THE QUARTERLY JOURNAL OF EXPERIMENTAL PSYCHOLOGY
2009, 62 (9), 1685–1695

Psychology Press
Taylor & Francis Group

Short article

Distractor interference in focused attention tasks is not mediated by attention capture

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Distractor stimuli possessing information that is relevant for a task (henceforth, *task-relevant distractors*) often interfere with task performance. The interference by task-relevant distractors is observed even when distractors are positioned outside the main attentional focus. We investigated whether such interference is due to an attention capture by the distractors. Participants responded to a target colour while ignoring word distractors positioned within (Experiment 1) or outside (Experiments 2 and 3) the attentional focus. The words carried task-relevant information in their colour and personally significant information in their content. Because personally significant information affects performance only when positioned in an attended region, it was used as a marker for the locus of the attentional focus. As expected, when distractors were attended, both task-relevant and personally significant information affected performance. However, when distractors were unattended, only task-relevant information caused interference, suggesting that attention did *not* shift to the distractors' location. We discuss possible accounts for interference effects in focused-attention tasks.

Keywords: Attention capture; Attention gradient; Focused attention.

Attention strongly influences performance of visual tasks (Posner, 1980). Indeed, focusing visual attention on a target may be a prerequisite for producing overt behaviour toward it (A. Cohen & Shoup, 1997). Attentional selection, however, is not perfect, and certain distractors in the visual field may affect performance despite their irrelevance to current goals. Factors that affect attention are therefore critical for understanding task performance.

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This research was funded by grants from the Israel Science Foundation to Gershon Ben Shakhar and to Asher Cohen. We thank Hadas Gutman, Moran Israel, Assaf Breska, and Ori Cohen for their assistance in this research. We also thank Holger Mitterer and an anonymous reviewer for their helpful comments on an earlier version of this manuscript.

http://www.psypress.com/qjep
DOI:10.1080/17470210902811223

Numerous studies revealed that stimuli that are irrelevant for one's goals, yet possess information that is relevant for the task (henceforth, *task-relevant distractors*), exert a strong influence on behaviour (e.g., Folk, Remington, & Johnston, 1992). Performance interference by task-relevant distractors (e.g., coloured stimuli in a colour discrimination task) is observed even in focused-attention tasks, where visual attention is constrained in advance to a particular location, and distractors appear elsewhere in the visual field (Eriksen & Eriksen, 1974; Miller, 1991).

The goal of the present study is to investigate the mechanism by which task-relevant distractors affect performance in focused-attention tasks. While much evidence suggests that stimuli possessing task-relevant information capture attention under "diffused" attention conditions such as visual search tasks (e.g., Folk et al., 1992), it is unclear whether attentional shifts toward task-relevant distractors also occur under more restricted conditions of focused-attention tasks. Some researchers have argued that task-relevant distractors capture attention even when subjects focus their attention in advance on a target location (Folk, Leber, & Egeth, 2002; Kahneman & Chajczyk, 1983; Kahneman & Henik, 1981). Others have posited that attention does not shift at all under focused-attention conditions. For instance, according to the attention gradient model, task-relevant distractors affect performance by utilizing the *residual* attentional activation surrounding the focus of attention, rather than by drawing attention to their location (e.g., LaBerge, 1983; Ro, Machado, Kanwisher, & Rafal, 2002).

The ability to distinguish between the different explanations of task-relevance interference is crucial for understanding the operation of the attentional mechanism. Previous focused-attention studies faced a persistent difficulty in requiring subjects to focus attention on the target's location and simultaneously assessing whether attention has shifted to the distractors' location. Consequently, while much evidence suggests that attention mediates interference caused by task-relevant distractors (LaBerge, 1983; Lavie, 1995), it has not been possible to date to convincingly determine whether this interference reflects an actual attention capture by the distractors or not.

