

An Onset Advantage without a Preview Benefit: Neuropsychological Evidence Separating Onset and Preview Effects in Search

Glyn W. Humphreys¹, Christian N. L. Olivers², and Eun Young Yoon¹

Abstract

■ Visual search is facilitated if half the distractors are presented as a preview prior to the presentation of the target and second set of distractors—the preview benefit [Watson, D. G., & Humphreys, G. W. Visual marking: Prioritizing selection for new objects by top-down attentional inhibition of old objects. *Psychological Review*, 104, 90–122, 1997]. On one account, the preview advantage is due to automatic capture of attention by the onsets in the second, search display [Donk, M., & Theeuwes, J. Visual marking beside the mark: Prioritizing selection by abrupt onsets. *Perception & Psychophysics*, 93, 891–900, 2001]. We provide a neuropsychological test of this assertion. We examined onset capture and preview ben-

efits in search in a group of neuropsychological patients with unilateral parietal damage. We demonstrate a normal pattern of performance when patients detected targets defined by onsets relative to those defined by offsets, irrespective of whether the onset target fell contra- or ipsilateral to the lesion. In contrast, there was a normal preview benefit in search only for ipsilesional targets, and preview search was impaired in the contralesional field. The data demonstrate that the preview benefit can dissociate from the onset advantage in search, and that onsets remain strongly weighted for attention even in the contralesional field of patients with parietal lesions. ■

INTRODUCTION

In many everyday situations it may be useful to attend selectively to new relative to old objects because the new objects may uniquely provide novel information. Nevertheless, the processes underlying the attentional prioritization of new objects remain controversial. On one view, new objects capture attention automatically, provided that observers do not focus attention on another object (e.g., Yantis & Jones, 1991; Yantis & Johnson, 1990). There may be limits to this, however, so that capture is limited to about four new stimuli (Yantis & Jones, 1991). Watson and Humphreys (1997) proposed that, in addition to automatic capture by new objects, attentional prioritization could be enhanced by top-down inhibitory filtering of old items, a process they termed visual marking. They used an adaptation of a standard color–form conjunction task (find the blue H) in which they presented half the distractors as a preview (the green H's) prior to the second set of distractors plus the target (blue A's and blue H). They found that search in this preview condition was more efficient than in the standard conjunction baseline and as efficient as when only the second of stimuli appeared (in a single feature baseline). Subsequent studies have shown that

this preview benefit in search occurs when old and new stimuli are not distinguished by color (e.g., search for a target in a random letter display) and that it can hold even with displays of up to 15 old and 15 new items (Olivers, Watson, & Humphreys, 1999; Theeuwes, Kramer, & Atchley, 1998). Watson and Humphreys proposed that the old distractors were subject to inhibitory marking, and so had minimal impact on search even with relatively large display sizes.

More recently, Donk and Theeuwes (2001; see also Peterson, Belopolsky, & Kramer, 2003) proposed that the preview benefit could be explained in full by onset capture of attention by the new search stimuli. They examined search through random letter displays in which the stimuli were isoluminant with the background. Under these circumstances, they failed to find a preview advantage. They proposed that this was because, under isoluminant conditions, the search displays are no longer defined by onsets and so do not generate automatic attentional capture. The authors did not address how, with non-isoluminant stimuli, the advantage could be maintained across displays of 15 or so new items (Theeuwes et al., 1998), but this may reflect a difference across experimental conditions. In the original studies of onset capture, search for targets defined by onsets was compared with search for targets defined by offsets (Yantis & Jonides, 1984). The apparent

¹University of Birmingham, UK, ²Vrije Universiteit, The Netherlands

capacity limit on onset capture may be most pronounced when offsets compete for selection. In contrast, in preview search the old items typically remain constant, so they may compete less for selection with the new items, enabling more new items to be prioritized.

In the present article, we provide a neuropsychological test of the onset capture account of preview search. We used the paradigm pioneered by Yantis and Jonides (1984) to examine onset capture, and a random-letter search version of preview search (Theeuwes et al., 1998) to compare onset capture and preview search in a group of patients with unilateral parietal damage. Unilateral parietal damage, particularly of the right hemisphere, is associated with a range of neuropsychological symptoms including a reduced sensitivity to stimuli presented on the side of space contralateral to their lesion. This deficit is perhaps most pronounced in the syndrome of unilateral visual neglect (Heilman, Watson, & Valenstein, 1993), and it can be demonstrated in visual search tasks in which patients show abnormal increases in search difficulty as the saliency of the contralesional target decreases (e.g., Humphreys & Price, 1994; Humphreys & Riddoch, 1993). However, no studies hitherto have evaluated whether there are effects of unilateral parietal damage specifically on the onset advantage in search, when targets defined by onsets are compared with those defined by offsets. Even if there is abnormally decreased sensitivity to stimuli as they decrease in saliency, it still may be that there is a relatively preserved bias favoring onsets over offsets, given the importance of onsets for visual attention. To assess this, we presented the patients with a set of premasks on each trial. Subsequently, a set of letters was presented, created either by offsets of contours from the premasks or by a new onset into a previously empty region of field. The task was to detect and then localize a target letter H presented among a set of randomly selected other letters, with the target created either by a new onset or by contour offsets from the premasks. The target appeared in either the ipsi- or contralesional field. We ask whether there is an advantage for detecting a target defined by an onset relative to one defined by an offset, and whether any onset advantage is modulated by the visual field. This procedure was run twice—once with displays matched to those in the preview search task (with four and eight search stimuli) and once with smaller display sizes (two and four search stimuli). The last procedure was conducted as a control to assess whether differences in the slopes of the search functions for onset and offset targets would emerge when there were fewer items in the displays. Onset capture would be shown by reaction times (RTs) to onset targets being faster than RTs to offset targets, and by RTs to onset targets being less affected than offset targets by the number of distractors present (Yantis & Jonides, 1984).

