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Grouping Influences in Unilateral Visual Neglect

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Abstract

Effects of grouping on unilateral neglect were investigated in 8 neurological patients with right hemisphere damage. It is well documented that arranging items to form a group spanning the midline decreases the magnitude of neglect. In the present study we examined how clusters of groups within the left or right visual field affect neglect and whether isolated groups within the neglected field deflect attention from right-sided displays. We orthogonally varied the strength of grouping on the right and left sides of a display and measured the time to find a predesignated target in one of those groups. Groups on the neglected left side did not affect right-sided target detection any more than an empty left page. However, strength of grouping did affect left sided target detection. These findings are discussed as they relate to attention and preattention in unilateral visual neglect.

Patients with unilateral visual neglect – most often due to right hemisphere damage – do not scan or direct attention to the leftmost elements in a visual scene or stimulus display. Different types of neglect have been documented (see Heilman, Watson, & Valenstein, 1985; Mesulam, 1985) but all have in common a lack of overt orienting towards the contralesional side of space. This deficit poses many problems in every day life and can be life threatening if certain items, such as a moving car, are not detected.

Despite the dense lack of awareness of the contralesional side of space, items that appear on that side seem to be registered by the visual system. There have been many reports of intact processing of neglected information without awareness (see Driver & Vuilleumier, 2001). Although unable to report the presence of stimuli on the neglected side, performance can be influenced by figure/ground organization (Driver, Baylis, & Rafal, 1992), as well as illusory contours and perceptual illusions that are defined by stimulus properties on the neglected side of objects (Ro & Rafal, 1996; Vuilleumier & Landis, 1998; Mattingley, Davis, & Driver, 1997). Even semantic information of neglected items appears to be registered without conscious awareness (McGlinchey-Berroth, Milberg, Verfaellie, Alexander, & Kilduff, 1993).

Findings such as these demonstrate that basic perceptual information that is assumed to contribute to the explicit perception of objects and object parts is encoded even when dense neglect is present. Demonstrations that higher order information is encoded raise questions such as how the underlying information might be accessed or what information is most likely to bring neglected information to awareness? One factor that is effective in reducing the magnitude of neglect is grouping (e.g., Gilchrist, Humphreys, & Riddoch, 1996). Stimuli

that are grouped to form a unit between ipsilesional and contralesional sides of space reduce neglect.

One example relevant to the methods used in the present studies was reported by Grabowecky, Robertson, and Treisman (1993) who varied grouping in a visual search task and reported that the “center” of a group of items could move the vertical meridian of neglect rightward or leftward depending on the left/right extent of the group as a whole. Irrelevant items were added to a central display so that the center of the display (relevant plus irrelevant) extended towards the right, left or neither. When items were added to the ipsilesional side, neglect worsened, but when *more* items were added to the left as well, neglect returned to the same levels observed when no irrelevant items were present. In other words, grouping factors that changed the extent of the display as a whole affected neglect in a way that was defined by the center of the group, whether it was shifted rightward or leftward.

The results of this study are consistent with others showing that the magnitude of neglect can be changed by grouping items across the midline to form a unitary display. However, neither this study or previous studies have examined the ability of groups to draw attention into the neglected field when the groups are limited to the neglected field. Do groups only help when they perceptually connect contralesional and ipsilesional information? The question addressed in the present study is how clustered groups that create separate units on the right and/or left sides of a display affect neglect. The major question was whether a strongly grouped cluster on the contralesional side would be more likely to attract attention in patients with neglect than a weakly grouped cluster or a blank field?

Given the substantial evidence that visual processing takes place in the neglected field even when neglected, we hypothesized that a grouped cluster should increase attentional orienting on the neglected side and would paradoxically decrease the efficiency of finding a target on the ipsilesional side. If groups attract attention to the left, then search efficiency on the right should suffer. To address this question we used visual search methods in which participants were asked to search for a target in either grouped or randomly arranged clusters of items. The length of time it took to find the target was the dependent measure.

Visual search methods introduced by Treisman and Gelade (1980) demonstrate that distinct features (e.g., a red dot among blue and yellow dots) can be detected on the neglected side with little effort in patients with relatively severe neglect (Eglin, Robertson, & Knight, 1989; Eglin, Robertson, Knight, & Brugger, 1994; Esterman, McGlinchey-Berroth, & Milberg, 2000). However, when searching for a target that is a conjunction of two features (e.g., a red O target among green Os and red Xs), a target on the neglected side is often missed or it can take several seconds or minutes before the target is found (Eglin et al., 1989; Esterman et al., 2000).

