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Intertrial target-feature changes do not lead to more distraction by singletons: Target uncertainty does ☆

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ABSTRACT

The presence of an irrelevant singleton disrupts search for a singleton target substantially more when the target feature varies unpredictably (mixed-singleton search) than when it is known in advance (fixed-singleton search). This finding suggests that advance knowledge of the target feature guides singleton search. Pinto et al. [Pinto, Y., Olivers, C. N. L., & Theeuwes, J. (2005). Target uncertainty does not lead to more distraction by singletons: Intertrial priming does. *Perception & Psychophysics, 67*, 1354–1361] proposed an alternative account, according to which this difference results from inter-trial priming effects. They based their argument on the finding that distractor interference is reduced when the singleton target feature repeats vs. switches from one trial to the next. However, Lamy et al. [Lamy, D., Carmel, T., Egeth, H., & Leber, A. (2006). Effects of search mode and inter-trial priming on singleton search. *Perception & Psychophysics, 68*, 919–932] reported no such modulation of distractor interference by target-feature repetition. Here, we show that differences in design (blocking conditions of distractor presence in the former study vs. randomly mixing them in the latter) account for this discrepancy. We conclude that the different task demands induced by the blocked distractor-present and distractor-absent conditions rather than distractor presence per se interact with intertrial priming effects. These findings argue against the claim that singleton search relies exclusively on stimulus-driven factors and suggest that preknowledge of the target feature, when available, can guide attention. In addition, the present results challenge the ambiguity hypothesis of intertrial priming, according to which increased competition for attentional selection boosts inter-trial priming effects.

1. Introduction

The extent to which behavioral goals can modulate the allocation of attention in parallel search is a matter of debate (e.g., for a review see Ruz & Lupianez, 2002). At one end of the continuum, the pure bottom–up view stipulates that a salient object (e.g., a "singleton", i.e., an object carrying a unique feature) captures attention even when it is irrelevant to the task at hand and subjects attempt to ignore it (e.g., Theeuwes, 1991, 1992). An intermediate view is that when subjects search for a singleton defined in a particular dimension, a more salient singleton defined in a task-irrelevant dimension captures attention, because subjects adopt a default "singleton-detection mode". By contrast, the same irrelevant singleton does not capture attention when subjects search for a target that is not defined as a singleton (Bacon & Egeth, 1994). At the other end of the continuum, Folk and colleagues have suggested that attentional capture is contingent on the match between the irrelevant singleton and the top–down "set" of the observer (Folk & Remington, 1998; Folk, Remington, & Johnston, 1992).

A straightforward prediction of the pure bottom–up view and of the notion of a default singleton-detection mode is that a similar pattern of results should be observed in search for a fixed singleton, that is, for a singleton the salient feature of which is known in advance on each trial (henceforth, fixed-singleton search), and in search for a singleton the salient feature of which varies from trial to trial and is thus not known beforehand (henceforth, mixed-singleton search). Yet, several differences have been reported between the two types of search. Search for a known singleton is fast and yields flat search slopes, that is, performance is unaffected by the number of distractors in the display. By contrast, search for an unknown singleton is slow and yields negative search slopes, that is, performance improves when distractors are added to the display (e.g., Bravo & Nakayama, 1992). In addition, interference from a salient distractor is substantially larger in mixed-singleton search than in fixed-singleton search (Theeuwes, 1991 vs. Theeuwes, 1992, respectively). These differences suggest that the mechanism that one uses to perform a singleton search task depends on whether or not advance knowledge of the target feature

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is available. In search for a fixed singleton subjects use a feature-based strategy in which attention is guided by knowledge of the target feature. In search for a mixed singleton, subjects use a salience-based strategy in which attention is directed to the most salient object in the visual field (e.g., Bravo & K. Nakayama, 1992).