Findings by Gronau, Cohen, and Ben-Shakhar (2003) allowed us to overcome this problem. Gronau et al. (2003) investigated whether distractors that are not relevant for the task but nevertheless carry significant personal information for the participant affect performance. This question has a long history, and studies on this topic produced conflicting results (e.g., see review in Harris, Pashler, & Coburn, 2004). Gronau et al. (2003) used a Stroop-like task in which participants were instructed to name a colour as fast as possible and to ignore a word denoting either a personally significant item (e.g., the participant's own name) or a neutral item (e.g., some other person's name). Visual attention was manipulated by presenting in some experiments the word and the colour at the same location (as in the original Stroop paradigm) and by spatially separating the colour from the word in other experiments. When the word was combined with the target colour, thus appearing within the focus of visual attention, personally significant distractors elicited slower latencies and larger orienting responses (i.e., skin conductance responses, SCRs) than neutral items. However, when the word was spatially separated from the colour, hence appearing outside the main focus of visual attention, these effects disappeared. In contrast, and in accord with previous findings (e.g., Dyer, 1973; Kahneman & Chajczyk, 1983), task-relevant distractors (e.g., words denoting colour names) affected performance both inside and outside the focus of attention. Namely, slower latencies were obtained for words conveying colour-incongruent than colour-congruent names, whether these appeared in an attended or an unattended location. The magnitude of interference caused by the colour words was identical to that of the personally significant words when both types of distractors appeared within the focus of attention, further emphasizing the dissociation between the two types of words when they appeared in an unattended region.

Most relevant for the present study, the results of Gronau et al. (2003) suggested that personally significant (task-irrelevant) distractors can serve as a marker for the location of the attentional focus because they affect behaviour and elicit SCRs only when presented within, but not outside, the main focus of attention. Our present research took advantage of this finding to investigate the mechanism by which task-relevant distractors influence performance in a focused-attention task.

In our experiments participants were required to perform a colour naming task while ignoring distractor words. In the first experiment (Experiment 1) a colour target and a distracting word were both presented within the focus of visual attention, while in the following two experiments (Experiments 2–3) the distracting word was spatially separated from the target and was presented in a region outside the main focus of attention. Critically, and unlike the Gronau et al. (2003) study, the word's content and its colour of print were independently manipulated. The word was either personally significant or neutral in its content and was congruent, neutral, or incongruent in its colour with respect to the target's colour. Note that whereas the content dimension of the distracting word was task irrelevant, the colour dimension was task relevant because participants performed a colour identification task. By independently manipulating these two properties we were able to assess task relevance interference (i.e., colour-congruency effects), while simultaneously monitoring the locus of the attentional focus (indexed by a significance effect, i.e., enhanced responses to personally significant than to neutral words). In accord with previous studies (e.g., Gronau et al., 2003; Gronau, Sequerra, Cohen, & Ben-Shakhar, 2006; Kahneman & Chajczyk, 1983) we expected to find the colour-congruency effect both when the distractors are within and when they are outside the focus of attention. In addition, in accord with the findings by Gronau et al. (2003), we expected personally significant information to affect performance when it is presented within the focus of attention. The critical question concerns the effect of personally significant information when it is presented outside the focus of attention because the very same stimuli simultaneously carry task-relevant (colour) and personally significant information. If task-relevant distractors capture attention (i.e., cause an actual shift of the attention focus to their location), we should find a colour-congruency effect along with a personal significance effect even when the distracting words appear outside the focus of attention. If, however, task-relevant interference occurs in the absence of an attentional shift, there should be no personal significance effect when the distracting words appear in an unattended region, while the very same distracting words should affect performance via their task-relevant information.

EXPERIMENT 1

Method

A total of 32 students, all native Hebrew speakers, performed a colour discrimination task while their voice latencies (response times, RTs) and skin conductance responses (SCRs) were recorded. Participants were required to fixate on the centre of the screen and to name the colour of a rectangle (red/green) that appeared briefly in either an upper or a lower screen position. A coloured word was presented inside the rectangle, and participants were told to ignore it altogether (Figure 1). Note that despite its *peripheral* location, the word appeared *inside* the main focus of attention because it was placed within the target rectangle on which participants had to focus in order to produce their responses. The word appeared in red, green, or blue colours, forming the congruent (e.g., a red word with a red rectangle), incongruent (e.g., a green word with a red rectangle), or neutral (e.g., a blue word with a red rectangle) conditions. The blue colour was considered as neutral since it was not part of the response set for the rectangle colour (red/green). The word denoted either a personally significant or a neutral meaning. We used four categories of personal significance: the participant's first name, family name, mother's name, and father's name. The personal details of each participant were collected prior to the experiment and were

