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The modulation of exogenous Spatial Cueing on Spatial Stroop interference: Evidence of a set for "cue-target event segregation"

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Two experiments are reported that test whether the modulation of exogenous cuing effects by the presence of a distractor at the location opposite the target (altering the time course of cueing effects, Lupiáñez et al., 1999, 2001) is due to the fast reorienting of attention or to a set for preventing the integration of the cue and the target within a single event representation. A Spatial Stroop task was used to explore whether the long lasting facilitation effect usually found in this task, as well as the typical reduction of Spatial Stroop interference on cued trials (Funes et al., 2003, 2005) is prevented by the presence of distractors. In Experiment 1, the distractor produced a shift towards more negative cuing effects even at the shortest 100 ms SOA, and eliminated the Spatial Stroop by Cueing interaction. In Experiment 2, a larger range of SOAs was introduced, demonstrating further that the negative shift of cueing effects found in Experiment 1 affected all levels of SOA equally. This pattern of results is explained in terms of the event segregation hypothesis.

Salient properties of visual stimuli (e.g., abrupt visual onsets) seem to orient our attention towards their location in a fast and automatic manner, even when these stimuli are completely irrelevant for the goals of our task. Researchers refer to this phenomenon as "attentional capture" or "reflexive attentional orienting", and it is widely assumed that reflexive orienting processes play an important role in the rapid and efficient scanning of visual environments (see Ruz & Lupiáñez, 2002, for a review).

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One way to study reflexive attentional orienting empirically is the cuing paradigm introduced by Posner and colleagues (Posner 1980, Posner & Cohen, 1984). Typically, an abrupt onset cue is presented at one of two (or more) peripheral spatial locations where a target may subsequently appear. After a short cue-target time interval, the target appears with equal probability either at the location previously occupied by the spatial cue or at the opposite location. The result typically observed is a facilitation effect; that is, a reduction in reaction time (RT) and/or an increase in accuracy (AC) to detect, discriminate, or localize targets that appear at the cued location relative to those appearing at the location opposite the cue. The introduction of longer cue-target intervals in these cuing paradigms led researchers to discover that the robust facilitation effect observed with peripheral non-informative cues is transient. Indeed, when the target onset follows the cue onset by several hundred milliseconds or more (i.e., at longer cue-target stimulus onset asynchronies, or SOAs) the opposite result is observed; responses are faster for targets that appear at the location opposite the cue than for targets at the cued location. This later negative cuing effect was first reported by Posner and Cohen (1984), and later termed Inhibition of Return (IOR) by Posner, Rafal, Choate and Vaughan (1985).

According to Posner and colleagues, visual attention may be first oriented towards the cued location in an obligatory and automatic manner. If the target does not appear shortly after the cue, then attention is reoriented towards a central location because of the uninformative nature of the spatial cue. Finally, attention may then be inhibited from returning towards the cued location, with the idea that attention should be biased against re-sampling old locations and instead biased in favor of sampling new locations. Thus, a bias in favor of the sampling of new locations is often thought to underlie the IOR effect (Posner & Cohen, 1984; Posner, Rafal, Choate & Vaughan, 1985). This biphasic view of attention with facilitation being replaced by inhibition is at present one of the most accepted views to explain the dynamics of reflexive attention

Apart from Posner view, alternative explanations of IOR have been proposed. Based on Posner and Cohen observation that IOR only occurred if a voluntary saccade was made to the cued location but not if covert attention were allocated voluntarily to the location indicated by a central cue and then withdrawn (Posner & Cohen, 1984), Rafal and colleagues suggested that oculomotor activation was critical for generating the inhibitory effect, (Rafal, Calabresi, Brennan, and Sciolto, 1989). More concretely they proposed that when the oculomotor system is activated, an inhibitory tag is generated by a corollary discharge from the colliculus.

Favoring this view, these authors found that preparation of a voluntary saccade was sufficient to generate IOR, even if there was no exogenous peripheral signal and no eye movements were actually made (Rafal et al., 1989).

In the last two decades, much research has addressed whether cueing effects and their typical time course are the products of inflexible, hardwired properties of our reflexive orienting mechanism, or the products of flexible processes that are subject to strategic modulation (see Cave & Bichot, 1999, and Ruz & Lupiáñez, 2002, for reviews). One set of factors that seems to modulate both the magnitude and time course of exogenous cuing effects concerns the perceptual and response demands of the task. In general, studies have shown that facilitation effects become larger in magnitude, and persist to longer levels of SOA, when people are required to do a feature discrimination task (i.e. X vs. O) rather than a simple detection or localization task (Lupiáñez, Milán, Tornay, Madrid, & Tudela, 1997; Lupiáñez & Milliken 1999; Lupiáñez, Milliken, Solano, Weaver & Tipper, 2001). This enhancement in the facilitation effect and/or the delay in the emergence of IOR is even more pronounced when the perceptual difficulty of the task is increased (i.e. X-O vs. M–N discriminations, Lupiáñez et. al., 2001; detection of non-degraded vs. degraded stimuli, Castel, Pratt, Chasteen & Scialfa, 2005). Another experimental context in which facilitation effects are especially large and long lasting was identified in recent studies in our lab using a Spatial Stroop paradigm, where the resolution of conflict between two competing spatial dimensions is required (see Lu and Proctor, 1995 for a review). This task is similar to the well-known color-word Stroop task, but in the Spatial Stroop task two visuo-spatial dimensions, location and direction, are in competition. More concretely, in this task an arrow target that points either to the left or to the right is presented either to the left or to the right of fixation. Participants are required to respond to the direction that the arrow points whilst ignoring its location. Typically, spatial interference is observed in this task as indexed by longer and less accurate responses to incongruent trials (e.g., an arrow target appearing to the right but pointing to the left), as compared to congruent trials (e.g., an arrow target appearing to the right that also points to the right), presumably because the location information is processed in a faster and/or more automatic manner than the direction dimension (see Lu & Proctor, 1995 for a review). Within the context of this type of conflicting task no IOR effect has been found, even at SOAs as long as 850ms (Funes, Lupiáñez & Milliken, 2007). In summary, several prior studies show that increasing task difficulty at either perceptual and/or response levels leads to larger as well as longer lasting facilitation effects.

A recent hypothesis proposed by Klein (2000) seems to account well for this modulation of cueing effects by *task difficulty*. According to his view, participants' attentional set in response to the impending task may constrain the amount of attentional resources that are captured by the cue. In particular, given that it may be difficult to shift attentional sets rapidly it seems reasonable that the attentional resources prepared to be allocated to the target are in fact also captured by the cue (this reasoning is based on the notion of attentional control settings, ACS, see Folk, Remington & Johnston, 1992; Folk, Remington & Wright 1994). Consequently, in any situation in which the system is set to allocate few attentional resources to the target (e.g., an easy detection task) the cue would produce a correspondingly small capture of attention. Following a small attentional capture, attentional reorienting would in turn, occur very quickly. Together, these processes would be manifested as small facilitation effects (or null effects) at very short SOAs followed by a rapid transition to IOR. On the other hand, in any situation in which the system is set to allocate a large amount of attentional resources to the target (e.g., a difficult discrimination task), the cue should produce a large capture of attention, and a delay in the reorienting of attention. These processes would be manifested as large facilitation effects, and a late transition to IOR.

However, as noted by Klein (2000), task difficulty may not be the only factor that defines ACS, and that consequently modulates the magnitude and time course of cueing effects. Indeed, some recent findings have shown cueing effects to be modulated in ways that seem difficult to explain in terms of the effect of task difficulty on the capture of attentional resources by the cue.

One piece of evidence that is difficult to explain in terms of an increase of attentional orienting to the cue for difficult discriminations comes from the findings of Lupiáñez and colleagues (1999; 2001), where a distracting stimulus (an asterisk) was introduced simultaneous with the onset of the target, but in the opposite location, in a conventional peripheral cueing study. The distractor condition produced a significant slowing of RTs and an increase in the percentage of errors, compared with a non-distractor condition, which is consistent with the idea that the presence of the distractor made the task more difficult. However, the distractor condition produced a second set of effects on performance, that is, a general shift towards more negative cueing effects (including a reduction in the magnitude of facilitation at very short levels of SOA) and an earlier appearance of IOR. The resulting time course of cuing effects was very similar to the one usually observed in detection tasks. This shift in the time course of cuing effects occurred even for a difficult M vs. N discrimination task. Thus, although the likelihood of the distractor made the task more difficult, it had the opposite influence on cueing effects to that produced when increasing target perceptual or response difficulty.