Performance in the onset task was compared with that in a preview search task. In the preview task, the

patients were presented with one set of distractor letters prior to the new search display containing the target plus the other distractors. The distractors were equally dispersed across the two fields and targets appeared either in the ipsi- or contralesional field. We ask whether there was a preview advantage for targets in either field relative to two baseline conditions: full-set search (all the distractors presented together) and half-set search (presenting just the new distractors from the preview condition, along with the target). For normal participants, the preview advantage is demonstrated by higher search efficiency (i.e., a lower slope on the search function) for the preview condition compared with the full-set baseline, and with search efficiency in the preview condition matching that in the half-set baseline. If the preview benefit is due to onset capture by the new stimuli, then patients showing an onset capture effect should also demonstrate a preview benefit. Note also that, if any capacity limitations in the onset capture paradigm reflect competition for onset targets from offset distractors, then if anything, we would expect the patients to show a preview—rather than an onset—advantage (because there should be reduced competition from the old distractors in preview search, relative to the offset distractors in the onset capture paradigm). Example displays from the onset/offset and preview/full-set/half-set search conditions are shown in Figure 1.

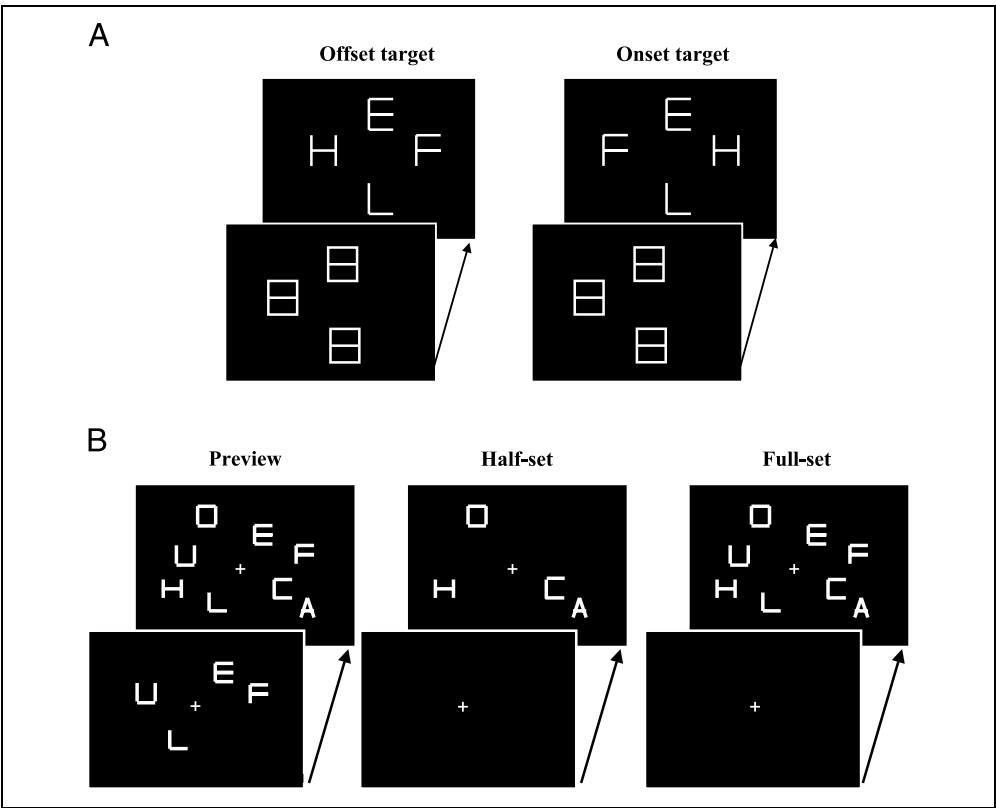
RESULTS

Correct and incorrect trials were analyzed separately. All RTs less than 200 msec were counted as errors. Any outliers in the remaining RTs were removed by use of a recursive elimination procedure advocated by Van Selst and Jolicoeur (1994). RTs s standard deviations from the cell mean are removed, with s depending on the number of data points in the cell. This typically led to the loss of about 2–3% of the data points for any participant.

Onset/Offset Condition: Display Sizes 4 and 8

The mean correct RTs for onset- and offset-defined targets in each visual field, for patients and age-matched controls, are depicted in Figure 2.¹ The data were subject to a mixed-design ANOVA. The within-subjects factors were condition (onset vs. offset target), field (target contra- or ipsilesional), and display size (4, 8); subject group was a between-subjects factor. There was a reliable main effect of condition, $F(1,15) = 43.26, p < .001$, and of display size, $F(1,15) = 36.84, p < .001$. There was no effect of visual field, $F(1,15) = 2.13, p = .17$, and/or subject group ($F < 1.0$). There was a trend for an interaction between display size and subject group, $F(1,15) = 2.59, p > .05$, but no other interaction approached significance (all F s < 1.0). RTs were faster to onset than to offset targets, and they were faster for the smaller display size.

Figure 1. (A) Example displays from the onset and offset target detection tasks. (B) Example displays from the preview, half-set, and full-set search conditions.



These effects held across both visual fields. The patients did not differ from the controls.

The error rates are presented in Table 1. These data were subject to a similar analysis to the RT data. There

were no reliable main effects or interactions. Although errors tended to be higher at the larger display size this was not reliable, $F(1,15) = 2.21, p > .05$. More importantly, there was no evidence for a speed–accuracy trade-off.

Figure 2. The mean correct RTs (msec) to the onset and offset targets with display sizes 4 and 8. (A) Parietal patients. (B) Age-matched controls.