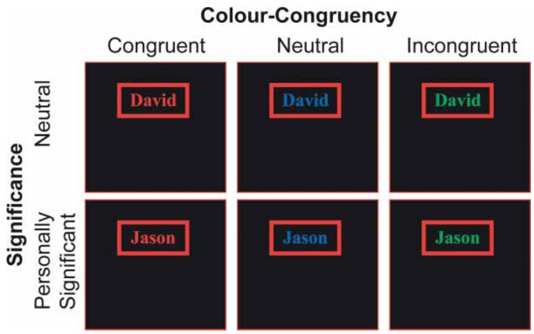

Figure 1. *The stimuli display of the different conditions for Experiment 1. In the present example, "Jason" denotes the participant's name, and "David" denotes a nonpersonal, neutral name.*

subsequently used without prior notification to the participants. Each name category included the participant's relevant information and 4 nonpersonal (i.e., neutral) items (e.g., 4 first names, 4 family names, etc), which were matched in length. The size of the letters forming the distractor words was $0.5^\circ \times 0.43^\circ$ in visual angles, and the distance between the centre of the screen and the centre of the word in each trial was 1°. The rectangle's height subtended 0.57°, and its length subtended on average 2.15°, depending on the length of the word. Altogether there were 4 (name categories) by 5 (items) by 3 (repetitions of each category) = 60 experimental stimuli, presented in two blocks of 30 stimuli each. The experiment comprised 20 congruent, 20 incongruent, and 20 neutral trials. The relative number of personally significant and personally neutral items was identical in these three task relevance conditions. Thus, the colour-congruency factor and the personal significance factor were orthogonally balanced (Figure 1). The order of stimulus presentation within each block was random.

Each trial consisted of a presentation of a central white fixation point (for 500 ms), followed by the target display (for 100 ms). The target display was immediately masked by a white pattern mask (####), which covered the area of the rectangle and the word for another 100 ms, precluding possible eye movement effects on performance. The interstimulus interval ranged from 16 to 24 s, with a mean of 20 s, allowing for a recovery of the SCRs to baseline level. The SCRs were defined as the maximal increase in skin conductance change obtained from 1 s to 5 s after stimulus onset (see Gronau et al., 2003, for a detailed description of the SCR measurement procedure). Trials in which participants made errors and trials with RTs that deviated from the participant's mean RT by more than three standard deviations, were excluded from all analyses (4%).

Results and discussion

The main results are presented in Table 1.[1] A three (congruency: congruent, neutral, incongruent) by two (significance: significant, neutral) repeated measures analysis of variance (ANOVA) was conducted for each measure (RT and SCR).[2] As expected, a statistically significant colour-congruency effect was obtained for the RT, $F(2, 62) = 14.8$, $p < .001$, $f = .39$, but not for the SCR measure, $F(2, 62) = 1.2$, $p > .1$, $f = .11$, replicating our previous results (Gronau et al., 2003, 2006). The significance factor, on the other hand, showed a strong effect for both measures, $F(1, 31) = 17.7$, $p < .001$, $f = .30$; $F(1, 31) = 14.1$, $p < .001$, $f = .27$; for the RT and SCR, respectively. Thus, the colour-congruency and the significance factors affected responses when word distractors were presented in an attended region. There were no hints of

[1] Effect-size estimates (Cohen's d values) were computed for the colour-congruency effect (incongruent − congruent colours) and for the significance effect (personally significant − neutral words). According to J. E. Cohen (1988), the values of $d = 0.2$, $d = 0.5$, and $d = 0.8$ correspond to small, medium, and large effect sizes, respectively. For all ANOVA analyses, Cohen's f values were computed (where $f = .10$, $f = .25$, and $f = .40$ correspond to small, medium, and large effects). Error rates in all experiments were low and did not allow a meaningful effect-size computation.

[2] A preliminary analysis in all experiments indicated that there were no differences in responses between the first block and the second block. Therefore, all the results reported in the manuscript are collapsed across blocks.

Table 1. *Mean responses of the different conditions within each measure in Experiment 1*

		RT	*SCR*	*Proportion of errors*
Colours	Incongruent	687 (21)	1.11 (0.1)	.02 (.04)
	Neutral	659 (21)	1.00 (0.17)	.00 (.01)
	Congruent	640 (19)	1.02 (0.17)	.01 (.02)
	Effect size (incongruent − congruent)	1.29	0.36	—
Words	Personally significant	691 (23)	1.32 (0.22)	.02 (.04)
	Neutral	654 (19)	0.97 (0.16)	.01 (.02)
	Effect size (personally significant − neutral)	0.82	0.70	—

Note: Standard errors in parentheses. RT = response time. SCR = skin conductance response. Effect size estimates refer to Cohen's *d* values (J. E. Cohen, 1988).