According to Klein (2000), a different kind of ACS could account for the pattern of results found for the distractor present condition in Lupiáñez and colleagues studies. In his view, the distractor absent condition might trigger a control setting to find onsets, which would also apply to the onset of the cue, thus causing a strong attentional engagement, a long dwell time, and hence a late appearance of IOR. In contrast, when the target is always accompanied by a distractor, luminance onset no longer provides the signal to locate the target. Hence, the control setting required to locate the target is less likely to produce strong attentional capture towards the cue, and consequently, IOR would appear sooner. A similar explanation based on a set for fast reorienting could also account for the early appearance of IOR on the distractor present condition.

Although these alternative ACS accounts based on the orienting of attention do a reasonable job of explaining the influence of a distractor on cueing effects, there are two aspects that concern us. First, considering these explanations within the context of Posner general framework of exogenous attention being biphasic, with inhibition following a previous shift of attention towards the cued location, if the likelihood of a distractor set the system to prevent orienting, then one might expect null cueing effects to occur rather than IOR. Second, fast reorienting from the cued location in the distractor present condition also seems an unlikely explanation, as the reduced facilitation effect at the distractor present condition could be observed even at short (i.e., 100 ms) SOAs. In fact, most studies that support a fast reorienting hypothesis have found their behavioural and electrophysiological effects at levels of SOA longer than 150ms (Arnott, Pratt, Shore & Alain, 2001; Kim & Cave, 1999; Pratt & McAuliffe; 2002; Theeuwes, Atchley & Kramer, 2000; Warner, Juola & Koshino, 1990). Only after an extended amount of practice do people seem to be able to reorient their attention away from the cued location at a SOA of 100ms (Kim & Cave, 1999; Warner, Juola & Koshino, 1990). In sum, although the alternative ACS account proposed by Klein could account for the influence of distractors on cueing effects, an additional process seems to be necessary to explain the general shift towards more negative cueing effects even at very short levels of SOA. As we will discuss later, an overarching set favoring cue-target segregation might be the source of this shift toward negative cueing effects.

A second piece of evidence that also seems difficult to explain in terms of an increase of attentional orienting to the cue for difficult discriminations comes from the Spatial Stroop studies described above, where apart from requiring target discrimination, an additional process of conflict resolution was necessary on incongruent trials (half of the trials). In these studies, large and long-lasting facilitation effects are observed, but in addition, Spatial Stroop interference is systematically reduced on cued trials as compared to no cue or oppositely cued trials (Funes & Lupiáñez, 2003; Lupiáñez & Funes, 2005; Funes, Lupiáñez & Milliken, 2007; see Funes, Lupiáñez & Milliken, 2005, for a recent review of this literature). This effect is difficult to be explained in terms of an increase in the attentional resources allocated towards the cued location due to an increase in task difficulty. If that were the case, an increase instead of a decrease in Spatial Stroop should be observed on cued trials, due to the attentional enhancement of the interfering location dimension. Favoring this argument, a recent study has found that the reduction of Spatial Stroop on cued trials does not depend on the predictive value of the cue (Funes, Lupiáñez & Milliken, 2007, experiment 2). Thus, meanwhile the facilitation effect produced by predictive peripheral cues became three times larger compared with non-predictive peripheral cues, even at the shortest 100ms SOA, the magnitude of the Spatial Stroop by cueing modulation kept constant for both conditions. Thus, even though more attentional resources were allocated to the cued location for predictive cues, it didn't magnify the reduction Spatial Stroop on cued trials. This result makes an ACS account based on more attentional resources unlikely.

The cue-target integration vs. segregation hypothesis:

Lupiáñez, Milliken and colleagues (1999, 2001) have recently proposed an alternative framework that seems to fit well with the two pieces of data described above. According to these authors, participants may adopt a general set that modulates the extent to which two spatio-temporally contiguous events, such as the cue and target on cued trials at short SOAs, are encoded as part of the same event representation. In a typical exogenous cueing task, the cue, in addition to triggering the orienting of attention, may initiate the creation of an object representation. If the target appears soon after the cue, and at the same location as the cue, it may be integrated within the object representation created by the cue onset. This integration process would consequently prevent the need to encode onset and location information for the target, as that information was already encoded as part of the object representation of the cue. Of course, this cue-target integration process would not occur when cue and target appear at different locations. Instead, a new object representation would be created with the onset of the target on uncued trials a process that may take more time than the efficient updating of an already created representation that occurs on cued trials (Kahneman, Treisman & Gibbs, 1992).

Given this premise, if the aim of the task is to discriminate some kind of additional target feature such as its color or form, then the advance processing of its onset and location due to integration might lead to a processing advantage, as additional time and resources would be available to better focus on task relevant target dimension. In this way, an event *integration* process might be particularly helpful on cued trials in difficult discrimination tasks, producing large and long lasting facilitation effects.

However, within the context of a detection task, the information provided by the cue (its onset), is quite similar to the critical information required to detect the target (the target onset). Consequently, integrating the target within the object representation created by the cue could be detrimental to performance, as the onset of the target would be less noticeable and could be misattributed to the onset of the cue. As a result, participants might set the system to process the cue and the target as different events, thus preventing perceptual integration. Indeed, just as cue-target integration is afforded by spatio-temporal correspondence, cue-target segregation may be aided by spatio-temporal non-correspondence, an effect that may facilitate performance when cue and target appear at different locations (uncued trials). In other words, a set favoring cue-target segregation rather than integration may contribute to the lack of facilitation or even early IOR in detection tasks.

Lupiáñez and colleagues (1999, 2001) proposed that a similar segregation control setting could account for the modulation of cueing effects in discrimination tasks by the systematic presence of distractors. Thus, although the aim of a task is to perform a discrimination based on target form, the fact that a distractor rather than a target can be integrated with the cue on half of the trials might lead participants to set the system to prevent integration, and consequently prevent facilitation at short SOAs.

EXPERIMENT 1

The cue-target event segregation-integration hypothesis proposed by Lupiáñez and colleagues described above has never been directly tested, so the aim of the present study was to test it by using the Spatial Stroop discrimination task described above, where large and long lasting facilitation effects have been systematically observed. A similar Cue-target integration process has also been proposed to account for the finding of a reduction of Spatial Stroop on cued trials (Funes & Lupiáñez, 2003; Funes, Lupiáñez & Milliken, 2007; Lupiáñez & Funes, 2005). According to this view, on cued trials, the target representation is processed as a continuation of the cue event, and consequently the distracting location dimension of the arrow target is linked with an event that occurred at an earlier point in time (the cue). Consequently, the representation of the irrelevant location may decay by the time the relevant direction dimension is coded (see Hommel, 1993 for a further explanation of this temporal overlap hypothesis to account for another kind of spatial congruency effect known as Simon interference). This process might be responsible for the reduction of Spatial Stroop interference on cued compared with uncued trials.

The aim of the present experiments was to test the event integration-segregation hypothesis by comparing the performance of two groups of participants within the Spatial Stroop paradigm, the distractor absent group and the distractor present group, that were equated in all respects except the absence or presence of a distractor in the location opposite the target. In the distractor absent group, no distractor was presented, so that the experimental conditions were very similar to our previous Spatial Stroop studies (Funes & Lupiáñez, 2003; Lupiáñez & Funes, 2005, see Funes, Lupiáñez & Milliken, 2005, for a recent review). In this case, we expected to replicate the results found in those experiments, that is, large and long lasting facilitation effects as well as a reduction of Spatial Stroop on cued trials. Both of these effects would be consistent with the occurrence of cue-target event integration. In the distractor present group, a distractor stimulus (a plus sign) was presented on every trial. The distractor appeared simultaneously with, and in the location opposite to, the arrow target. If this distractor context induces a task set to prevent the occurrence of cue-target event integration, then we should find a shift towards more negative cueing effects, that is, a reduction of facilitation at the short SOA. More importantly, if the reduction of Spatial Stroop by peripheral cues systematically found in our previous experiments is really due to a process of cue-target event integration, then the presence of distractors should eliminate the reduction of Spatial Stroop on cued trials, and a null modulation of Cuing on Spatial Stroop should be found. Such a finding would favor the event segregation hypothesis in particular if it is found even at short SOAs, where a reorienting process is unlikely to have occurred.