An alternative account that supports the bottom–up view was suggested by Maljkovic and Nakayama (1994). They showed that in a mixed-singleton search, performance is enhanced when the target has the same feature on consecutive trials, a repetition effect they called "priming of pop-out" (henceforth, PoP). They concluded that the same salience-based mechanism underlies singleton search whether or not the target feature is known, because the difference in the pattern of results observed in the two types of search results from repetition effects rather than from advance knowledge of the target feature. In line with this conjecture, they showed that PoP cumulates over up to eight consecutive same target-feature trials, at which point performance in a mixed-singleton search reaches the RT level observed in a fixed-singleton search.

In a recent study, Lamy, Carmel, Egeth, and Leber (2006) showed that while target-feature repetition or PoP did reduce the RT gap between the two singleton search types, it did not interact with either search slopes or distractor interference. That is, the negative search slopes did not become flatter when the target feature repeated, nor was distractor interference reduced. Lamy et al. (2006) concluded that PoP cannot explain all the differences observed between fixed-singleton search and mixed-singleton search, thereby arguing against the pure bottom–up view and against the existence of a default singleton-search mode. However, Pinto, Olivers, and Theeuwes (2005; see also Meeter & Olivers, 2006) reported conflicting findings. Using tasks and stimuli similar to the ones used by Lamy et al. (2006) they found distractor interference to interact with PoP, namely, they found the presence of an irrelevant singleton to disrupt search performance to a lesser extent when the target feature repeated. This finding supports the notion that PoP accounts for the difference in the magnitude of distractor interference observed in mixed- vs. fixed-singleton search.

The objective of the present study was to determine the source of the discrepancy between the two studies. These differed in a number of seemingly minor aspects. The potentially most consequential difference was in the way the presence of the irrelevant distractor was manipulated. Whereas distractor-present and distractor-absent trials were randomly mixed within a block of trials in Lamy et al.'s (2006) study, they were presented in different blocks of trials in Pinto et al. (2005) and in Meeter and Oliver's (2006) studies. In order to determine the role of the mixed vs. blocked distractor presence manipulation, we first replicated Pinto et al.'s Experiment 1, using similar stimuli and design. Then, we conducted a second experiment that differed from the first one only in the fact that distractor presence was mixed as in Lamy et al.'s study rather than blocked as in Pinto et al.'s study. If advance knowledge of the presence or absence of the irrelevant singleton is indeed the critical difference between the two studies, then we should expect PoP to interact with distractor interference in Experiment 1 (replicating Pinto et al.'s finding) but not in Experiment 2 (replicating Lamy et al.'s finding).

2. Experiment 1

This experiment was a replication of the first experiment reported by Pinto et al. (2005). It consisted of three conditions. Participants searched for a uniquely shaped target and had to report the orientation of a T letter inside the target. In the fixed-circle condition, the target was a circle among diamonds throughout a block of trials. In the fixed-diamond condition, the target was a diamond among circles throughout a block of trials. In the mixed-target condition, the target was unpredictably either a diamond among circles or a circle among diamonds within a block of trials. In a given block of trials, an irrelevant color singleton was either present or absent on each trial.

2.1. Method

2.1.1. Subjects

Subjects were ten Tel-Aviv University undergraduate students who participated in the experiment for course credit. All reported having normal or corrected visual acuity and normal color vision.

2.1.2. Apparatus

Displays were generated by an Intel Pentium 4 computer attached to a 17" CRT monitor, using 640 × 480 resolution graphics mode. Responses were collected via the computer keyboard. A chin-rest was used to set viewing distance at 50 cm from the monitor.