Congruency × Significance interaction effects ($F < 1$ for both measures).

These results replicated Gronau et al.'s findings (2003), with the added finding that the significance and congruency effects did not interact. We now turn to the main question of our present research—namely, examining the two effects when the distractors are presented outside the focus of attention.

EXPERIMENT 2

Method

Two experiments (Experiments 2a and 2b) were conducted to examine the congruency and significance effects when distractors appear outside the focus of attention. All aspects of the experiments were identical to those in Experiment 1, except that participants were now required to respond to the colour of a centrally presented square while the distracting word appeared either above or below it (in a location identical to that of the word in the first experiment). As in Experiment 1, we manipulated independently the colour of the word (congruent, neutral, or incongruent) and its content (personally significant or neutral). Note that although the word was presented in the same location as that in the previous experiment, it now fell outside the focus of attention since it was spatially separated from the central target. To allow optimal focusing of visual attention on the central square, a nonword distractor was added to the display in an opposite location to that of the word. The nonword was composed of repetitions of a single letter randomly chosen by the computer (e.g., XXXX). The length of the nonword matched that of the word on each trial. The size of the letters composing the word and the nonword was identical to that in Experiment 1, and the size of the central square was $0.5^\circ \times 0.5^\circ$.

In Experiment 2a, the colour of the nonword was identical to that of the word, such that the central square was flanked by two coloured peripheral distractors (a word and a nonword, see Figure 2). In Experiment 2b, we sought to balance task-relevant (colour) and task-irrelevant (content) properties of the distracting stimuli, and therefore only a single colour distractor was presented on each trial, while the additional distractor was achromatic. Thus, on half of the trials the distractor word appeared in colour (red, green, or blue), accompanied by an achromatic (white) nonword, and in the remaining trials the word was achromatic, accompanied by a coloured nonword. Each trial, therefore, included a single (task-relevant) colour distractor and a single (task-irrelevant) word carrying meaning. Colour-word and achromatic-word trials were randomly intermixed during the experiment.

A total of 32 students, all native Hebrew speakers, participated in each of the two experiments. Trials on which participants made errors or produced deviant responses were excluded from all statistical analyses (3% across both experiments).

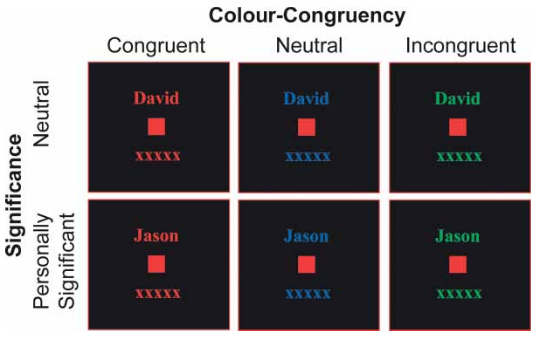

Figure 2. *The stimuli design for the different conditions of Experiment 2a. In Experiment 2b, one of the two peripheral distractors was coloured, while the other peripheral distractor was achromatic (white).*

Results and discussion

Experiment 2A

A three (congruency: congruent, neutral, incongruent) by two (significance: significant, neutral) repeated measures ANOVA was conducted for each measure (RT and SCR). As in Experiment 1, no congruency by significance interaction effects in the experiment were obtained (all Fs < 1). A robust colour-congruency effect was obtained for the RT, $F(2, 62) = 12.3, p < .001, f = .36$. A marginally significant colour-congruency effect was also obtained with the SCR measure, $F(2, 62) = 3.0$, $p < .06$, $f = .18$. However, in contrast to the results of Experiment 1, the significance effect was completely eliminated in both measures, $F(1, 31) = 0.01$ for the SCR measure, and a nonsignificant effect in the opposite direction for the RT measure (see Table 2).