It is not particularly surprising that conjunction targets are neglected, since hundreds of studies with healthy young normal participants have shown that finding a conjunction requires a serial search, the very thing neglect patients seem to have the most difficulty doing on their contralesional side. Serial search is shown by linear increases in detection time as the number of distractors increases. Also in normals the slope of the search function can be reduced by grouping (Wolfe, 1994). Conversely, a distinct feature “pops out” regardless of the number of distractors. Feature search does not require a serial attentional scan, and this may explain why a feature on the neglected side can be detected even with relatively severe neglect.

In the present study we again use visual search procedures but group items into clusters such that the target either pops out from the distractors in its cluster or requires a serial attentional

search within the cluster. The target (a blue circle) was presented among red circles and blue triangles so that one feature of the target (blue) was present in some distractors and the other feature (circle) was present in others (Fig. 1). The participants' task was to locate the target in each display as rapidly as possible. In order to motivate the patients to keep looking for a target when they could not find it after searching the right side, they were reassured that a target was present in every display and were asked to keep looking until they found it. On trials when they seemed to give up, they were also encouraged to keep looking. The target was presented in one of the clusters, each cluster containing 8 items (there could be two clusters on the left side, two on the right side, or two on each side).

Before presenting the patient data, we first report a similar experiment with older healthy participants that verifies that our grouping measures do indeed affect visual search in the way predicted by the cognitive literature. Unlike the normal procedure of measuring response time to detect the presence or absence of a target, a target appeared on every trial and its location had to be designated. This was necessary with the patients in Experiment 2 in order to motivate them to keep searching even when the target was not found on the ipsilesional side. Therefore, Experiment 1 was also designed to determine whether expected search functions would appear when a target was present and had to be located on every trial.

EXPERIMENT 1

METHOD

Participants—Seven males and one female participated in this experiment. They were employees at a local hospital, all right-handed, with normal (20/20) or corrected-to-normal vision. Mean age was 58.38 years ($SD=9.66$). Their mean education was 15.25 years ($SD=2.77$). They were not taking any medications affecting the central nervous system and had no history of severe medical problems or head injury. They were paid \$10.00 for participation and all gave informed consent before beginning the experiment.

Stimulus: Displays were presented on a computer monitor, and reaction time to locate a target was recorded to the closest millisecond. The stimuli were blue or red circles and triangles on a white/gray background. The target was always a blue circle which was present in every display to equate for the method used with patients in Experiment 2 (see rationale above). The distractors were blue triangles (having blue in common with the target) and red circles (having shape in common with the target) (see Fig. 1). Each display subtended a visual angle of about $23.2 \times 11.4^\circ$. The diameter of each circle was 1.7° and the length of a triangle's sides was 2.09° of visual angle.

There were either 0 or 16 items in each half of the display. The 16 items were always presented in two clusters of 8 items. Six displays with the target on the right side were created. These were then reflected to produce six displays with the target on the left side. In two unilateral conditions, the 16 items (including the target) were either randomly distributed within the two clusters on that side (random condition) or arranged into a cluster of blue triangles and a cluster of red circles (grouped condition), with the target equally often in either cluster. These were similar to Figure 1 except that clusters opposite to the target side were not present. There was no case in which two clusters with the same distractor type were present on one side of the grouped display. When grouped clusters appeared, one contained red circle distractors and the other contained blue triangle distractors. The 4 bilateral conditions contained 32 items. The 16 items on the right side of the display (including the target) were either random or grouped into 2 clusters. These were combined with 16 items (either 2 random or grouped clusters) on the left side of the page. There were 96 trials total with each condition consisting of 8 trials.

An imaginary rectangular grid consisting of 9×5 squares was centered on the screen. Without using the center row and the center column of squares in this imaginary rectangle, there remained eight squares in each quadrant of the display. Each item was centered in one of these squares to form four clusters.

On the target side, the target appeared with seven red circles and eight blue triangles on half the trials, and with eight red circles and seven blue triangles on the other half. On the side opposite to the target, eight distractors of each kind were used on each trial. The triangles in each row alternately pointed straight up and straight down. In any given column the triangles would either point up in the top two rows and down in the bottom two rows, or point down in the top two rows and up in the bottom two rows. This was also the case in the random condition.

In the random clusters, the circles and triangles within each cluster were placed such that they looked randomly arranged. No specific randomization procedure was used. In the grouped arrangements, the 16 items on one side of the page were grouped into a cluster of red circles and a cluster of blue triangles. In conditions with grouped stimuli on both sides, clusters with the same distractor type were placed diagonally.