2.1.3. Stimuli

An example of the stimulus display are presented in Fig. 1. The fixation display was a white (0.3° × 0.3°) plus sign in the center of a black background. The stimulus display consisted of the fixation display with the addition of nine shapes equally spaced along the circumference of an imaginary circle, centered at fixation. The shapes were outline circles (1.71° in diameter) and outline diamonds (rotated squares, 1.6° in side), colored red (CIE coordinates .630/.340), green (CIE coordinates .280/.591), or gray (.280, .290). Centered inside each shape was a gray T letter (0.56° in length and 0.37° in width) rotated by 90° and pointing either to the right or to the left. The display always contained either five left-pointing Ts and four right-pointing Ts, or vice-versa. All colors were matched for equiluminance using a Minolta ColorCAL colorimeter (19 cd/m^2). In the fixed-circle condition, one shape was a circle (the target) and the remaining shapes were diamonds (the nontargets). In the fixed-diamond condition, one shape was a diamond (the target) and the remaining shapes were circles (the nontargets). In the mixed-target condition, the target was unpredictably either a diamond among circles or a circle among diamonds. In the distractor-absent condition,

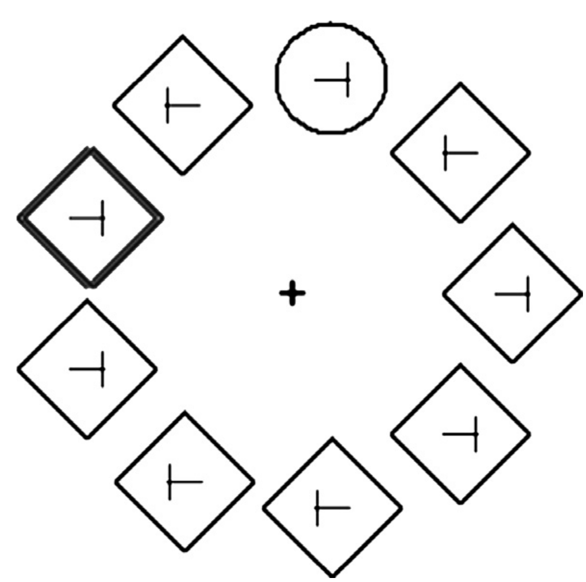

Fig. 1. Sample stimulus display. The example corresponds to the distractor-present condition, with the T inside the target circle pointing to the right. The thick black stroke corresponds to the color of the irrelevant singleton (either red or green) and the thin black stroke designates the color of the remaining elements (gray). The stimulus appeared against a black background.

all shapes in the display were gray. In the distractor-present condition, one of the nontargets was either red or green.

2.1.4. Procedure

Participants had to determine whether the T inside the color singleton target pointed to the right (by pressing the "z" key on the computer keyboard with their right hands) or to the left (by pressing the "3" keypad key with their left hands) as fast as possible, while maintaining high accuracy. Error trials were followed by a 500-ms feedback beep.

Each trial began with the fixation display. After 500 ms, the stimulus display followed, and remained visible until response. The screen went blank for 500 ms before the next trial began. Eye movements were not monitored, but subjects were explicitly requested to maintain fixation throughout each trial.

2.1.5. Design

The experiment consisted of five clusters of six blocks, each containing 16 trials. Each 6-block cluster consisted of the crossing of the three target conditions (fixed circle, fixed diamond and mixed-target) by the two conditions of distractor presence (distractor present and distractor absent). The order of the blocks within a cluster was random. Before each block, the words "circle", "diamond", or "both" appeared on the screen to inform the participants as to what type of target would appear in the block that followed. At the beginning of the experiment, the participants were told that a singleton distractor would appear in some of the blocks but should be ignored. The first cluster of blocks was disregarded as practice. The other four clusters of blocks were included in the analyses. Participants were allowed a short break after each cluster of blocks. The target shape was equally likely to appear in any of the nine possible locations. The distractor in the distractor-present condition was equally likely to appear in any of the remaining eight locations. In the mixed-singleton condition the target was equally likely to be a circle or a diamond. The T inside the shapes was equally likely pointing to the left or to the right.