METHOD

Participants. Two groups of 28 students from introductory psychology courses at McMaster University, Canada, participated in the experiment. Participants were randomly assigned to either the distractor absent group or the distractor present group. Data from 3 additional participants, one from the distractor absent group and two from the distractor present group, were excluded from the analysis because of a very high error rate (higher than 50% for the incongruent uncued condition). All participants reported normal or corrected to normal visual acuity and all were naïve as to the purpose of the experiment.

Apparatus and Stimuli. Stimuli were presented on a 14-inch color VGA monitor. An IBM compatible 486/33 microcomputer, running MEL2 software (Schneider, 1998) controlled the presentation of stimuli, timing operations and data collection. Responses were made by pressing a key on the keyboard. Participants pressed either the "X" key (left response) with the index finger of their left hand or the "M" key (right response) with the index finger of their right hand. Subjects sat in front of the computer screen at a viewing distance of about 57 cm**.** Targets appeared at the center of one of two boxes, which were always present during the trial and only disappeared between trials. The boxes subtended 22 mm in height by 23 mm in width. The inner edge of each box was 25 mm from the fixation point (a dark grey dot). The target stimulus was a white arrow, which subtended 10 mm in height by 11 mm in length and could point either to the left or to the right. Boxes were displayed in dark gray on a black background. The cue consisted of a change in one of the two boxes from gray to white for 50 ms, which gave the impression that the box flickered.

For the distractor present group, a “+” sign inside one of the boxes was added to the target display, which served the role of a distractor. The distractor was bright white and was 7 mm in width and 10 mm in height.

Procedure. The sequence of events in each trial was as follows (see figure 1). The fixation point was displayed together with the two boxes for 500 ms. Then, one of the two boxes flickered for 50 ms to cue one of the possible locations where the target could appear. After the flicker, the fixation point and boxes were displayed either for 50 or 550 ms. The target was then displayed for 33 ms, and the fixation point and the boxes were again displayed alone until the participants' response, or for 1500 ms if they did not make any response. The target appeared inside the box at the previously cued location on half the trials, and inside the box opposite the cued location on the other half. This made the peripheral cue non-predictive about the target location (50% cued and 50% uncued trials). As in our previous research, two different response mappings were used in each half of the experiment, which we call Compatible and Incompatible. For one half of the experiment the response was compatible, and participants were instructed to press the "X" key (left response) when the arrow pointed to the left, and the "M" key (right response) when it pointed to the right, independent of the arrow's location. For the other half the response was incompatible, and participants were to make the opposite response; that is, they were to press the "M" key (right response) when the arrow pointed to the left, and the "X" key (left response) when it pointed to the right. Each participant performed both the compatible and incompatible response mapping. Half of the participants performed the compatible mapping first, while the other half performed the incompatible mapping first. In our previous work (Funes, Lupiáñez & Milliken, 2007; Lupiáñez & Funes, 2005) we have systematically shown that the incompatible mapping reduces the magnitude of Spatial Stroop, but has no effect on either the magnitude and time course of cueing effects or on the Cueing by Spatial Stroop interaction. Therefore, and given that this manipulation is not relevant for the main aim of the present paper, in the following experiments we will analyze the data by collapsing across the two levels of compatibility, for the sake of simplicity[1].

[1] The two experiments described in the present study were run in tandem with a set of experiments recently published elsewhere (Funes, Lupiáñez & Milliken, 2007; Lupiáñez & Funes, 2005) using the spatial Stroop/Cueing paradigm, including the response compatibility manipulation. The original reason to include the compatibility manipulation in all these experiments was to see whether peripheral cues modulate Spatial Stroop interference by reducing the conflict between the stimulus dimensions at perceptual or at motor-related stages of processing. The finding in all these experiments was that the S-R compatibility manipulation had a null effect on the standard reduction of congruency effect on cued trials, leading to the conclusion that the cueing modulation of Spatial Stroop acted at perceptual stages of processing (Funes, Lupiáñez & Milliken, 2007; Lupiáñez & Funes, 2005). In the present experiments we have partially replicated this null effect, with the exception of experiment 1 where we found a significant four-way interaction between Spatial Stroop, Cueing, Distractor group and Response Compatibility. Thus, the standard reduction of Spatial Stroop on cued trials for the distractor absent condition was only present for the incompatible response mapping, but not for the compatible one (see appendix 1 and 2) At present we don't have a clear explanation for this *unexpected*

Either immediately after the response of the participant, or 1500 ms after the offset of the target, the screen remained black for 1000 ms, after which the next trial began. Auditory feedback (a 500 ms computer-generated tone) was given on error trials.

Trials were grouped in blocks and presented randomly within each block. The experiment stopped between blocks, allowing participants to rest for a few seconds. Participants were instructed to rest a few seconds between blocks and to continue with the experiment by pressing the space bar.

The experimenter provided both written and spoken instructions about the experiment. Participants were informed that their task was to decide whether the arrow pointed left or right, and to record that decision by pressing the key assigned to that direction. They were informed that the spatial location of the arrow was irrelevant for the task and that they should ignore that information. They were asked to respond as fast as possible while trying to avoid errors. Finally, they were instructed to maintain fixation at the centre of the screen and to avoid eye movements while stimuli were present on the screen.

For the distractor present group, the target appeared inside one of the boxes while the distractor (the "+" sign) appeared inside the box in the opposite location. The target and distractor disappeared simultaneously, 33 ms after their onset.

Design. The experiment had a mixed factor design, with SOA (100 vs. 600 ms), Spatial Congruency (congruent vs. incongruent), and Cuing (cued vs. uncued) being manipulated within-participants, whereas Distractor group (absent vs. present) was manipulated between-participants. Participants had a practice block (16 trials) followed by 7 experimental blocks of 32 trials each for each response mapping (compatible and incompatible), with a total of 448 trials (56 trials per experimental condition).

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exception to the rule (one experiment among seven) but considering all these studies where the response mapping was included as a whole, may be able to conclude that this response manipulation has null or a very small effect on the spatial Stroop by Cuieng modulation. Because this conclusion has already been addressed elswhere (Funes, Lupiáñez & Milliken, 2007; Lupiáñez & Funes, 2005), and for the sake of simplicity, in the following experiments we have described the data by collapsing across the two levels of compatibility.