Experiment 2B

A three-way repeated measures ANOVA was conducted for the colour-congruency (congruent, neutral, incongruent), significance (personally significant, neutral), and word-type (coloured, achromatic) factors. Since there were neither main nor interaction effects associated with the word-type factor (all Fs < 1 in both measures), we refer only to the effects of the colour-congruency and the significance factors (Table 3). As in previous experiments, a robust effect was obtained for the colour-congruency factor for RT, $F(2, 62) = 11.24$, $p < .001$, $f = .34$, but not for the SCR measure, $F(2, 62) = 2.46$, $p > .05$, $f = .16$. Most importantly, and in accord with the results of Experiment 2a, there was no effect for the significance factor (i.e., personally significant vs. neutral words) in either measure, $F(1, 31) = 0.2$, $p > .1$, $f = .03$; $F(1, 31) = 2.61$, $p > .1$, $f = .12$; for the RT and SCR, respectively.

It might be particularly instructive to focus on trials on which the meaning and colour were carried by the very same distractor stimulus in Experiment 2b (i.e., to exclude trials where the nonword was coloured and to examine only these trials in which the coloured distractor was a word carrying personally significant or neutral content). In these trials, the congruency effect was necessarily caused by the meaningful words. Yet, the very same pattern of results was observed (Table 4). Namely, colour-incongruent words produced slower RTs than colour-neutral and colour-congruent words, $F(2, 62) = 4.79$, $p < .01$, $f = .22$, while at the same time there was no hint of a difference

Table 2. *Mean responses of the different conditions within each measure in Experiment 2a*

		RT	*SCR*	*Proportion of errors*
Colours	Incongruent	569 (15)	1.06 (0.17)	.02 (.03)
	Neutral	540 (14)	0.91 (0.14)	.01 (.02)
	Congruent	536 (15)	0.95 (0.14)	.00 (.01)
	Effect size (incongruent − congruent)	1.26	0.32	—
Words	Personally significant	547 (14)	0.98 (0.16)	.02 (.03)
	Neutral	549 (14)	0.97 (0.14)	.01 (.02)
	Effect size (personally significant − neutral)	0.00[a]	0.03	—

Note: Standard errors in parentheses. RT = response time. SCR = skin conductance response. Effect size estimates refer to Cohen's d values (J. E. Cohen, 1988). [a]Effect in opposite direction.

Table 3. *Mean responses of the different conditions for RT and SCR in Experiment 2b*

		RT	*SCR*	*Proportion of errors*
Colours	Incongruent	562 (16)	1.09 (0.19)	.01 (.00)
	Neutral	536 (15)	0.96 (0.14)	.01 (.00)
	Congruent	532 (15)	1.03 (0.17)	.00 (.00)
	Effect size (incongruent − congruent)	0.77	0.23	—
Words	Personally significant	544 (14)	1.07 (0.18)	.01 (.01)
	Neutral	542 (15)	0.99 (0.16)	.01 (.00)
	Effect size (personally significant − neutral)	0.08	0.28	—

Note: Mean responses (across the word-type factor). Standard errors in parentheses. RT = response time. SCR = skin conductance response. Effect size estimates refer to Cohen's *d* values (J. E. Cohen, 1988).

between personally significant and neutral (coloured) words in either measure ($F < 1$ in both cases).

Taken together, the results of Experiments 2a and 2b suggest that the effects of task-relevant stimuli appearing outside the focus of attention are exerted in the absence of an attention shift.

However, one caveat to our conclusion is that we used different visual displays in Experiments 1 and 2 leading to possible respective differences in perceptual qualities. Specifically, in Experiment 1 (words within attention) both target and distractor appeared in a peripheral location, whereas in Experiments 2a and 2b (words outside attention) only the distractor appeared peripherally while the target (a coloured square) was presented centrally. These variations in stimulus display may have contributed to the differential results in the two experiments. We therefore conducted an additional experiment in which both target and distractor were presented in opposing peripheral locations; hence, the stimulus display was perceptually comparable to that of Experiment 1 (albeit words now appeared, as in Experiment 2, outside the attentional focus). In Experiment 3 only RTs were recorded.

EXPERIMENT 3

Method

Each trial consisted of a coloured rectangle and a word as in Experiment 1. The rectangle appeared either above or below fixation (0.57° from its centre to fixation) and either to its right or to its left (0.86° from its centre to fixation). The word was presented on the same horizontal right/left side but in the opposite vertical upper/lower position; thus, effectively, the word appeared outside the main focus of attention. The rectangle's vertical upper/lower position was fixed within blocks and alternated between blocks (with order of blocks counterbalanced between subjects). The

Table 4. *Mean responses of the different conditions for RT and SCR among the coloured words only in Experiment 2b*