2.2. Results and discussion

Mean RT and accuracy scores are shown in Fig. 2 (left panels). In all RT analyses, error trials (4.0% of all trials) were removed from analysis, and following Pinto et al.'s procedure, trials with reaction time longer 3000 ms were considered as outliers. However, this procedure did not remove any outlier in the present experiment.

2.2.1. Overall analysis

An Analysis of Variance (ANOVA) was conducted with search condition (fixed singleton vs. mixed singleton) and distractor presence (present vs. absent) as within-subject factors.

2.2.1.1. Reaction times. Main effects of search condition and singleton-distractor presence were significant [$F(1,9) = 64.36$, $p < .0001$, and $F(1,9) = 57.08$, $p < .0001$, respectively]. The interaction between the two factors was also significant [$F(1,9) = 13.90$, $p < .005$], with larger singleton-distractor interference in the mixed-singleton condition [178 ms, $F(1,9) = 62.86$, $p < .0001$] than in the fixed-singleton condition [93 ms, $F(1,9) = 41.30$, $p < .0001$].

2.2.1.2. Accuracy. The main effect of singleton-distractor presence was significant [$F(1,9) = 20.80$, $p < .002$] with more errors when a singleton distractor was present rather than absent. The main effect of search condition was non-significant [$F(1,9) = 1.52$, $p > .2$]. However, paired comparisons showed that singleton-distractor interference was significant only in the mixed-singleton condition [$F(1,9) = 10.75$, $p < .01$], and not in the fixed-singleton condition [$F(1,9) = 3.31$, $p > .1$].

The present results replicated the differences observed in previous studies between search for a known singleton (fixed-singleton condition) and search for a singleton the shape of which changes unpredictably from trial to trial (mixed-singleton condition): search was slower and distractor interference larger in the mixed- relative to the fixed-singleton condition (e.g., Bravo & K. Nakayama, 1992; Lamy et al., 2006; Pinto et al., 2005; Theeuwes, 1991 vs. 1992).

2.2.2. Inter-trial effects

An ANOVA was conducted only on trials from the mixed-singleton condition with target-shape repetition (repeated vs. switched) and distractor presence (present vs. absent) as within-subject factors.

2.2.2.1. Reaction times. The main effect of target-shape repetition was significant [$F(1,9) = 34.50$, $p < .0002$], with shorter RTs on

