwisher, 1994). Of special importance is the fact that associated with the retrieved episode would be the label "do not respond" or "not relevant," whereas the current stimulus has the opposite label associated with it (Neill & Valdes, 1992). It has also been proposed that NP could reflect difficulties for discriminating the present from the past when a stimulus is repeated, combined with a set that favors relatively novel stimuli (Milliken & Rock, 1997).

Our experiments have not been designed to discriminate between these interpretations, but they do make one of them more credible. In our experiments the SOA is sufficiently short for participants to be unable to report the identity of the presented stimuli, although indirectly we can be sure that they are identified preattentively. It does not seem that in these conditions our cognitive system is capable of creating an episodic trace that interferes with encoding the target. Moreover, if the interference were related to retrieval, there would be no reason for it to take place only with delay 3, and not with delays 4, 5, or 6. Milliken and Tipper (1998) have emphasized the inconsistencies obtained in studying the temporal course of negative priming. Rapid disappearance is more compatible with the inhibitory interpretation, whereas prolongation in time is more compatible with the interpretation based on retrieval. Thus, our results appear to fit more closely the inhibitory interpretations, whether they be of a particular representation or of their connection with the response system.

However, it seems unlikely that all of the inhibitory effects obtained with different experimental paradigms are produced in the same way. Inhibitory phenomena are present in many aspects of cognition (Dempster & Brainerd, 1995), and it is unlikely that they are always the result of the same mechanisms. It is possible that in the paradigm with separate prime and probe trials, retroactive inhibitory mechanisms come into play, associated with retrieval, and do not appear in other paradigms, like ours, in which inhibition appears to be the result of a mechanism more akin to that described in models based on temporal inhibition (Houghton & Tipper, 1994). The succession of events in the present RSVP paradigm are more likely to interfere with specific episodic memories while leaving intact more automatic excitatory and inhibitory components of priming. These different combinations of factors would explain why interference sometimes correlates positively with inhibition, while on other occasions the correlation is negative (Neill & Valdes, 1996). Nonetheless, we have observed a transition, over a few hundred milliseconds, from facilitatory to inhibitory influences of the same distractor stimulus on subsequent target processing. These results thus provide a more complete representation of the phenomena only sampled in more typical, simple studies of flanker effects and positive and negative priming.

RESUMEN

Interacciones Temporales entre el Procesamiento del Blanco y los Distractores: Efectos de *Priming* Positivo y Negativo. El paradigma de los flancos y el paradigma con presentaciones de preparación/prueba (*prime/probe*) para el estudio del *priming* positivo y negativo se basan en la compatibilidad entre información relevante e irrelevante presente en los mismos estímulos o en estímulos que son temporal o espacialmente contiguos. En el paradigma de los flancos se presentan distractores a la vez que el blanco que pueden mejorar el rendimiento sin son flancos compatibles y empeorarlo si son incompatibles. En el paradigma de *priming* los distractores pueden facilitar o interferir con respuestas a blancos compatibles que se presentan posteriormente. En los experimentos que se describen aquí hemos conseguido una transición gradual entre estos dos paradigmas, mediante el uso del procedimiento de Presentación Rápida de Series Visuales (PRSV), manipulando la compatibilidad del distractor y el desfase temporal entre los distractores y el blanco. Con SOAs cortos los distractores compatibles facilitan y los incompatibles interfieren; pero con SOAs en torno a 400 mseg. el rendimiento es peor con distractores compatibles que con incompatibles. Se han obtenido resultados similares tanto con paradigmas en los que los participantes deben responder al estímulo que produce el efecto (es un blanco) como con paradigmas en los que no tienen que responder a él (es un distractor). Los presentes resultados implican importantes limitaciones en las explicaciones teóricas tanto del efecto de compatibilidad de los flancos como de la dinámica temporal del *priming* positivo y negativo.

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