		RT	*SCR*	*Proportion of errors*
Colours	Incongruent	560 (16)	1.14 (0.22)	.02 (.01)
	Neutral	534 (16)	0.92 (0.15)	.01 (.01)
	Congruent	533 (16)	1.04 (0.19)	.00 (.00)
	Effect size (incongruent − congruent)	0.54	0.21	—
Words	Personally significant	542 (16)	1.09 (0.23)	.02 (0.01)
	Neutral	543 (15)	0.98 (0.15)	.00 (0.00)
	Effect size (personally significant − neutral)	0.00[a]	0.16	—

Note: Standard errors in parentheses. RT = response time. SCR = skin conductance response. Effect size estimates refer to Cohen's *d* values (J. E. Cohen, 1988). [a]Effect in opposite direction.

horizontal left/right position varied from trial to trial, preventing anticipatory eye movements.

A total of 35 students participated in the experiment. Participants responded to the colour (red/green) of the rectangle target while instructed to ignore the irrelevant, coloured (red/green) word. Participants were notified before each block whether the target would appear above or below fixation, but were instructed to maintain central fixation.

Since only RTs were measured in the experiment, we used a relatively short ISI of 3 seconds between trials. The experiment consisted of two blocks of 20 trials (4 name categories × 5 items). All other aspects of stimulus presentation and display were identical to those in the previous experiments. Trials on which participants made errors or produced deviant responses were excluded from all statistical analyses (5%).

Results and discussion

A two (congruency: congruent, incongruent) by two (significance: significant, neutral) repeated measures ANOVA was conducted. As in Experiment 2, a statistically significant effect was obtained for the colour-congruency factor, $F(1, 34) = 5.2$, $p < .05$, $f = .19$, yet there was no hint for a significance effect (see Table 5) nor for an interaction effect ($F < 1$). Once again, these results portray a robust task-relevant (colour) effect in the absence of any significance effect when the words containing the significant information appear outside the main attentional focus.

GENERAL DISCUSSION

The present study investigated the mechanism by which task-relevant distractors affect performance in focused-attention tasks. The goal of the study was to determine whether performance interference is caused by an attention shift to the distractors, or not. To this end, we manipulated independently the colour and the content of distractor words in a colour naming task. This allowed us to monitor the locus of the attentional focus during online task performance. Our findings revealed a colour-congruency (task-relevant) interference effect when distractors appeared both inside and outside the focus of attention. In contrast, a personal significance (task-irrelevant) effect was obtained only when words were presented within an attended region. Previous findings (Gronau et al., 2003) suggested that the effect of personally significant words can serve as an index of the attention focus. Thus, if attention has shifted to the task-relevant words, we should have observed increased RTs and SCRs when these words carried personally significant information. As our data clearly indicate that this was not the case, the attention-shift hypothesis can be rejected. Our results suggest, therefore, that attention capture is *not* the cause for distractor interference in focused-attention tasks.

What may possibly account for task-relevant interference effects in focused-attention situations? As mentioned earlier, one prominent theory of interference is the attention gradient model (LaBerge, 1983; Ro et al., 2002). According to this model, focusing attention on a

Table 5. *Mean responses of the different conditions in Experiment 3*

		RT	*Proportion of errors*
Colours	Incongruent	493 (24)	.05 (.05)
	Congruent	470 (20)	.04 (.04)
	Effect size (incongruent − congruent)	0.41	—
Words	Personally significant	481 (24)	.05 (.08)
	Neutral	481 (22)	.04 (.04)
	Effect size (personally significant − neutral)	0.00	—

Note: Standard errors in parentheses. RT = response time. SCR = skin conductance response. Effect size estimates refer to Cohen's *d* values (J. E. Cohen, 1988).

particular location creates a distribution of activation about this location with a peak at its focus and a gradual decrease of activation with increasing distance from the focused area. Due to this gradient of the attentional activation distribution, task-relevant distractors appearing outside the focus of attention still receive some residual activation that is sufficient to disrupt performance (e.g., LaBerge, 1983). Previously, we have suggested that task-relevant information may be stored in transient stores that are associated with online task requirements and with working memory processes (Gronau et al., 2003, 2006). Consequently, task-relevant stimuli may benefit from prioritized representations and lowered thresholds that allow behavioural interference despite their appearance outside the main focus of attention. The results of the present study are consistent with the notion that the distraction caused by unattended, but task-relevant, distractors is mediated by the attentional gradient.