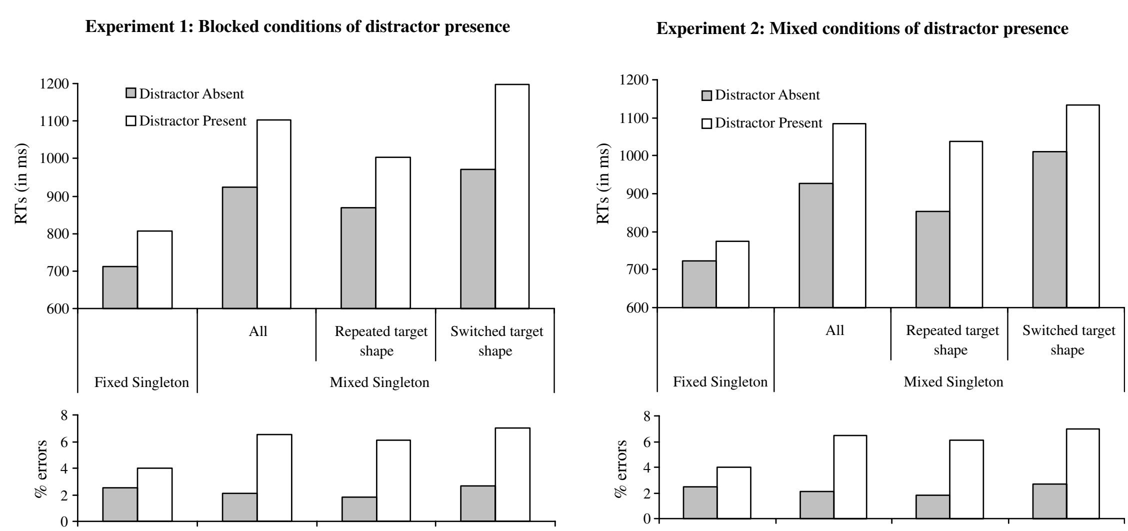

Fig. 2. Mean reaction times (RTs, upper panels) and percentage of errors (lower panels) in the fixed-singleton and mixed-singleton conditions for distractor-present vs. distractor absent trials. For the mixed-singleton condition, the data from trials in which the target feature repeated on at least two consecutive trials (repeated-target trials) or switched from one trial to the next (switched target trials) are presented in addition to the overall data for this condition. The left panels show the data from Experiment 1, in which conditions of distractor presence were blocked (as in Pinto et al., 2005). The right panels show the data from Experiment 2 in which conditions of distractor presence were mixed (as in Lamy et al., 2006).

repeated than on switched target shape trials, thus replicating the Priming of Pop-out (PoP) effect (Maljkovic & Nakayama, 1994). This effect interacted with singleton-distractor interference [$F(1,9) = 7.18$, $p < .03$], with stronger interference when target features switched from one trial to the next [226 ms, $F(1,9) = 27.70$, $p < .0005$] than when target features repeated [136 ms, $F(1,9) = 22.63$, $p < .001$]. Singleton-distractor interference was of similar magnitude in the fixed-singleton condition and on repeated target-shape trials of the mixed-singleton condition, [$F(1,9) = 2.64$, $p > 0.1$].

2.2.2.2. Accuracy. None of the effects approached significance, all Fs < 1.

The replication of Pinto et al. (2005) results was thus successful: we found that when conditions of distractor presence were blocked, the presence of an irrelevant singleton disrupted search performance to a lesser extent when the target feature repeated than when it switched. In order to determine whether blocking vs. mixing conditions of singleton distractor presence is indeed the critical difference between Pinto et al.'s and Lamy et al.'s studies, we now turn to examine whether this pattern changes when conditions of distractor presence are mixed within blocks.

3. Experiment 2

3.1. Method

3.1.1. Subjects

Subjects were 10 Tel-Aviv University undergraduate students who participated in the experiment for course credit. All reported having normal or corrected visual acuity and normal color vision.

3.1.2. Apparatus, stimuli, procedure and design

The apparatus, stimuli and design were the same as Experiment 1, except that conditions of distractor presence were randomly mixed rather than blocked.

3.2. Results and discussion

Mean RT and accuracy scores are depicted in Fig. 2 (right panels). In all RT analyses, error trials (4.1% of all trials) were removed from analysis. Again, Pinto et al.'s outlier exclusion procedure did not remove any outlier in the present experiment.

3.2.1. Overall analysis

An ANOVA was conducted with search condition (fixed singleton, mixed singleton) and distractor presence (present vs. absent) as within-subject factors.

3.2.1.1. Reaction times. Replicating the results obtained in Experiment 1, main effects of search condition and singleton-distractor presence were significant [$F(1,9) = 78.21$, $p < .0001$, and $F(1,9) = 56.09$, $p < .0001$, respectively]. The interaction between the two factors was significant [$F(1,9) = 23.29$ $p < .0009$], with larger interference in the mixed-singleton condition [M = 157 ms, $F(1,9) = 43.44$, $p < .0001$] than in the fixed-singleton condition [M = 50 ms, $F(1,9) = 40.79$, $p < .0001$]. Thus, again, search was slower and distractor interference larger in the mixed- relative to the fixed-singleton condition.

3.2.1.2. Accuracy. None of the effects approached significance, all ps > .15.

3.2.2. Inter-trial effects

An ANOVA was conducted only on trials from the mixed-singleton condition with target-shape repetition (repeated vs. switched) and distractor presence (present vs. absent) as within-subject factors.