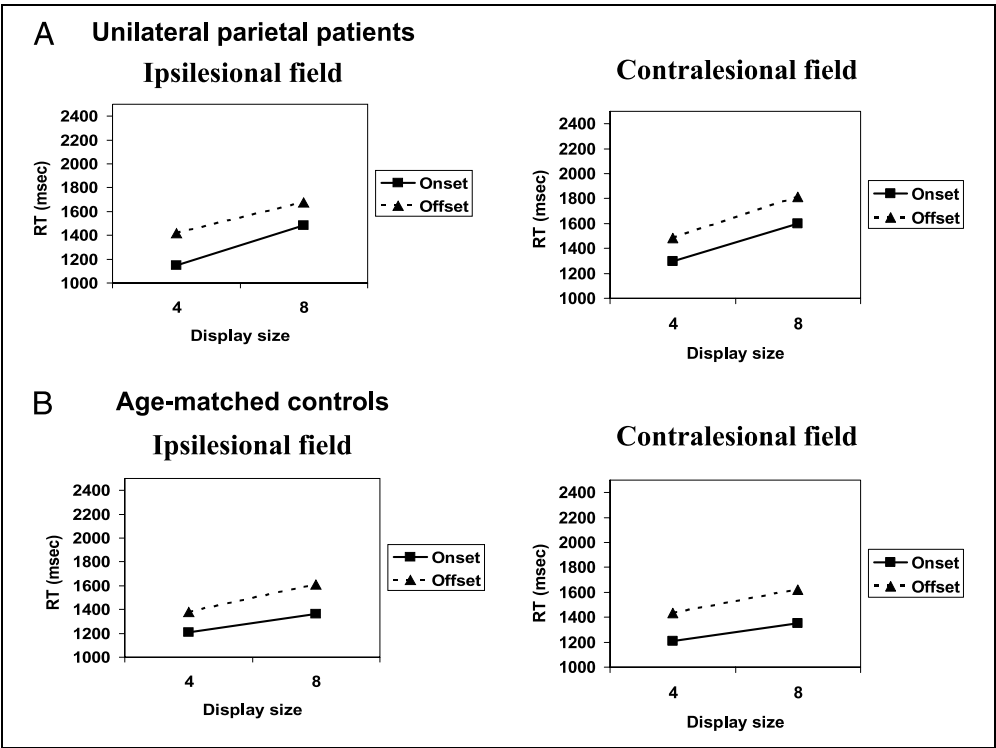


Table 1. Error Rates

Target field	Ipsilesional				Contralesional			
Display size	2	4	8	16	2	4	8	16 ^a
<i>(a) Parietal patients</i>								
Larger display sizes								
Onset target		7.7	2.2			9.9	4.0	
Offset target		4.3	6.2			8.9	3.9	
Smaller display sizes								
Onset target	2.1	2.3			2.5	2.2		
Offset target	2.8	2.6			2.2	2.6		
Preview target			7.4	7.6			9.1	9.7
Full-set baseline			4.7	8.2			6.1	9.5
Half-set baseline		7.7	7.5			4.6	8.3	
<i>(b) Age-matched controls</i>								
Larger display sizes								
Onset target		4.6	4.2			4.7	4.5	
Offset target		4.1	4.7			6.2	4.3	
Smaller display sizes								
Onset target	1.3	1.3			1.8	1.5		
Offset target	1.9	2.1			1.8	1.6		
Preview target			3.4	4.2			4.4	5.8
Full-set baseline			5.2	6.1			5.5	6.2
Half-set baseline		4.8	4.6			4.2	5.3	

^aFor the preview condition, performance is listed here according to the number of items in the final display, not the number of new objects (equal in the half-set baseline and the preview).

Onset/Offset Condition: Display Sizes 2 and 4

The mean correct RTs are given in Figure 3. ANOVA was done with the factors being condition (onset vs. offset target), field (target contra- or ipsilesional), and display size (4, 8).² There was a reliable main effect of condition, $F(1,12) = 18.57, p < .01$, and of display size, $F(1,12) = 23.29, p < .01$. There was again no effect of visual field or subject group (both F s < 1.0). There was one interaction, between condition (onset vs. offset) and display size, $F(1,12) = 5.04, p < .05$, but all other effects were not reliable (all F s < 1.0). There was no effect of display size on onset targets, $F(1,12) = 1.18, p > .05$, but there was on offset targets, $F(1,12) = 6.22, p < .05$. The contrast between onset and offset targets was not qualified by either the visual field or the subject group (F s < 1.0).

The error rates, reported in Table 1, went in the same direction as the RTs.

Preview and Baseline Search Conditions

Performance in the preview, full-set, and half-set baselines was assessed in a series of ANOVAs in which we compared the individual search conditions. The mean correct RTs are presented in Figure 4 and the error data in Table 1.

Full-set vs. Half-set Baseline

The RTs were subject to a mixed-design ANOVA with the within-subjects factors being condition (full-set vs. half-set), visual field, and display size; subject group was the between-subjects factor. There were reliable main effects of condition, $F(1,15) = 61.18, p < .001$; field, $F(1,15) = 5.33, p < .05$; and display size, $F(1,15) = 189.94, p < .001$. There was no overall difference between the subject groups ($F < 1.0$). There were reliable interactions between field and subject group, $F(1,15) = 4.84, p < .05$; between condition and display size, $F(1,15) = 93.60, p < .001$; between condition, field, and display size, $F(1,15) = 5.68, p < .05$, and a four-way interaction between condition, field, display size, and subject group, $F(1,15) = 10.36, p < .01$.

The four-way interaction was decomposed by analyzing the data separately for the parietal patients and the controls. For the parietal patients there was a significant interaction between condition, visual field, and display size, $F(1,6) = 8.76, p < .025$. RTs were longer and increased more with the display size in the full-set compared with the half-set baseline. The differential impact of the condition and display size was greater for targets in the contralesional field than for targets in the ipsilesional field; however, within both visual fields there were interactions between condition and display size [ipsilesional field: $F(1,6) = 42.88, p < .001$; contralesional field: $F(1,6) = 25.80$].