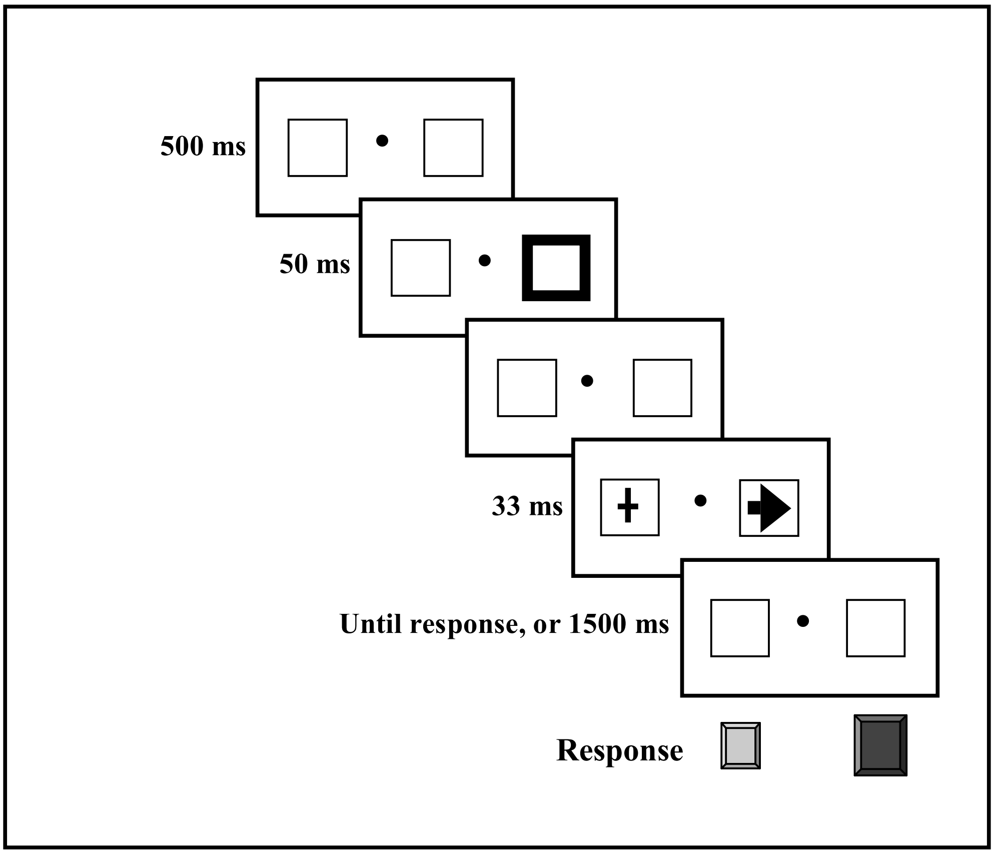

Figure1: Schematic view of a trial sequence, from top to bottom. Example of a congruent, cued trial for the distractor present condition.

RESULTS

Mean correct response latencies and error rates were computed for each participant and experimental condition. These means, collapsed across participants, are displayed in Table 1. A mixed-design ANOVA was conducted to analyse both mean RTs and errors percentages. The ANOVA included Cuing (cued vs. uncued), SOA (100 and 600 ms) and Spatial Congruency (congruent vs. incongruent) as within-participants factors, and Distractor (absent vs. present) as a between-participants factor.

Table 1. Mean RT (in ms) and percentage of errors (in brackets) as a function of Congruency, SOA, Cuing, and Distractor Group, in Experiment 1.

		Distractor Absent		Distractor Present	
SOA	**Congruency**	**Cued**	**Uncued**	**Cued**	**Uncued**
100 ms	Congruent	523 (3.6%)	542 (2.9%)	550 (2.9%)	558 (2.4%)
	Incongruent	541 (5.8%)	576 (6.0%)	574 (4.8%)	586 (5.1%)
600 ms	Congruent	529 (3.3%)	536 (4.4%)	554 (2.1%)	541 (2.9%)
	Incongruent	548 (4.3%)	566 (6.3%)	582 (5.2%)	568 (4.3%)

Discarded data. Trials from the practice block or those trials in which a miss (no response was emitted) or a wrong response was made were excluded from the RT analysis. In addition, trials with correct responses faster than 100 ms (0.14%) or slower than 1200 ms (1.18%) were excluded from the RT analysis.

RT analysis. The analysis revealed main effects of Cuing, $F(1, 54) = 17.12$, $MSe = 503.03$, $p<0.0005$, and Spatial Congruency, $F(1, 54) = 62.82$, $MSe = 1229.04$, $p<0,0001$. Responses were faster for cued (550 ms) than for uncued trials (559 ms), and for congruent trials (542 ms) than for incongruent trials (568 ms).

There was a two way interaction between Cuing and Distractor group $F(1, 54) = 27.17$, $MSe = 503.03$, $p<0.0001$. Separate ANOVAs for each group revealed that for the distractor absent group there was a significant facilitation effect (20ms), $F(1, 27) = 40.34$, $MSe = 545.08$, p<0.0001, while this effect was not observed for the distractor present group (-3ms, F<1).

The Cuing X SOA interaction was also significant, F(1, 54) = 19.67, MSe = 495.91, p<0.01. Separate analysis for each level of SOA revealed a significant facilitation effect when the SOA was short (18ms), p<0,001, but not when the SOA was long (-1ms), p>0.50. The Cuing X SOA X Distractor group interaction did not reach significance (p>0.1), indicating that the tendency for Cuing effects to be more negative at the longest SOA was similar for the distractor absent and present groups (see figure 2).

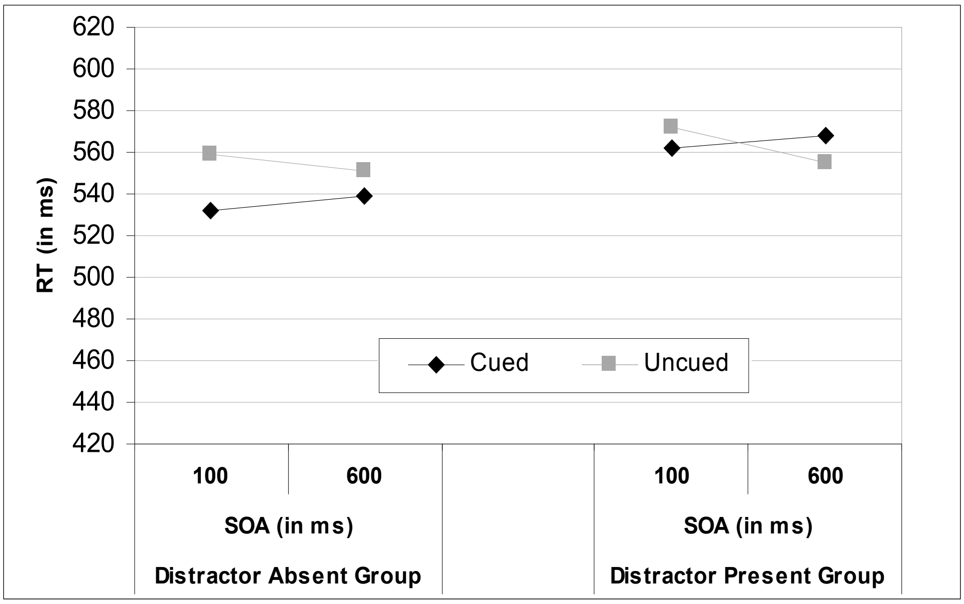

Figure 2. Mean RTs for the cued and uncued conditions as a function of SOA in Experiment 1, showing performance of the distractor absent group (left panel) compared to that of the distractor present group (right panel).

Planned comparisons revealed that the cuing effect was positive at both SOAs in the distractor absent group (p<0.001 and p<0.05, for the long and short SOA respectively), whereas a facilitation effect was observed at the short SOA (p<0.01) and a significant IOR effect was observed at the long SOA (p<0.01) in the distractor present group.

Regarding the modulation of the Spatial Stroop effect, there was a significant interaction between Cuing and Spatial Congruency, F(1, 54) =

8.17, MSe = 193.41, p<0.01, as well as a significant three way interaction between Cuing, Spatial Congruency, and Distractor group, F(1, 54) = 4.78, MSe = 193.41, p<0.01. To interpret this interaction, separate ANOVAs were conducted for each distractor group. For the distractor absent group, there was a highly significant Cuing X Spatial Congruency interaction, F(1, 27) = 10.84, MSe = 227.11, p<0.005. The Spatial Stroop effect was significantly smaller on cued trials than on uncued trials (18 and 32 ms, respectively). The analysis conducted for the distractor present group showed that the Cuing X Spatial Congruency interaction did not approach significance (F<1). This result demonstrates that the Spatial Stroop effects for cued and uncued trials were not different in the distractor present group (see figure 3, right panel).