3.2.2.1. Reaction times. The main effect of target-shape repetition was significant, with shorter RTs on repeated vs. switched target shape trials [$F(1,9) = 23.79$, $p < .0009$], thus again replicating the PoP effect. However, by contrast with the pattern of results observed in Experiment 1, the interaction between the two factors did not reach significance, [$F(1,9) = 3.18$, $p > 0.1$] and in fact showed a clear numerical trend in the opposite direction, that is, towards larger distractor interference on repeated relative to switched target shape trials [186 ms, $F(1,9) = 33.55$, $p < .0003$ vs. 123 ms, $F(1,9) = 17.15$, $p < .003$, respectively].

A between-experiment analysis with design (blocked vs. mixed distractor conditions) as a between-subjects factor, and target-shape repetition (repeated vs. switched) and distractor presence (present vs. absent) as within-subject factors showed a significant 3-way interaction, $F(1,18) = 6.69$, $p < 0.03$, thus confirming that effects of PoP on distractor interference differed between the blocked- and mixed-distractor conditions (see Fig. 3).

It should be noted that mixing conditions of distractor presence does not only eliminate advance knowledge as to whether or not a distractor will be present in the next trial, but also creates different sequences of distractor presence conditions. That is, by contrast with the situation that prevails when conditions of distractor presence are blocked, half of the distractor-present trials are preceded by distractor-absent trials and half of the distractor-absent trials are preceded by distractor-present trials. To test the possibility that such sequential effects rather than pre-knowledge about the upcoming distractor presence condition accounted for the different results observed with a mixed design (in the present experiment and in Lamy et al., 2006) relative to a blocked design (in Experiment 1 and in Pinto et al., 2005), we ran an ANOVA with target-shape repetition (repeated vs. switched) and distractor presence (present vs. absent) but included only trials for which distractor presence conditions repeated from one trial to the next. In other words, we included only distractor-present trials that were preceded by distractor-present trials and distractor-absent trials that were preceded by distractor-absent trials. Thus, for this subset of trials, the mixed design differed from the blocked design only with regard to the participants' expectations of the upcoming distractor presence condition. The main effects of target-shape repetition and singleton distractor interference remained significant, [$F(1,9) = 8.25$, $p < .02$ and ($F(1,9) = 7.99$, $p < .03$, respectively). Of most interest, however, the two factors did not interact, [$F < 1$], indicating

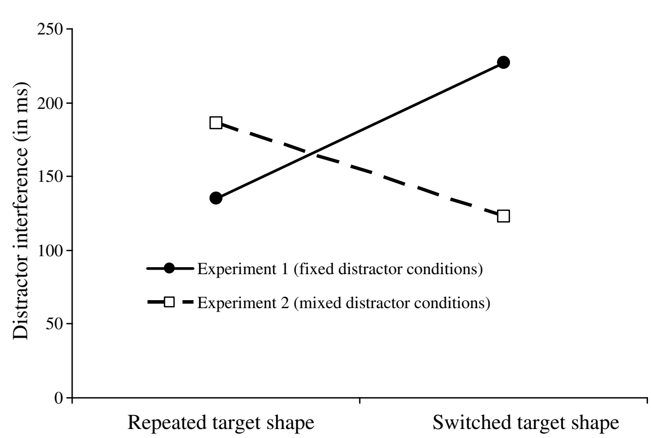

Fig. 3. Mean distractor interference (in milliseconds) in the repeated vs. mixed target shape conditions in Experiment 1 (fixed conditions of distractor presence, as Pinto et al., 2005) and in Experiment 2 (mixed conditions of distractor presence, as in Lamy et al., 2006).

that distractor interference was not reduced when the target feature repeated [173 ms, $F(1,9) = 12.86$, $p < .005$] relative to when it changed [131 ms, $F(1,9) = 6.94$, $p < .03$]. Again, the numerical trend was in the opposite direction to that predicted by Pinto et al. (2005). The 3-way interaction (design by target-shape repetition by distractor presence) remained significant, $F(1,18) = 5.69$, $p < 0.03$, even when distractor presence sequences were equated between the two conditions[1].