An alternative account for task-relevant interference is the unlimited capacity model of attention, proposed by Van der Heijden and colleagues (e.g., Mitterer, La Heij, & Van der Heijden, 2003; Van der Heijden, 1992). According to this model, task-relevant distractors are processed in parallel (i.e., pre-attentively), and therefore distractors may interfere with task performance independently of visual attention (albeit, attention can enhance the interference effect, according to the model). In contrast to the gradient model, the unlimited capacity model does not necessitate *any* attentional activation outside the focus of attention for distractor interference (Mitterer et al., 2003). While the results of the present study can be accounted for by both the gradient and the unlimited capacity models, previous evidence suggests that task-relevant interference effects are eliminated to a great extent when distractors are strictly deprived of attentional resources (e.g., Lavie, 1995). In line with the gradient model, therefore, it seems likely that *some* attentional capacity is required for distractor processing and for task-relevance interference.

Our findings are in agreement with previous findings by Starreveld, Theeuwes, and Mortier (2004), who used a visual search task to assess the effects of search efficiency on task-relevant interference. Starreveld et al. found that task-relevant distractors that differed in their colour from a target affected responses to target identification, even though they were searched efficiently (as reflected by flat search slopes). In accordance with our results, task-relevant interference was obtained in the absence of serial deployment of attention to the distractors.

Our results are also in agreement with studies directly assessing task-relevant interference in focused-attention paradigms. Ro, Machado, Kanwisher, and Rafal (2002) used a flanker paradigm in combination with a spatial cueing paradigm (Posner, 1980) in order to determine the role of attention capture in the flanker interference effect. Typically, responses to a central target in the flanker paradigm are affected by task-relevant distractors located on both sides of the target (e.g., Eriksen & Eriksen, 1974). Ro et al. (2002) showed that the amount of interference generated by the flanker distractors is not modulated by the facilitative (or inhibitive) effects of spatial attention cues to these distractors. Namely, flanker interference effects were shown to be independent of whether (task-relevant) flankers appeared in a spatially cued or an uncued location. Cohen, Ivry, Rafal, and Kohn (1995) investigated the flanker effect in two patients exhibiting clinical extinction. This syndrome is characterized by difficulties to orient visual attention towards stimuli appearing in one's contralesional side. Cohen et al. (1995) showed that while the patients were impaired in explicitly identifying a target presented to their contralesional side (in accord with their spatial attention deficit), task-relevant flanker distractors presented on the neglected side did affect performance to a central target. In accordance with the Ro et al. (2002) study, these findings suggest that task-relevant distractors in the flanker paradigm interfere with task performance regardless of the locus of the attention focus.

One study mentioned earlier (Folk et al., 2002) appears to be at odds with our findings. In this study, participants viewed a central rapid serial presentation of visual stimuli and had to report the identity of a red letter among black letters. Folk et al. (2002) found that a peripheral distracting red letter presented just prior to the target impaired performance to the target letter, suggesting that attention was captured by the peripheral distractor. There are two critical differences, however, between our study and the Folk et al. study, which may account for the differential findings. First, whereas in our study the target and distractors appeared simultaneously, in the paradigm used by Folk et al. (2002) the task-relevant (red) distractor always preceded the target. It is possible that presentation of a task-relevant onset *prior* to the target may be a special case in which visual attention may inadvertently shift to the distractor, despite one's attempt to maintain focus on the target's location. Our findings suggest that attention capture does not take place in the more general case, in which the target and task-relevant distractors appear simultaneously. Second, in the flanker paradigm as well as in the present research, "task relevance" refers to a property of the distractor that is relevant for selecting a response to the target (e.g., the colour red, when one is engaged in a colour-naming task). In the paradigm used by Folk et al. (2002), in contrast, the distractor possesses information that is relevant for the actual *detection* of the target, rather than for response-selection processes (e.g., the colour red, when one searches for a red target among a central stream of black stimuli). While in both paradigms the distractor is related in some way to the participants' current goals, it is possible that different attentional mechanisms mediate the different types of task-relevance effects within the two paradigms. Spatial attention may therefore be particularly vulnerable to attention shifts in situations in which one needs to *search* for a target among a series of distractors. This vulnerability to attention capture may hold even when the target's location is known in advance (e.g., Folk et al., 2002).

Original manuscript received 31 August 2008
Accepted revision received 5 February 2009
First published online 11 April 2009

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