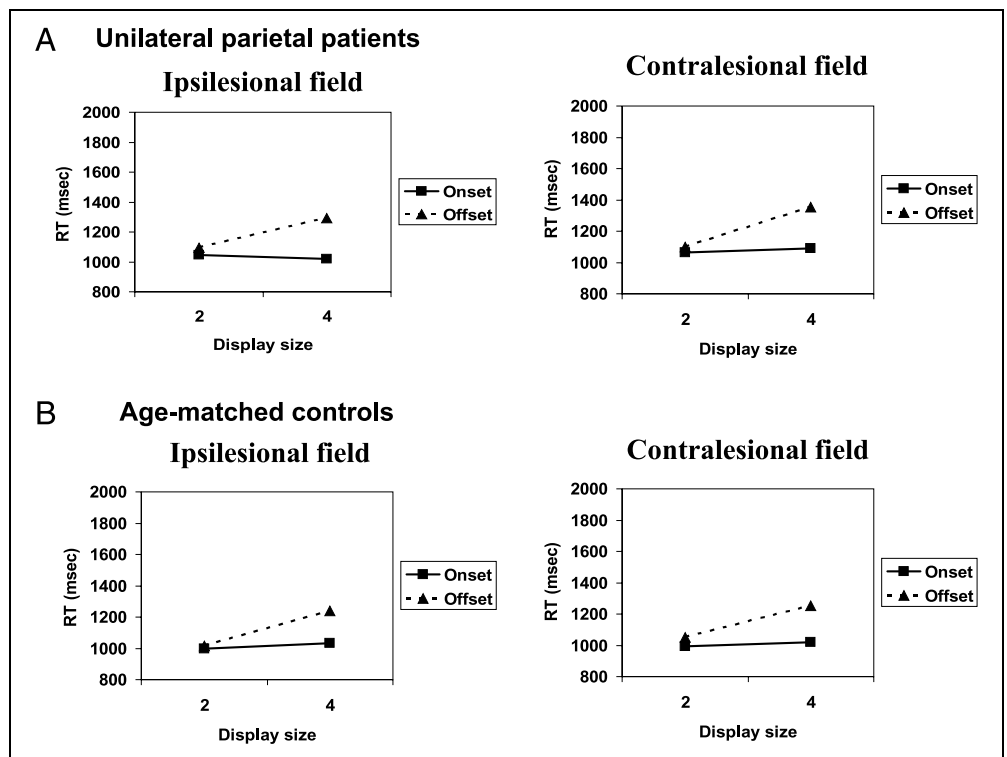
For the controls there was only a significant interaction between condition and display size, $F(1,9) = 61.54, p < .001$, which was not qualified by the visual field ($F < 1.0$ for the three-way interaction). The effect of display size was larger in the full-set compared with the half-set baseline.

Preview vs. Half-set Baseline

There were reliable main effects of condition, field, and display size, $F(1,15) = 6.27, 5.74$, and $81.18, p < .05, .05$, and $.001$, respectively. There were three reliable interactions: between condition and display size, $F(1,15) = 17.14, p < .001$; between condition, field, and display size, $F(1,15) = 12.92, p < .01$; and between condition, field, display size, and subject group, $F(1,15) = 18.28, p < .001$.

For the patients, there were two reliable interactions: between condition and display size, $F(1,6) = 26.04, p < .01$, and between condition, visual field, and display

Figure 3. The mean correct RTs (msec) to the onset and offset targets with display sizes 2 and 4. (A) Parietal patients. (B) Age-matched controls.



size, $F(1,6) = 11.28$, $p < .02$. For targets in the ipsilesional field, there were reliable main effects of condition and display size, $F(1,6) = 11.50$ and 22.24 , both $ps < .02$. The interaction did not approach significance ($F < 1.0$). RTs were faster in the half-set baseline and at the smaller display size, but there was no difference in the slopes of the search functions for the two conditions. A different pattern emerged for targets in the contralesional field. There were reliable main effects of both the condition and the display size, $F(1,6) = 37.42$ and 30.51 , both $ps < .001$, and a Condition \times Display Size interaction, $F(1,6) = 24.93$, $p < .01$. The effects of display size were larger in the preview condition than in the half-set baseline.

For the controls there was only a main effect of display size, $F(1,9) = 31.19$, $p < .001$. RTs increased at the larger display sizes, but this held across both fields and for the half-set and preview conditions equally.

Preview vs. Full-set Baseline

There were significant main effects of condition, field, and display size, $F(1,15) = 4.92$, 7.87 , and 146.19 , $p < .05$, $.025$, and $.001$, respectively. There was no overall difference between the subject groups ($F < 1.0$). There were significant interactions between field and subject group, between condition and display size, between field and display size, and between field, display size, and subject group, $F(1,15) = 6.56$, 14.49 , 6.40 , and 6.50 , all $ps < .05$, respectively, and these were qualified by a further four-

way interaction involving all the factors, $F(1,5) = 5.17$, $p < .05$.

For the patients, there was a significant three-way interaction between condition, visual field, and display size, $F(1,6) = 5.99$, $p < .05$. For ipsilesional targets, there was an overall effect of display size, $F(1,6) = 33.40$, $p < .001$, and a Condition \times Display Size interaction, $F(1,6) = 28.97$, $p < .01$. The effects of display size were reduced in the preview condition compared with the full-set baseline. For contralesional targets, there was only a reliable main effect of display size, $F(1,6) = 51.36$, $p < .001$, and this did not interact with the condition, $F(1,6) = 1.24$, $p = .31$.