3.2.2.2. Accuracy. None of the effects approached significance, all Fs < 1.

We replicated Lamy et al. (2006) findings: when conditions of distractor presence were mixed within blocks of trials, the presence of an irrelevant singleton did not disrupt search performance to a lesser extent when the target feature repeated from one trial to the next than when it switched.

4. General discussion

Using exactly the same task and stimuli in Experiments 1 and 2, we found that when conditions of distractor presence are blocked, distractor interference is reduced on repeated target shape trials (Experiment 1), thus replicating Pinto et al.'s finding. By contrast, when conditions of distractor presence are mixed, distractor interference is unaffected by target shape repetition (Experiment 2), thus replicating Lamy et al.'s finding. Taken together, these results show that blocking vs. mixing conditions of singleton distractor presence was indeed the critical difference between Pinto et al.'s and Lamy et al.'s studies. Additional analyses showed that the differential effects of the blocked vs. mixed design did not result from intertrial repetition of distractor presence conditions. We conclude that participants' expectancies regarding distractor presence rather than distractor presence per se allowed PoP to modulate distractor interference. It follows that when expectations and intertrial contingencies are equated in the distractor-present and distractor-absent conditions PoP does not modulate distractor interference and therefore cannot account for the increased vulnerability of mixed-singleton search relative to fixed-singleton search to such interference.

The present results further undermine the notion that the same salience-based mechanism underlies search for a singleton target whether its specific feature is known (Fixed Singleton search) or unknown (Mixed Singleton search) to the observer and argue against the notion of a default singleton-search mode (e.g., Bacon & Egeth, 1994; Maljkovic & Nakayama, 1994; Theeuwes, 1992). Instead, and in line with Lamy et al.'s (2006) claim, they suggest that participants use their knowledge of the target feature in fixed-singleton search, which reduces distractor interference. By contrast, as participants rely exclusively on salience in mixed-singleton search, a salient distractor produces strong interference effects.

The present results also have implications with regard to the mechanisms underlying PoP. Meeter and Olivers (2006) proposed that an important factor determining whether or not intertrial priming occurs in visual search is the ambiguity of the task. According to these authors, the presence of an irrelevant distractor increases competition for visual selection and thereby also increases the ambiguity of the task. Thus, this account predicts larger PoP effects on distractor-present relative to distractor-absent trials. Yet, while this prediction was confirmed when conditions of distractor presence were blocked [Experiment 1, 194 vs. 103 ms, $F(1,9) = 7.18$, $p < .03$, respectively], there was a clear trend in the opposite direction when conditions of distractor presence were mixed [95 vs. 158 ms, $F(1,9) = 3.18$, $p > 0.1$, respectively].

It is noteworthy that in line with the present results, previously reported effects of ambiguity on PoP were observed only with blocked conditions of ambiguity level (Meeter & Olivers, 2006; Olivers & Meeter, 2006; Pinto et al., 2005)[2]. By contrast, PoP was either not significantly affected by randomly mixed conditions of ambiguity (Lamy et al., 2006) or actually decreased with increased ambiguity. Indeed, Lamy, Amunts, and Bar-Haim (in press) reported stronger PoP effects with salient relative to non-salient targets. Their participants had to detect the face displaying a discrepant expression of emotion in an array of four face photographs. On each trial, the target when present was either a neutral face among emotional faces, or an emotional face among neutral faces, unpredictably. In line with previous reports (e.g., Calvo, Avero, & Lundqvist, 2006; Lundqvist & Öhman, 2005), RTs were faster for emotional targets than for neutral targets, indicating that emotional faces were more salient than neutral ones. In addition, target detection was faster when the target displayed the same emotion on successive trials, that is, an emotional PoP was observed. However, this effect occurred only for emotional faces, not for neutral faces. That is, salient targets produced PoP effects while non-salient targets did not. A similar trend was observed in Experiment 2.