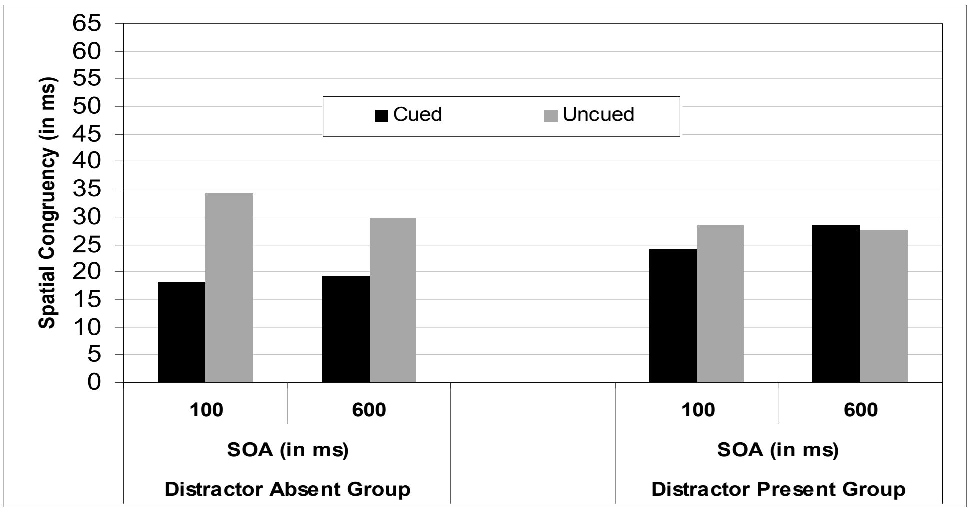

Figure 3. Spatial Stroop effect (incongruent minus congruent trials, in milliseconds) as a function of Cuing and SOA in Experiment 1 for the distractor absent group (left panel) and the distractor present group (right panel).

Error rate analysis. The analysis of errors revealed a main effect of Spatial Congruency, F(1, 54) = 29.35, MSe = 0.002, p<0.0001, indicating that participants committed more errors on incongruent trials (5.2%) than on congruent trials (3%). The Cuing X Distractor interaction did not reach significance in this analysis (p= 0.16), although the pattern of results was similar to that found for the RT analysis; that is, a more positive Cuing effect for the distractor absent group (0.7%) than for the distractor present group (0.01%).

Both the Cuing X SOA interaction as well as the Cuing X SOA X distractor group interaction were significant, F(1, 54) = 4.55, MSe = 0.001, p<0.05 and F(1, 54) = 4.80, MSe = 0.001, p<0.05, respectively. To interpret this three way interaction we conducted separate ANOVAs for each distractor group. For the Distractor absent group, the Cuing X SOA interaction was significant, F(1, 27) = 6.54, MSe = 0.0007, p<0.05. More thorough analysis of this interaction revealed a pattern that was slightly different to the RT analysis, with a small and non-significant negative effect at the 100 ms SOA(-0.3%, F<1), and a significant facilitation effect at the 600 ms SOA (1.5%, p<0.05). For the distractor present group, a null Cuing X SOA interaction was characterized by similar and very small cuing effects for both levels of SOA (0.1% and 0.2% respectively).

DISCUSSION

Regarding the Cuing effects, the pattern of results found with the distractor manipulation in Experiment 1 is similar to the one obtained in previous experiments with other types of discrimination tasks (Lupiáñez et al., 1999, 2001). For the distractor absent group, we replicated the findings from our previous studies within the context of the Spatial Stroop task (Funes & Lupiáñez, 2003; Lupiáñez & Funes, 2005; Funes, Lupiáñez, & Milliken, 2007) so that facilitation effects were observed at both levels of SOA. However, the introduction of a distracting stimulus at the location opposite the target for the distractor present group completely changed the pattern of results in comparison to that found for the distractor absent group. First, the presence of a distractor produced Cuing effects that were less positive than those found for the distractor absent group. The null Cuing X Distractor X SOA interaction indicated that this shift toward less positive Cuing effects occurred uniformly at both short and long levels of SOA. It is interesting to note that a significant IOR effect was observed for the first time in the context of the Spatial Stroop task. This result suggests that the presence of distractors constitutes a strong experimental manipulation, capable of disrupting and even inverting the usual large and robust facilitation effect produced by peripheral cues in previous experiments with discrimination tasks requiring conflict resolution. More importantly, the fact that the presence of a distractor modulated the Cuing effect even at the shortest level of SOA is difficult to be explained in terms of the speed with which attention is reoriented away from the location of the cue. By that account, if attention were oriented towards the cued location (i.e., at around

100 ms SOA) but rapidly reoriented towards more central locations (i.e., at about 300 ms SOA), we should expect similar facilitation effects at the shortest 100 ms SOA for the distractor absent and present conditions. The cuing effects for the two groups should then be expected to differ only at longer SOAs, as the presence of a distractor would elicit a rapid shift of attention away from the cued location. This account seems unlikely, given that the effect produced by the presence of distractors was independent of SOA. In this sense, the fast reorienting hypothesis does not adequately explain the finding of more negative cuing effects with the presence of distractors for both levels of SOA.

To test the fast reorienting hypothesis further, we conducted an ANOVA limited to the shortest 100 ms SOA. The purpose of the analysis was to examine whether the presence of distractors made Cuing effects significantly more negative even at that short level of SOA. The analysis revealed a highly significant interaction between Cuing and Distractor, $F(1, 54) = 13.08$, $MSe = 333.40$, $p<0.001$, with a large and significant facilitation effect for the distractor absent group ($p<0.0001$, 27 ms) and a much smaller facilitation effect for the distractor present group (9 ms; see figure 2 for a visual comparison). This final analysis allowed us to conclude more confidently that the presence of distractors triggers processes other than mere faster reorienting of attention. These processes appear to modulate target processing at very early stages, before attentional reorienting might occur.

Concerning the modulation of Spatial Stroop by Cueing, the distractor manipulation led to a drastic alteration of the typical pattern of results found in previous studies without such a manipulation. While Spatial Stroop was reduced on cued compared with uncued trials for the group without a distractor, replicating our previous findings with this task (Funes & Lupiáñez, 2003; Funes, Lupiáñez & Milliken, under review; Lupiáñez & Funes, 2005), we found that the presentation of a distractor at the location opposite the target completely eliminated the Spatial Stroop by Cueing interaction that was observed for the distractor absent group. Again, this finding is difficult to explain in terms of fast attentional reorienting processes for distractor present trials, as the presence of a distractor eliminated the Spatial Stroop by Cueing interaction even at the very short SOA of 100 ms.

In general, both patterns of results are more consistent with the "event segregation" hypothesis (Lupiáñez et al. 1999, 2001), according to which participants may adopt a general task set to encode the cue and the target as separate events because integrating the cue and distractor within the same event representation may be detrimental to performance. One consequence of this set favouring segregation rather than integration would be that facilitation effects are smaller with a distractor present than with a distractor absent. A second consequence of a set favouring segregation rather than integration is that the reduction of Spatial Stroop on cued trials no longer occurs.

EXPERIMENT 2

One of the more important findings of Experiment 1 was that the presence of a distractor altered cuing effects uniformly across both levels of SOA, making them generally more negative, a result that is difficult to explain by reference to changes in the speed of reorienting attention away from the location of the cue. However, with only two levels of SOA we cannot rule out the possibility that a faster transition from Facilitation to IOR on the distractor present compared with the distractor absent condition could also have taken place. More concretely, it is possible that with the presence of a distractor both a general shift towards more negative cueing effects and a faster transition from positive to negative cueing effects might have taken place, which is consistent with the idea that a general set for cue-target segregation, but also a set for speeding up the reorienting of attention might jointly occur. To examine this last possibility further, we carried out Experiment 2, which was very similar to Experiment 1 with the exception that two additional levels of SOA were added to the design. These additional cue-target SOAs allowed us to observe with better fidelity the influence of the presence of distractors on cuing effects, their time course, as well as the time course of the Cuing by Spatial Stroop interaction.

In this experiment, participants were presented the same experimental conditions as in Experiment 1, with the exception that four levels of SOA (100, 350, 600 and 850 ms) were used rather than the two levels used in Experiment 1 (100 and 600 ms).

For the distractor absent group, we expected to find a pattern of results similar to that observed in Experiment 1, that is, large facilitation effects that decrease as a function of SOA, and a reduction of Spatial Stroop on cued trials. For the distractor present group, we also expected to replicate the pattern of results found in Experiment 1. Thus, we anticipated that Cuing effects would become increasingly more negative with increasing SOA, and that the Spatial Stroop effect would not be modulated by Cuing.