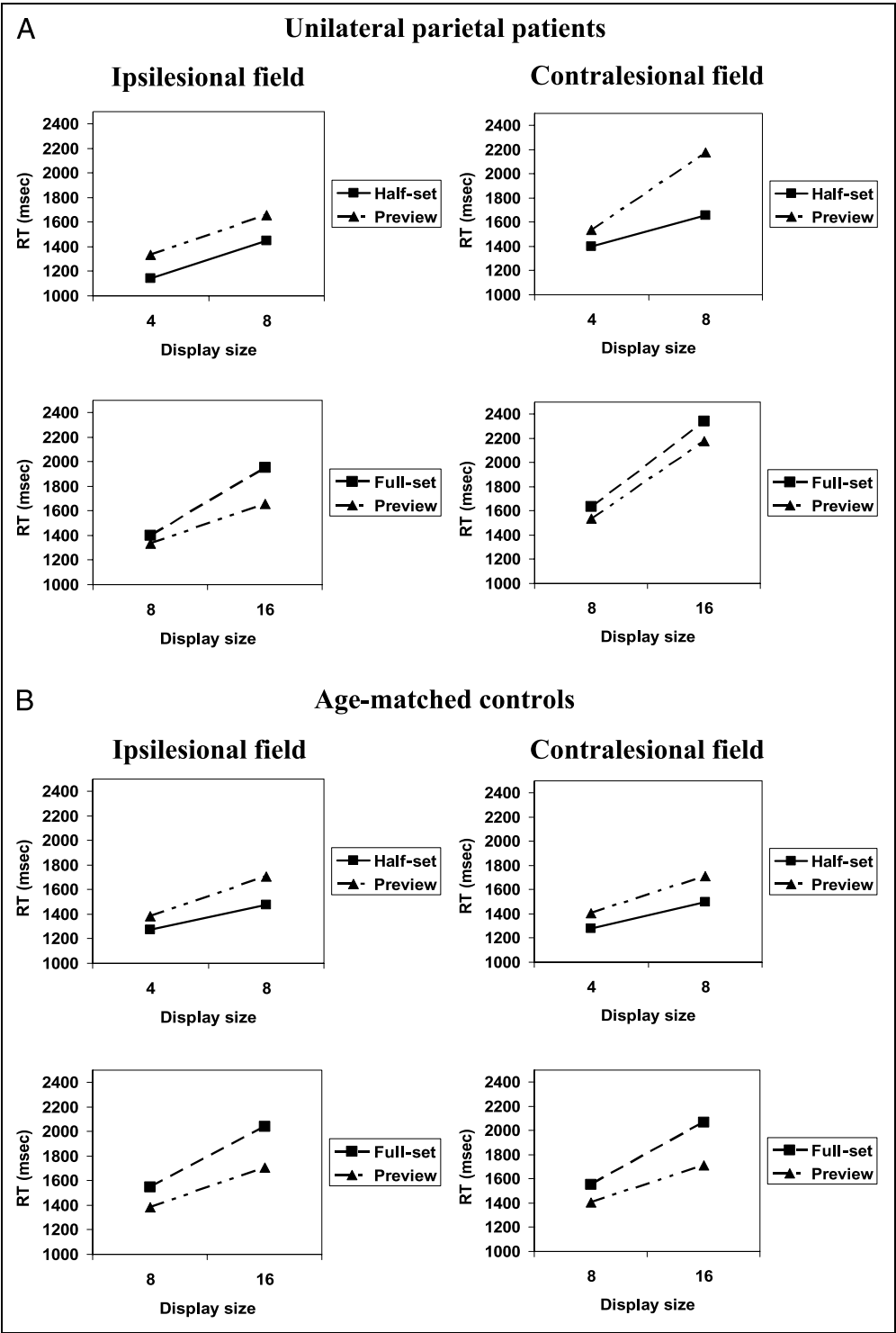
For the controls there was only a reliable interaction between condition and display size, $F(1,9) = 7.31$, $p < .025$, and this held across both visual fields. Preview search was more efficient than full-set search; hence there was a smaller effect of display size on preview search.

Errors in the search task generally followed the same pattern as RTs (Table 1) and there was no sign of any speed-accuracy trade-offs.

DISCUSSION

The results were clear. The patients showed an advantage for detecting onset over offset targets, and this did not differ across the visual fields (in fact, with the display sizes matched to those in the preview search condition, the magnitude of the benefit for onset over offset targets for the patients tended to be larger in the contralesional

Figure 4. The mean correct RTs (msec) to targets in the preview, half-set, and full-set search conditions. Top graphs show performance with display sizes matched to the number of new items in the preview and half-set baseline final search. The bottom graphs show performance with display sizes matched to the number of items in the final search display (for the comparison between the preview and the half-set baseline). (A) Parietal patients. (B) Age-matched controls.



field: 131 vs. 101 msec in the contra- and ipsilesional fields, averaged across display sizes 4 and 8). This onset advantage for the patients was not significantly different from the advantage shown by age-matched controls, and it occurred although targets were no more likely to be the onset item than any of the items defined by offsets. This result is of considerable interest in its own right because it suggests that mechanisms of exogenous

attention, biasing attention toward onset over offset targets, do not necessarily differ across the ipsi- and contralateral fields in patients with inferior parietal damage. In their classic article on the effects of unilateral parietal damage on attentional orienting, Posner, Walker, Friedrich, and Rafal (1984) reported that orienting to a single, valid exogenous cue in the contralateral field was relatively intact. The present data extend this by

revealing that responses to the onset target are as good in the contra- as in the ipsilesional field even when there are competing offsets in the ipsilesional field (unlike the static boxes used in the cueing study of Posner et al., 1984).