By demonstrating striking differences between mixed and blocked manipulations of distractor presence, the present study imposes important boundary conditions to the ambiguity hypothesis proposed by Meeter and Olivers (2006). Indeed, we showed that expectation of a high level of ambiguity over a given block of trials rather than ambiguity per se (defined by Meeter & Olivers, 2006, as competition for selective attention) affects PoP: knowing in advance that the target will be salient in the upcoming block of trials (low ambiguity) appears to lessen the contribution of intertrial priming effects to visual search performance; conversely, knowing that the target will suffer from strong competition (high ambiguity) appears to boost effects of PoP. Thus, PoP effects appear to be less automatic than previously thought, as they are sometimes modulated by strategic factors (see Fecteau, 2007 for related findings). When top–down factors and target salience are unconfounded by randomly mixing the different conditions of target salience (e.g., singleton distractor absent vs. present, salient vs. non-salient target), the more salient the target is, the stronger PoP effects appear to be (Lamy et al., in press; but this numerical trend was non-significant in the present study). Further research is needed to test this hypothesis and to determine what mechanisms underlie the effects of target salience (or ambiguity) expectancy on PoP.

[1] It should be noted that using Pinto et al.'s cutoff procedure (RTs longer than 3000 ms) did not remove any outlier, thus leaving a fair amount of noise. In order to clarify whether non-excluded outliers might account for the present results, we conducted additional analyses excluding (1) trials exceeding three standard deviations from their cell mean (which removed less than 1% of all trials), or 2000 ms (which removed slightly more than 2% of all trials). These analyses showed that (1) the interaction between distractor presence and PoP in Exp. 1—which replicates Pinto et al. (2005) procedure—tended to become less significant when more outliers were excluded; (2) this interaction disappeared completely with all cut-offs when conditions of distractor presence were mixed (Experiment 2): the numerical trend in the opposite direction persisted but remained non-significant and (3) the between-subject manipulation of mixing vs. blocking distractor-presence conditions significantly affected the modulation of PoP by distractor presence, that is, the 3-way interaction was significant, with all cutoffs. These analyses are presented in Appendix A.

[2] In one experiment (Olivers & Meeter, 2006, Experiment 5), the low- and high-ambiguity conditions were mixed but not randomly so: they alternated in a completely predictable sequence. Thus, subjects knew in advance what the level of ambiguity would be on the next trial.

Appendix A. Analyses of the data from Experiments 1 and 2 with different cut-off procedures

	Cutoff RT < 3000			Cutoff RT < 3 std			Cutoff RT < 2000		
	Exp1	Exp 2	Exp 1 vs. Exp 2	Exp1	Exp 2	Exp 1 vs. Exp 2	Exp1	Exp 2	Exp 1 vs. Exp 2
Distractor-absent—switch	972	1010		954	958		944	946	
Distractor-absent—repeated	869	852		854	840		855	833	
Distractor-absent—PoP effect	103	158	55	100	117	17	89	114	25
Distractor present—switch	1198	1133		1180	1121		1109	1078	
Distractor-present—repeated	1004	1038		999	1034		961	985	
Distractor-present—PoP effect	194	95	−99	181	88	−94	148	94	−55
Distractor absent vs. present —PoP difference	91	−63		81	−30		59	−20	
Distractor presence × PoP interaction—F value	7.18	3.18		7.23	1.31		3.86	$F < 1$	
Distractor presence × PoP interaction—p value	$p < .03$	$p > .1$		$p < .03$	$p > .2$		$p < .08$	$p > .3$	
Exp. × Distr. presence × PoP interaction—F value			6.69			6.06			4.95
Exp. × Distr. presence × PoP interaction—p value			$p < .03$			$p < .04$			$p < .04$

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