Most important to the aim of the present experiment are comparisons of the results across the two groups. Thus, if the presence of distractors leads to a fast reorienting of attention away from the cued location, then there ought to be a significant Cuing X distractor X SOA interaction. In contrast, if the presence of distractors alters cuing effects by some means other than fast reorienting of attention away from the cued location, then there ought to be a significant Cuing X Distractor interaction but no significant Cuing X Distractor X SOA interaction. Such a pattern of results would indicate that Cuing effects can shift uniformly across all levels of SOA with the presence of distractors, a finding not consistent with the fast reorienting hypothesis, but consistent with the event segregation hypothesis.

METHOD

Participants. Two groups of 24 students from introductory psychology courses at the University of Granada, Spain, participated in the experiments. Participants were randomly assigned either to the distractor absent or the distractor present group. All participants reported normal or corrected to normal visual acuity and all were naïve as to the purpose of the experiment.

Apparatus and Stimuli. The apparatus and stimuli used in the present experiment were similar to those used in Experiment 1 except for the following changes. Stimuli were presented on a 15-inch colour monitor connected to a PC Pentium 4 (instead of a 14-inch color VGA monitor, connected to an IBM compatible 486/33 microcomputer). Given the slightly different dimensions of the monitor, all stimulus measures were slightly different. Thus, the arrow was 11 mm in length and 13 mm in height. The boxes were 21 mm in height and 24 mm in width. And finally, the inner edge of each box was 32 mm from the fixation point.

Procedure. The procedure in the present experiment was exactly the same as that of Experiment 1, apart from the two additional levels of SOA.

Design. The experiment had a mixed factor design, with SOA (100, 350, 600 and 850 ms), Spatial Congruency (congruent vs. incongruent), and Cuing (cued vs. uncued) manipulated within-participants, and Distractor group (absent vs. present) manipulated between-participants. Participants completed a practice block followed by 7 experimental blocks of 32 trials each for both response mappings (compatible and incompatible), with a total of 448 trials (28 trials per experimental condition).

RESULTS

Mean correct response latencies and error rates were computed for each participant and experimental condition. These means, collapsed across participants, are displayed in Table 2. A mixed-design ANOVA was conducted to analyse both mean RTs and error percentages. The ANOVA included Cuing (cued vs. uncued), SOA (100, 350, 600, and 850 ms) and Spatial Congruency (congruent vs. incongruent) as within-participants factors, and Distractor (absent vs. present) as a between-participants factor.

Discarded data. Trials from the practice blocks and those in which a miss (no response was emitted) or a wrong response was made were excluded from the RT analysis. In addition, trials with correct responses faster than 100 ms (0.13%) or slower than 1200 ms (1.81%) were excluded from the RT analysis.

RT analysis. The analysis revealed main effects of Spatial Congruency, $F(1, 46) = 72.38$, $MSe = 2154.62$, $p<0.0001$, and SOA, $F(3, 138) = 6.48$, $MSe = 871.34$, $p<0.0005$. Participants responded faster to congruent (553 ms) than to incongruent trials (582 ms), and responses appeared to be faster at the 350 and 600 ms SOAs (563 ms for both) than at the 100 and 850 ms SOAs (570 ms and 574 ms, respectively).

As in Experiment 1, Cuing interacted with Distractor, $F(1, 46) = 17.95$, $MSe = 1872.90$, $p<0.0005$. Separate ANOVAs for each group revealed that for the distractor absent group the Cuing effect was positive (19 ms) and significant ($p<0.0001$), whereas for the distractor present group the Cuing effect was negative in sign (–7 ms) but not statistically significant ($p>0.1$).

Cuing also interacted with SOA, $F(3, 138) = 2.9$, $MSe = 554.14$, $p<0.05$, indicating that Cuing effects became more negative with increasing SOA (the cuing effects were 12, 9, 1, and 1 ms for the 100, 350, 600 and 850 ms of SOA, respectively).

Important to the aim of the present experiment, the Cuing X SOA X Distractor three-way interaction was not significant ($F<1$), indicating that the tendency of Cuing effects to become more negative with increasing SOA itself did not differ significantly for the distractor absent and present groups. Thus, for the distractor absent group the Cuing effects were 22, 22, 15, and 17 ms for the 100, 350, 600 and 850 ms SOA, respectively (all $ps<0.05$, as shown by planned comparisons). For the distractor present group, the Cuing effects were 3, -3, -14, and -14 ms, respectively for the

100, 350, 600, and 850 ms SOA (only the IOR effects at the two longest SOAs were significant, both ps<0.05) (see figure 4).

Table 2. Mean RT (in ms) and percentage of errors (in brackets) as a function of Congruency, SOA, Cuing, and Distractor group, in Experiment 2.

SOA	Congruency	Distractor Absent		Distractor Present	
		Cued	Uncued	Cued	Uncued
100 ms	Congruent	532 (3.6%)	547 (4.4%)	576 (3.6%)	577 (4.5%)
	Incongruent	543 (5.0%)	573 (6.3%)	601 (8.0%)	606 (8.2%)
350 ms	Congruent	524 (3.0%)	540 (5.4%)	573 (3.2%)	571 (5.5%)
	Incongruent	536 (5.2%)	565 (8.7%)	599 (8.2%)	594 (9.8%)
600 ms	Congruent	523 (3.6%)	536 (4.1%)	570 (4.4%)	553 (3.5%)
	Incongruent	551 (4.5%)	569 (7.2%)	607 (9.3%)	595 (8.6%)
850 ms	Congruent	535 (3.9%)	547 (4.6%)	579 (5.0%)	566 (4.4%)
	Incongruent	559 (5.1%)	581 (8.6%)	620 (8.0%)	605 (9.1%)

Given our specific hypothesis regarding the effect of distractor presence on the time-course of cuing effects, we conducted separate Cuing x Distractor group ANOVAs for each level of SOA. These analyses revealed that the Cuing x Distractor group interaction was significant at all levels of SOA ($p<0.01$, $p<0.05$, $p<0.005$, and $p<0.0001$, respectively for the 100, 350, 600 and 850 ms SOA). Therefore, for all levels of SOA, the Cuing effect was significantly more negative for the distractor present group than for the distractor absent group.

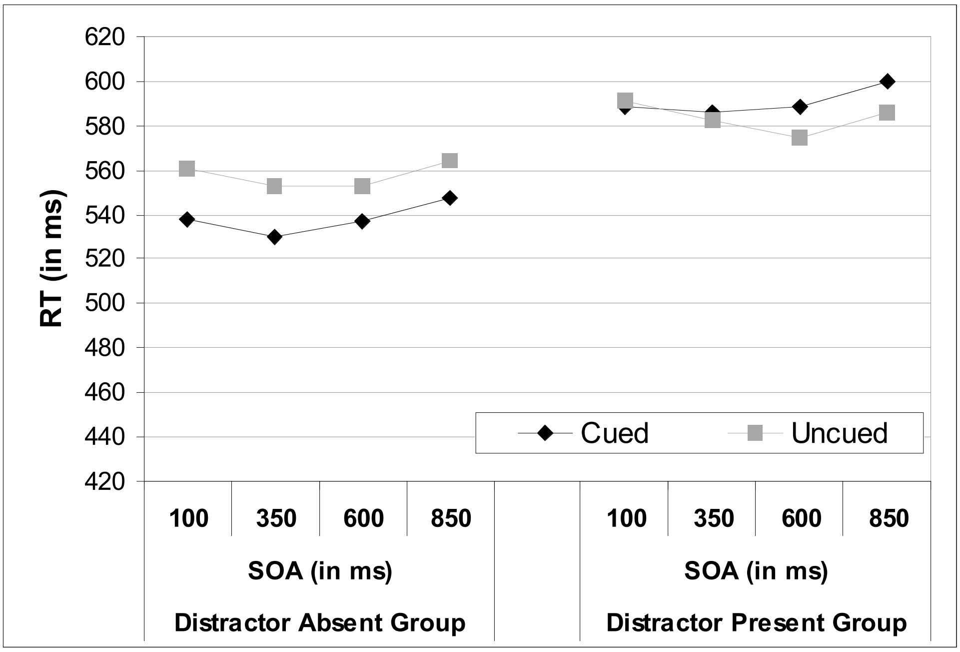

Figure 4. Mean RTs for cued and uncued conditions as a function of SOA in Experiment 2, for the distractor absent group (left panel) compared to the distractor present group (right panel).