In contrast to the data on the onset advantage, there was a striking difference in performance in the preview condition according to whether targets appeared in the ipsi- or contralesional fields. There was a preview benefit for targets that fell in the ipsilesional field. The slope of the search function was reduced in the preview condition compared with the full-set baseline (mean search rates, 40 versus 69 msec/item, respectively, taking the final items in the display into account), and there was no difference in the slopes for the preview and half-set baselines (taking just the new items into account, the mean search rates were 80 and 76 msec/item for the preview and half-set baseline). There was a general slowing of RTs for the preview condition relative to the half-set baseline (an intercept effect), but this has been observed before with normal observers (e.g., Watson & Humphreys, 1997) and likely reflects extraneous factors including inhibition of a response to the preview and switching from ignoring the old items to searching for the new (Mason, Humphreys, & Kent, 2004). In terms of both the slope and the intercepts of the condition, the performance of the patients with ipsilesional targets was close to that of controls. In contrast to this, the patients showed no preview benefit for targets in the contralesional field. For these targets, there was no difference in the slope of the search functions for the preview and full-set baselines (search rates = 80 and 89 msec/item, respectively, taking into account all of the items in the field), and the slope for the preview condition was now more than double that for the half-set baseline (measuring search relative to just the new items: search rates = 160 and 66 msec/item for the preview and half-set conditions). The patients were not able to keep old items out of search when the new target appeared in the contralesional field. There was thus a dissociation between the ability to detect a target defined by an onset relative to offset distractors (equally good across the fields) and the ability to prevent competition from old distractors in preview search (impaired for contra- relative to ipsilesional targets). This selective deficit in preview search in patients with parietal damage replicates data reported by Olivers and Humphreys (2004).

One point to note, however, is that, in the present study, the onset advantage at the larger display sizes was manifest in terms of an intercept effect rather than a change in slope for onset- and offset-defined targets. This held for age-matched controls and patients alike. When the display sizes decreased, however, a difference in slope emerged—onset targets were less affected by offset distractors than offset targets were by an onset distractor. These data suggest that, for small display

sizes, both parietal patients and elderly controls maintain some differential sensitivity in competition for selection between onsets and offsets. However, as the number of offsets co-occurring with an onset increase (at the larger display sizes) this differential competition for selection decreases. There may be some capacity limitation in differentiating between the onset and offset items, which generates display size effects for each type of target (see Martin-Emerson & Kramer, 1997, for evidence of capacity limits on discriminating onsets from offsets in normal young observers). More importantly, the patients were no more affected by any such limitations than the controls. Moreover, even at the larger display sizes there remained an overall RT advantage for onset over offset targets. This “intercept effect” can be accounted for in several ways. On one view, there is a different selection threshold for onset and offset targets set by both the age-matched controls and the patients. A lowered selection threshold for onsets will lead to an onset target being detected faster than an offset target, even if the slowing in RT due to competition between the onset and multiple offset items is roughly equal for each target type. Alternatively, the overall RT advantage for onset targets may be attributed simply to onsets producing a greater local change in luminance than offsets, with this change being calculated in parallel across the display (so that offset targets, defined by a relatively smaller luminance change, are no more affected by the display size than onset targets). More importantly for our present purposes, the point is that, whether expressed in terms of the slope (at small display sizes) or the intercept (at larger display sizes), the onset advantage held across both fields for the patients, and in each case it did not differ from that found for age-matched controls. In contrast, the patients produced a preview advantage only for ipsilesional targets. If the preview advantage was due solely to onset capture, then the patients should have shown a preview advantage for both contra- and ipsilesional targets, and this preview advantage should also have been equivalent to that found in the controls. For example, take the preview advantage that the patients produced with ipsilesional targets. If this was caused by the onsets from the new relative to the old stimuli, then the same advantage should have occurred for contralesional targets (because any onset advantage held across both fields of the patients). Similarly, if the preview benefit for controls reflected onset capture, then the patients should have produced equivalent effects inasmuch as their performance in the onset capture paradigm did not differ from the controls. The failure by the patients to show any preview benefit with contralesional targets argues against an onset capture account of the preview search (cf. Peterson et al., 2003; Donk & Theeuwes, 2001).

Can the onset account be reconciled with the data? One possibility is that the patients may have some capacity limit in the number of new onsets they can

prioritize that is particularly brought out in preview search. In particular, if ipsilesional onsets are prioritized over contralesional onsets and there is a strong capacity limitation in preview search, there may then be minimal prioritization for contralesional targets, selective to this condition. The data contradict this position, though. Notably, for the patients there was a minimal difference in the effect of display size on (1) selecting one onset target among multiple offsets (Figure 2) and on (2) selecting one onset target among multiple onset distractors, in the half-set baseline condition (Figure 3). There was a slope of 79 msec/item for the onset target amongst offset distractors and a slope of 70.5 msec/item for the half-set baseline. The patients were able to select the target among multiple onset distractors (in the half-set baseline) as easily as they were able to select it among multiple offset distractors (in the onset target condition). In addition, there was no evidence for onset stimuli in the ipsilesional field dominating those in the contralesional field; the effect of the display size in the half-set baseline was 76 msec/item for ipsilesional targets and 65 msec/item for contralesional targets. Contralesional onsets, in the half-set baseline, did not suffer noticeably in competition with ipsilesional onsets when there were no old distractors present. For an onset capture account, then, we would expect the preview benefit to be equal in the two fields. It was not.

The dissociation between the onset advantage and preview search suggests that the preview benefit depends on more than onset capture by new stimuli. On one alternative view, the preview benefit is influenced by inhibitory filtering (marking) of the old items, which are actively deprioritized to facilitate selection of the new target (Watson & Humphreys, 1997). If there is poor marking within the contralesional field, the old items may remain available as relatively strong competitors for selection, overruling any bias for preferential selection of new targets in that spatial region. In contrast, when the search stimuli are formed by both new onsets and offsets of premasks, there is simply differential competition between sets of new stimuli defined either by relatively strong (onset) or weak dynamic changes (offsets), with selection operating faster for targets defined by the stronger dynamic changes (onset targets). One other account that has been offered for the preview benefit in search is in terms of temporal segmentation (Jiang, Marks, & Chun, 2002). On this view, either new or old items can be selectively attended in preview search because the temporal interval between the preview and the search display facilitates their coding as distinct groups. For this proposal, parietal damage could disrupt preview search if it reduced any temporal segmentation between the old and new displays, particularly for stimuli in the contralesional field. There is certainly evidence from studies of so-called "prior entry" that temporal coding is impaired for stimuli appearing in the contralesional field of parietal

patients (Rorden, Mattingley, Karnath, & Driver, 1997), and lack of a temporal signal differentiating new from old items in the contralesional field may be sufficient to minimize the preview benefit.