In each condition, the target appeared once in every other of the 16 imaginary squares on one side of the display. All conditions were completely counterbalanced, such that the target appeared equally often in each position and equally often in a group of triangles as in a group of circles. Clusters of triangles and circles were placed equally often in the top and bottom two rows.

Displays were generated by VGA graphics onto a NEC-3 monitor. Participants were tested in an illuminated room with a viewing distance of about 54 cm. A PC computer controlled stimulus exposure and RT measurements. Stimulus timing was tied to the vertical sync pulse. All other events were timed by the real time clock interrupt at 0.25 ms time base. The status of the response key was monitored by the game port.

Procedure—Participants were instructed to press a response key with their right index finger to generate a display. They were then told to locate the target visually and release the key as soon they found it. They were to immediately point to the target upon key release. RTs were measured from stimulus onset to release of the response key. The experimenter was present throughout the experiment to note any location errors (which did not occur) and hesitations in pointing to the target after key release. After the pointing response the display disappeared. Participants then pressed the response key again for the next display to appear. Two different randomization sequences were created and alternated between subjects.

A display timed out if the response key was not released within 3 s after onset (0.5% of the trials), and these trials were excluded from the analysis. After the release of the response key, the display stayed on the screen for 1 s to allow time for the pointing response. The experimenter noted any trials on which the response key was released prematurely and no immediate pointing response was given (1.2% of trials). These trials were excluded from the analysis.

RESULTS

Median response times were calculated for each participant for each cell of the design. There were no errors in finding the target. The data were analyzed by a $2 \times 2 \times 3$ ANOVA with Target side (left/right), Target-side clusters (random/ grouped) and Opposite-side clusters (random/ grouped/empty) as repeated measures. Although right sided targets were responded to 28 ms faster than left sided targets overall, this difference was not significant,

$F < 1$. Figure 3 shows the mean response times collapsed over target side. Two main effects were significant, Target-side cluster, $F(1, 7) = 48.96$, $p < .001$, and Opposite-side cluster $F(2, 14) = 39.70$, $p < .001$. All other main effects and interactions were not significant ($p > .10$).

Planned comparisons revealed that grouped opposite-side clusters slowed response time to detect a target compared to the empty conditions, $F(1, 7) = 19.07$, $p < .01$ and random opposite-side clusters slowed response time compared to grouped clusters, $F(1, 7) = 30.35$, $p < .001$.

DISCUSSION

The findings of Experiment 1 are consistent with serial search through the display for conjunctions, but one which is guided by grouping. Searching for a target among grouped clusters was faster than searching for a target among random clusters. Also, grouped clusters on the opposite side of the display from the target could be rejected rapidly without searching through each element. This rejection slowed reaction time relative to the case when no distractors were present but speeded it relative to cases when distractors were randomly configured. This pattern of results is the pattern that would be predicted by a guided search model of visual search that proposes organizational processes that precede and then guide spatial attention (Wolfe, 1994). Grouping is one of these processes. Grouped items could be rejected as a whole while random items were rejected item by item until the target was found.

These results demonstrate that the expected pattern of results are found even when the task is to locate the target rather than the typical task of detecting its presence or absence. They also demonstrate the reliability of measuring visual search when there is a target in every display that must be located, thus making this a suitable task for patients with neglect who do not search the contralesional side of a stimulus unless instructed or cued to do so.

EXPERIMENT 2

METHOD

Participants—Seven males and one female patient with a diagnosis of left-hemispatial neglect were recruited from local medical centers (see Table 1). Seven patients had had cerebro-vascular accidents, and one patient had an inoperable glioblastoma that was diagnosed 3 weeks earlier. On the day of testing each participant showed a contralateral deficit on the Albert's line cancellation task (Albert, 1973; see Table 1 and Fig. 2), and earlier formal neuropsychological or neurological examinations revealed the existence of unilateral visual neglect. All participants were right-handed. Their mean age was 60.9 years ($SD = 8.16$). Seven patients had participated in an earlier visual search study (Eglin et al., 1994).

The lesions evident on MRI or CT were reconstructed onto computer templates. The damaged areas for 6 patients are reported in Table 1. For 2 patients, no scan was available. The average lesion volume was 71.6 cc ($SD = 51.90$). Three patients had large lesions involving both posterior and lateral frontal cortex, including the temporal-parietal junction and the frontal eye field. Two patients showed only posterior involvement; one of the posterior lesions included damage to the hippocampus, calcarine cortex and the pulvinar. One patient's lesion was restricted to lateral frontal cortex. Four patients had left homonymous hemianopsia but did not compensate for this problem by turning their head, indicating hemineglect as well.