Regarding the modulation of the Spatial Stroop effect, we found that Spatial Congruency interacted with SOA, $F(3, 138) = 3.80$, $MSe = 678.35$, $p<0.05$. Examination of the means suggests that the Spatial Stroop effect was largest at the two longest SOAs (22ms, 21ms, 35ms and 34ms, for the 100, 350, 600 and 850 ms SOA, respectively).

Although neither the Spatial Congruency X Cuing interaction nor the Spatial Congruency X Cuing X Group interaction reached significance, ($p = 0.08$ and $p = 0.13$ respectively), given our a priori predictions, we conducted a separate ANOVA for each distractor group, with Cuing, Spatial Congruency and SOA as within-participants variables. The purpose of these analyses was to evaluate the a priori prediction that the Spatial Stroop effect ought to be smaller for cued trials in the distractor absent group (as in prior experiments), but not in the distractor present group. For the distractor absent group, the Spatial Stroop effect was significantly smaller for cued (18 ms) than for uncued trials (30 ms), $F(1, 23) = 6.12$, $MSe = 480.60$, $p<0.05$. In contrast, for the distractor present group, the Spatial Congruency X Cuing interaction was not significant ($F<1$). Clearly, the Spatial Stroop effects obtained for cued and uncued trials were similar (32 and 34 ms for cued and uncued trials respectively).

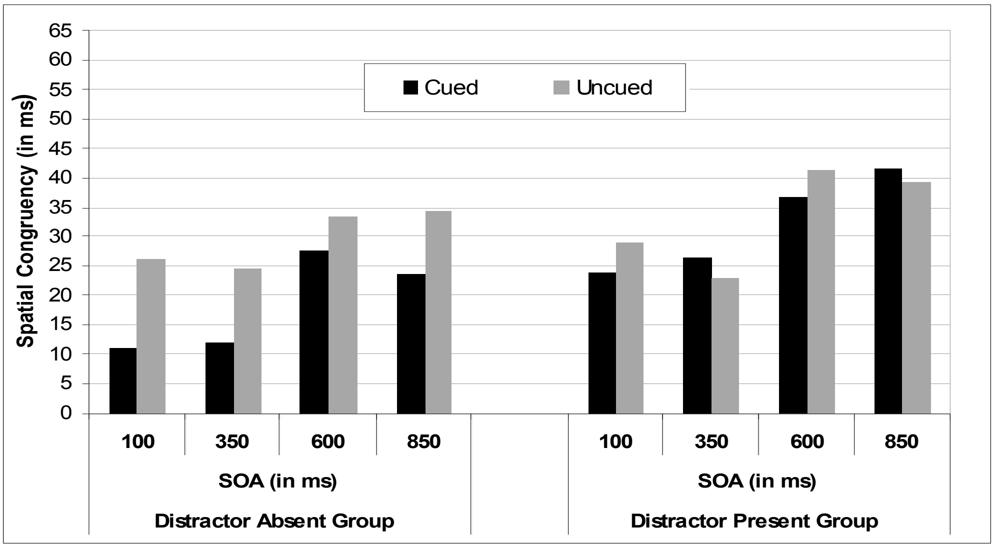

Figure 5. Spatial Stroop effect (incongruent minus congruent trials, in milliseconds) as a function of Cuing and SOA in Experiment 2 for the distractor absent group (left panel) and for the distractor present group (right panel).

Error Rate analysis. There were main effects of Cuing, $F(1, 46) = 17.06$, $MSe = 0.001$, $p<0.0005$, and Spatial Congruency, $F(1, 46) = 62.83$, $MSe = 0.009$, $p<0.0001$. Participants committed more errors for uncued trials (6.4%) than for cued trials (5.2%), and for incongruent (7.5%) than for congruent trials (4.2%).

As in the RT analysis, Cuing interacted with Distractor, $F(1, 46) = 6.57$, $MSe = 0.001$, $p<0.05$. Further analysis showed a significant facilitation effect (2%) for the distractor absent group ($p<0.0005$) that was not apparent (0.5%) for the distractor present group ($p>0.2$). Also, Cuing interacted with SOA, $F(3, 138) = 3.21$, $MSe = 0.001$, $p<0.05$, such that a significant facilitation effect was present at the 350ms ($p<0.0001$, 2.4%) and 850 ms SOAs ($p<0.05$, 1.2%), but not for the 100 ms ($p>0.1$, 0.8%) and 600 ms SOAs ($p>0.4$, 0.4%). As in the analysis of RTs, the Cuing X SOA X Distractor interaction was not significant ($F<1$).

Regarding the modulation of the Spatial Stroop effect, the Cuing X Spatial Congruency X Distractor interaction did not reach significance ($p>0.2$), but separate two-way ANOVAs examining the Cuing X Spatial Congruency interaction for each distractor group showed a pattern of results similar to that found for the RTs: a marginally significant reduction of the Spatial Stroop effect for cued (1.5%) relative to uncued trials (3.1%) for the distractor absent group ($p = 0.07$), but not for the distractor present group ($F<1$, 4.3% and 4.5% Spatial Stroop effects for cued and uncued trials, respectively).

DISCUSSION

The present experiment replicated the critical findings of Experiment 1 with respect to the effect of the presence of a distractor on the magnitude and time course of Cuing effects. Thus, for the distractor absent group, a large facilitation effect was observed at the shortest SOA, and this effect decreased as a function of SOA. For the distractor present group, the Cuing effects were more negative than for the distractor absent group, and the null Cuing X Distractor X SOA interaction indicates that this shift toward more negative cuing effects was uniform across all levels of SOA. The fact that the effect of the presence of the distractor on cueing effects was similar across all levels of SOA allows us to conclude more confidently that the negative shift in Cuing effects found in the distractor present group is not due to the fast reorienting of attention away from the cued location. Rather, it seems consistent with the notion that distractor presence induces participants to adopt a set favoring segregation of cue and target events, a set that affects performance beginning with even the shortest cue-target SOAs. With respect to the modulation of Spatial Stroop by Cuing, the results from this experiment mirrored the findings of Experiment 1. Thus, the presence of distractors eliminated the interaction between Spatial Stroop and Cuing systematically observed in several prior experiments (Funes & Lupiáñez, 2003; Lupiáñez & Funes, 2005). This finding provides converging support for our hypothesis that the modulation of Spatial Stroop by peripheral spatial cues is related to the spatio-temporal integration of cue and target representations within the same event representation. By this view, with the presence of a distractor, segregation of cue and the cued target into separate event representations rather than integration of the cue and the cued target within the same representation impacts both cuing effects and the influence of a peripheral cue on spatial congruency effects.

GENERAL DISCUSSION

The results found in Experiments 1 and 2 provide evidence for an important modulation of the effect of peripheral cues on target processing when a distractor is systematically presented in the location opposite the target. Apart from generalizing previous findings (Lupiáñez et al., 1999, 2001) by using a different type of discrimination task requiring spatial conflict resolution, the presence of distractors produced a uniform shift towards more negative Cuing effects for all levels of SOA. As discussed in the introduction, this finding is difficult to be explained in terms of the fast reorienting of attention away from the cued location with the presence of a distractor.

Apart from its influence on Cuing effects, the use of a Spatial Stroop paradigm allowed us to obtain qualitative evidence to further test the event segregation hypothesis. Thus, the presence of a distractor at the location opposite the target eliminated the reduction of Spatial Stroop on cued trials found in the distractor absent condition of the present study as well as in several prior studies (Funes & Lupiáñez, 2003; Lupiáñez & Funes, 2005, Funes, Lupiáñez & Milliken, 2007). In particular, with the presence of a distractor, the Spatial Stroop effect was equally large for cued and uncued trials. Given our explanation for the reduction of Spatial Stroop on cued trials in terms of integration of the spatial codes of the cue and the cued target (Funes et al, 2007; Funes & Lupiáñez, 2003, Lupiáñez & Funes, 2005) it seems likely that the distractor manipulation eliminated the Spatial Stroop by Cueing interaction because it disrupted the integration of spatial codes of the cue and the cued target.