These issues have recently been studied by Olivers and Humphreys (2004) in a larger study of the effects of parietal damage on preview search. As here, Olivers and Humphreys found that parietal patients showed little advantage for preview search when the targets appeared in their contralesional field. A failure in temporal segmentation alone, however, failed to explain the data. For example, preview search for both ipsi- and contralesional targets was relatively inefficient when the old items fell in the same field as targets compared with when the old distractors and the target appeared in different fields. For ipsilesional targets, this result is difficult to understand because such targets should be subject to efficient temporal segmentation from distractors. Instead, the data suggest that spatial as well as temporal segmentation is important and that both factors are impaired after parietal damage. In particular, parietal damage could affect the coding of a spatial representation of the old items that is used in the marking process, so that old items are not effectively deprioritized and kept out of search on the basis of temporal segmentation cues.

The data reported by Olivers and Humphreys (2004), on the effects of spatial as well as temporal segmentation, also speak to another possible account of the current data. This is that there was little preview benefit for contralesional targets because patients had problems in disengaging attention from the old distractors in their ipsilesional field (cf. Posner et al., 1984). In contrast, when onset and offset stimuli were compared, any problem in disengaging from ipsilesional premasks could have been helped by the offsets at those locations. However, on this disengagement account, performance should be worst for contralesional targets when old distractors fall on the ipsi- compared with the contralesional side. This is not what was found. Rather there was poor detection of new contralesional targets among old contralesional distractors. This fits better with there being poor spatial and temporal segmentation of old distractors and new targets due to impaired marking on the contralesional side. We also think it likely that problems in disengaging attention would be increased when the ipsilesional item changes (from a premask to a distractor letter, in the offset condition) than when it stays the same (in the preview condition), so the disengagement account may be even less plausible in the light of the patients' performance in the onset/offset condition here.

METHODS

Participants

There were seven patients, all with unilateral lesions involving the inferior parietal lobe. Three patients (PF,

MH, RH) had unilateral left parietal lesions, whereas four had unilateral right parietal lesions (BA, JB, MB, MP). The mean age of the patients was 56.7 years. There were few differences apparent between the unilateral left- and right-hemisphere-lesioned patients; hence they were treated as a single group. Reconstructions of MRI scans for each patient are shown in Figure 5. Table 2 gives the clinical details of each patient. All seven patients took part in the study with the larger display sizes; however, only six participated in the onset capture experiment with smaller display sizes (MB was unavailable). The performance of the patients was compared with a set of 10 age-matched controls (mean age, 58 years) for the procedures using the larger display sizes. For the procedure with smaller display sizes, a further group of eight age-matched controls was used (mean age, 58.7 years).

Apparatus and Stimuli

The stimuli were presented on a 15-in. monitor driven by a Pentium-200 PC with VESA graphics card running at 800 × 600 × 256 resolution. The displays with the larger display sizes were generated by a purpose-written program in Turbo Pascal 7, which also recorded RTs and responses. The displays for the study of onset capture with smaller display sizes were presented using Eprime. The viewing distance was about 75 cm. The letters for both the onset and the preview search tasks appeared in a grid 8.3° × 8.3° in visual angle. The letters were 0.6° high by 0.4° wide. The letters appeared in yellow against a black background.

Design and Procedure

Each trial began with the appearance of a yellow fixation cross, which then remained throughout the trial. For the study with larger display sizes, each participant took part in two experimental blocks, where they received, respectively, the onset/offset and the preview (and baseline) search tasks. These blocks were conducted on separate dates at least 1 week apart. In the onset/offset block, there was a set on $n - 1$ figure-of-eight premasks that appeared before the search display (n items). There were two display sizes, with either four or eight stimuli (3 offsets + 1 onset, or 7 offsets + 1 onset). The target was equally likely to be any of the offset or the single onset stimulus on the trial (i.e., the target was an onset on 25% and 12.5% of the trials for display sizes 4 and 8). The premasks appeared for 1000 msec before the search display, and the search display remained until a response was made.

In the preview condition, there were previews of either four or eight distractors, followed by equal numbers of search items (creating complete display sizes of 8 and 16 items). The preview letters appeared for 1000 msec and then remained when the search items were added into the field; the search display stayed in the field until a response was made. In the session for preview search, there were also full-set and half-set baseline search conditions. In the full-set baseline, we presented simultaneously all the items that were in the final search display in the preview condition. In the half-set baseline, we presented just the new items that appeared in the preview condition. If participants were

Figure 5. Lesion reconstructions for the patients listed in Table 2, taken from MRI scans. The lesions are drawn onto standard slices from Gado, Hanaway, and Frank (1979). Slices 3 to 8 are depicted here.