In general, the pattern of results found in these experiments seems consistent with the existence of event integration and event segregation processes, which contribute to both the magnitude and time course of cueing effects in peripheral cueing paradigms where the cue and the target may share spatio-temporal coordinates. A set favoring perceptual integration between the cue and the target within the same event representation on cued trials may be especially beneficial on discrimination tasks, where the accumulation of feature information about the target is critical to performance. However, participants may adopt a set to encode cue and target as separate events with the systematic presence of a distractor at the location opposite the target. A set favoring event segregation might help to prevent detrimental consequences produced by the integration of a cue and a distractor at the same location within the same event representation. As Lupiáñez and colleagues noted (Lupiáñez et al, 1999; 2001), this "event segregation" mode of processing may also be adopted in detection tasks, where fast detection of the abrupt onset of the target as separate from any other source of activation, is critical to performance (Lupiáñez et al, 1999, 2001). This set for cue-target segregation might contribute to the small and short lived facilitation effects usually found in detection tasks as well as in discrimination tasks where a distractor is present.

The alternative explanation proposed by Klein (2000) according to which an ACS towards onsets in the distractor absent condition might be prevented with the likelihood of a distractor, could also account, at least in part, for the cueing modulation produced by the presence of a distractor. In fact, Klein (2000) acknowledge that reflexive attention might not be biphasic, with facilitation being replaced by inhibition, but instead, cueing effects might be the result of two independent processes simultaneously triggered by the onset of the cue, one positive (attentional orienting) and responsible of facilitation, and one negative and responsible of IOR. If that were the case, IOR might begin with the appearance of the cue but be only measured when the inhibitory effect is larger than the facilitory effect produced by attention. Based on that view, an early appearance of IOR might then be expected by an experimental manipulation that prevents attentional orienting. Considering cueing effects in that terms and interpreting IOR as independent of the dynamics of attention, we might then agree with Klein's alternative proposal that the distractor manipulation could have set the system to prevent attentional orienting.

Nevertheless, we consider the second set of results obtained in the two experiments presented in this study, where the Spatial Stroop by cueing interaction was completely abolished with the presence of a distractor, more in agreement with an explanation in terms of a set to prevent cue-target integration. As discussed in the introduction, the effect of reduced Spatial Stroop on cued trials in the absence of a distractor has been shown to be unrelated to the predictive value of the cue (and consequently to the magnitude of facilitation) but to depend instead, on the spatial correspondence between the cue and the target (Funes et al., 2007). Even more importantly, a recent study (Luo, Fu & Lupiáñez, submitted), using a variant of the double-rectangles cueing task developed by Egly, Driver, and Rafal (1994) combined with the spatial Stroop task, demonstrates that the reduction of Spatial Stroop on cued trials depends not on cueing the target location but on cueing the object within which the arrow appears. Based on the cue-target object or event integration hypothesis, the cue would trigger the creation of an object representation, within which the arrow would be subsequently integrated. This account would predict that no location code is generated (or it is less strongly generated) by the target arrow onset when it appears within an object that is already represented. And because no location code is generated (or it is less strongly generated) the spatial Stroop effect would be reduced or eliminated at the cued object.

To conclude, we believe that the present results support the hypothesis that attentional sets favoring either cue-target integration or segregation do contribute to performance in peripheral cueing studies. Note that the present proposal does not rule out a contribution of attentional orienting-reorienting processes to peripheral cueing tasks, especially to account for the shift towards more negative cueing effects with the presence of a distractor. Instead, it highlights the need to understand further the range of processes that can contribute to peripheral cueing effects, and the conditions under which each of these processes (e.g., attentional orienting, perceptual integration, perceptual segregation) is most likely to contribute to performance.

RESUMEN

Modulación de la interferencia Stroop especial por la señalización espacial exógena. Evidencia a favor de un set de "segregación señal-objetivo". Se presentan dos experimentos para estudiar si la modulación de los efectos de señalización exógena debida a la presencia de un distractor en el lugar opuesto al estímulo objetivo (alteración del curso temporal de dichos efectos de señalización, Lupiáñez et al., 1999, 2001) son producidos por la reorientación rápida de la atención o por un set de tarea para prevenir la integración perceptual de la señal y el objetivo en una misma representación. Se usó una tarea de Stroop espacial para explorar si el efecto de facilitación tan prolongado que se suele usar con esta tarea, así como el típico efecto de reducción de la interferencia en los ensayos señalados (Funes et al., 2003, 2005, en prensa), desaparecería con la presencia de un distractor. En el experimento 1, la presencia del distractor produjo un cambio hacia efectos de señalización mucho más negativos, incluso al nivel de SOA más corto, 100ms, además de eliminar la interacción de Stroop espacial por Señalización. En el experimento 2, introdujimos un rango de SOAs mayor y demostramos que el cambio hacia efectos de señalización

más negativos encontrado en el experimento 1, afectaba por igual a todos los niveles de SOA. Este patrón de resultados es explicado en función de la hipótesis de la segregación de eventos.

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APPENDIX 1

Mean RT (in ms) and percentage of errors (in cursive) as a function of Congruency, SOA, Cuing, and Distractor group and Response mapping in Experiment 1.

		SOA 100 ms				SOA 600 ms			
		Cued		Uncued		Cued		Uncued	
Distractor	R Mapping	C	I	C	I	C	I	C	I
Absent	Compatible	494	538	518	561	498	539	509	551
		1,3%	*4,8%*	*1,3%*	*5,5%*	*1,3%*	*4,4%*	*2,1%*	*7,2%*
	Incompatible	554	545	567	593	562	558	566	584
		6,0%	*7,0%*	*4,5%*	*6,5%*	*5,3%*	*4,3%*	*6,8%*	*5,5%*
Present	Compatible	526	571	534	579	534	576	521	565
		2,5%	*4,5%*	*1,5%*	*4,6%*	*1,9%*	*5,3%*	*2,2%*	*4,2%*
	Incompatible	576	578	581	594	574	595	562	573
		3,4%	*5,1%*	*3,3%*	*5,7%*	*2,4%*	*5,3%*	*3,7%*	*4,5%*

APPENDIX 2

Mean RT (in ms) and percentage of errors (in cursive) as a function of Congruency, SOA, Cuing, and Distractor group and Response mapping in Experiment 2.

Present				Absent				Distractor		
Incompatible		Compatible		Incompatible		Compatible		R Mapping		
7,5%	603	*1,2%*	553	*5,4%*	563	*1,8%*	502	C	Cued	SOA 100 ms
8,8%	620	*6,6%*	584	*6,3%*	558	*3,6%*	529	I		
8,4%	609	*2,7%*	546	*5,5%*	584	*3,4%*	514	C	Uncued	
10%	624	*6,6%*	587	*7,4%*	590	*5,2%*	557	I		
7,8%	595	*1,5%*	551	*4,9%*	557	*1,2%*	494	C	Cued	SOA 350 ms
8,9%	609	*7,8%*	592	*8,9%*	555	*1,8%*	518	I		
8,0%	610	*1,5%*	535	*7,2%*	572	*3,6%*	511	C	Uncued	
9,4%	607	*5,8%*	584	*8,4%*	573	*9,0%*	556	I		
7,6%	606	*2,7%*	536	*5,2%*	565	*2,1%*	483	C	Cued	SOA 600 ms
8,8%	627	*3,8%*	588	*6,7%*	572	*2,4%*	531	I		
9,0%	588	*2,1%*	522	*5,1%*	568	*3,3%*	505	C	Uncued	
7,1%	596	*8,4%*	594	*7,5%*	585	*6,9%*	553	I		
10%	607	*3,0%*	553	*6,0%*	569	*1,8%*	506	C	Cued	SOA 850 ms
9,4%	631	*8,2%*	609	*6,3%*	570	*3,9%*	549	I		
7,8%	591	*3,0%*	543	*6,0%*	574	*3,3%*	522	C	Uncued	
11%	612	*5,9%*	602	*9,9%*	598	*7,5%*	564	I		