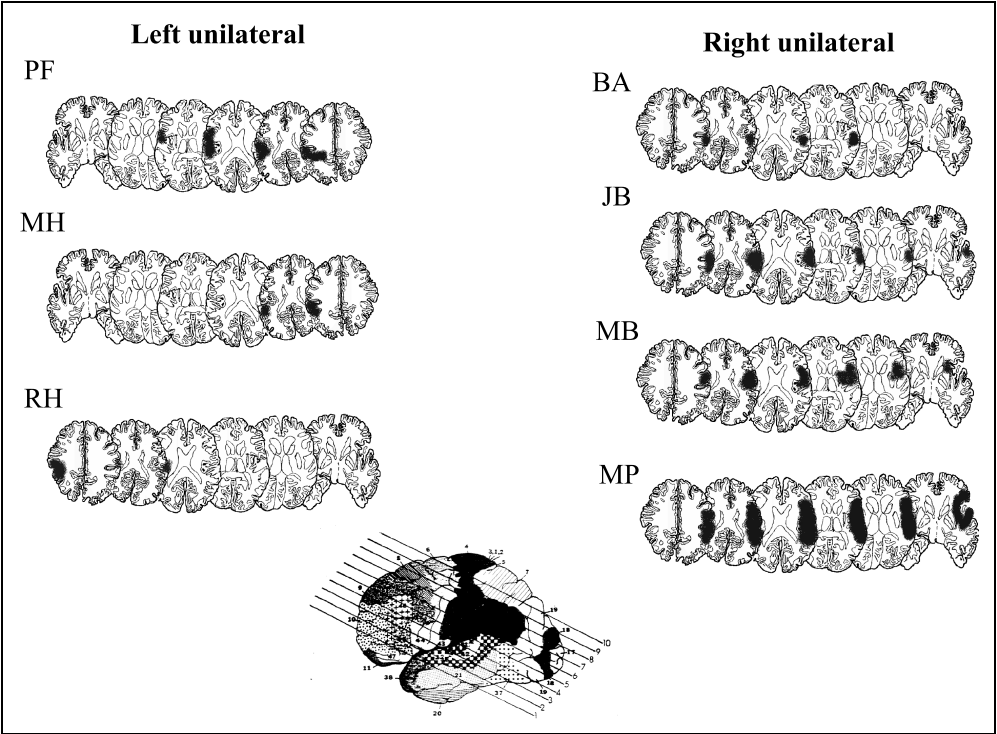


Table 2. Patient Details

<i>Patient</i>	<i>Sex/Age/Handedness</i>	<i>Main Lesion Site</i>	<i>Clinical Symptoms</i>	<i>Etiology</i>
BA	M/55/R	Right parietal (angular gyrus, supramarginal gyrus)	Minimal cognitive deficits; hemiplegia	Stroke
PF	F/54/R	Left parietal (angular gyrus, supramarginal gyrus), inferior frontal	Right extinction; dysgraphia	Stroke
JB	F/67/R	Right parietal (angular and supramarginal gyrus), postcentral gyrus, inferior frontal gyrus	Left extinction; neglect in reading and writing	Stroke
MB	F/59/R	Right parietal (supramarginal gyrus), inferior frontal and superior temporal, ventral putamen	Left extinction, hemiplegia	Stroke
MH	M/48/R	Left parietal (angular gyrus), lentiform nucleus (bilateral)	Right extinction, optic ataxia	Anoxia
RH	M/70/L	Left inferior parietal (angular and supramarginal gyrus) and superior temporal gyrus	Right neglect, aphasia	Stroke
MP	M/54/R	Right parietal (angular gyrus, supramarginal gyrus)	Left neglect and extinction, hemiplegia	Aneurysm

unable to ignore the old distractors in preview search, then performance in the preview condition should be worse than in the half-set baseline and it should be no better than in the full-set baseline. On the other hand, if the old items had no impact on search, then search in the preview condition should be as efficient as in the half-set baseline and more efficient than in the full-set baseline.

In all of the conditions the letters in the final search displays were equally divided across the two fields, and targets occurred equally often in the contra- and ipsilesional fields for each patient. Within the constraints that the letters in each display should be balanced across each field, the stimuli were presented at random within a virtual matrix 8° high by 8° wide. In both sessions the target was the letter H. Participants were asked to press the mouse as soon as they had detected the target, which was always present. When this occurred the search letters disappeared and were replaced by circular position markers; the participant had to move the mouse to click the marker where the target had appeared. We have previously used this procedure successfully in preview search tasks and have found standard search functions in the preview and baseline search conditions (Olivers & Humphreys, 2002). In both the preview search and onset/offset sessions the distractor letters were drawn at random without replacement from the set A, C, E, F, J, L, O, P, S, and U.

In the preview search session, each participant received the preview, full-set, and half-set baselines in separate blocks, with the order randomized across participants. There were 60 trials per block, resulting in 15 trials for each combination of display size and target visual field. In the onset/offset condition, there were 360 trials, 120 at display size 4 and 240 at display size 8, so that we

collected 15 data points for onset targets in both visual fields at both display sizes. Participants were given rests between each block of 120 trials. Participants received at least 30 practice trials per condition.

The procedure using smaller display sizes was conducted after the conditions using larger display sizes. For this study, the letters could fall at the corners of a virtual circle, each falling 4° away from fixation. On two item trials, one item appeared in the left field and the other in the right field either at the homologous location or diagonally opposite. There were either one or three premasks, which lost contours to create letters when another onset letter appeared. The letters were drawn at random without replacement from the set C, E, H, or U, and the target was as likely to be any one of the offset letters as it was the onset letter. Participants made a key press as soon as they detected the target and the experimenter then keyed in whether the target fell to the left or right of the field on the basis of the participant's vocal response.

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Reprint requests should be sent to Glyn W. Humphreys, Behavioural Brain Science Centre, School of Psychology, University of Birmingham, Birmingham B15 2TT, UK, or via e-mail: g.w.humphreys@bham.ac.uk.

Notes

- 1. For six randomly chosen controls, the left field was labeled “contralesional” and the right “ipsilesional”; for the remaining

four, these assignments were reversed. This approximates the proportions of right- and left-hemisphere lesioned patients in the study.

2. For this analysis, half of the controls were assigned the left side as “ipsilesional” and half were assigned the right side as “ipsilesional.” This matched the distribution of right- and left-hemisphere-lesioned patients in this condition.

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