The patients were informed of the experimental, nontherapeutic nature of the tests and consented to participate. They were free to withdraw from the study at any stage.

Stimuli Displays—The stimuli used for the patients were colored adhesive circles and triangles on white paper (21.6 cm × 27.9 cm). The target was always a blue circle which was present on every page. The distractors were blue triangles and red circles as in Experiment 1. The circles were 1.9 cm in diameter. All three sides of the triangles were 2.5 cm long. The design was the same as in Experiment 1.

Four orientation trials, two unilateral (grouped and random) and two bilateral (grouped and random on both sides) were also created to demonstrate the displays to the patients and make sure that they understood the instructions. A different random order of trials was used for the first, third, fifth and seventh patients. The reverse order was used for the second, fourth, sixth and eighth patient. There were 96 trials in all plus the 4 orientation trials.

Procedure—Three patients were tested at bedside (R.M., H.E., A.K.). The remainder were tested in a testing room on the ward (including outpatients). Each patient was first shown the four practice sheets, and the search task was explained to them. It was emphasized that a target was present on every page. The patients were instructed to point to the target with their right hand (which was centered in front of them on the display table before each trial) as soon as they saw the target. The stimulus sheets were centered in front of the patients at the beginning of every trial, but they were free to move their eyes and heads. Reaction times were measured with a stopwatch (to the nearest .10 ms) from the time a stimulus sheet was turned right-side up in front of a patient until he/she touched the target with his/her finger. In previous visual search studies we found that a stopwatch was sufficient to obtain reliable differences, since the response times were so long. This method also has advantages for designing clinical tests of visual search used at bedside with neurological patients.

RESULTS

Median reaction times for trials on which the target was correctly located were calculated for each patient for each condition of the design (Table 2). The data were analyzed by a $2 \times 2 \times 3$ ANOVA with Target side (left/right), Target-side clusters (random/grouped) and Opposite-side clusters (random/grouped/empty) as repeated measures. Figure 4 shows the mean response times in each condition averaged across patients. Since all patients in the present study had right sided lesions, 'RIGHT' corresponds to the ipsilesional and 'LEFT' corresponds to the contralesional display side. It is evident from Figure 4 that unlike healthy participants, the patients' search performance for targets on the right side of the display was very different from search for targets on the left side.

As would be expected with neglect patients, response times were slower for left sided targets than for right sided targets, $F(1, 7) = 17.94, p < .01$. As with normal participants there were also main effects of Target-side clusters, $F(1, 7) = 9.17, p < .01$ and Opposite-side clusters, $F(1, 7) = 17.74, p < .001$.

Unlike normal participants there was a highly reliable Target side × Opposite-side clusters interaction, $F(2, 14) = 11.67, p < .001$. When targets were on the right side, response times did not differ as a function of grouping on the left. There was no significant difference between grouped left side clusters and random left side clusters ($p > .25$) or between an empty left display and grouped left side clusters ($p > .90$). In other words, the configuration on the left, whether empty or not or grouped or random had no effect on the time to find a target on the right. This was true for every patient participant (see Table 2).

Conversely, when targets were on the left side, response times did differ as a function of opposite-side (right) clusters with grouped clusters slowing response time compared to the empty condition, $F(1, 7) = 9.74, p < .02$, and random clusters slowing response time compared to grouped clusters, $F(1, 7) = 10.50, p < .02$. There were no interactions between target side clusters and opposite-side clusters ($p > .90$). In other words, the search pattern for left sided targets looked much like those for normal participants in Experiment 1. When attention was first oriented toward the right, right sided groups were faster than random groups and both were more slowly compared to an empty display. Grouping of the right sided clusters determined how long before attention was moved to the left.

Errors—The target was missed only rarely: 13 times across all patients.

GENERAL DISCUSSION

There was no evidence that random versus grouped distractors on the neglected side affected detection of right sided targets in Experiment 2. Given the abundance of previous evidence for below threshold processing in the neglected field (Driver & Vuilleumier, 2001) one might expect that grouped clusters on the neglected side (in this case left) would draw attention and slow responses to a target on the right. However, there was not even a hint of support for this prediction. Whatever preattentive grouping in the neglected field might have occurred, it did not slow search performance of the right side by drawing attention to the left. Search on the right was affected only by the configuration of right-sided clusters (grouped vs. random). The results could not be attributed to visual field defects, as the data conformed to this pattern whether visual fields were full or not (Table 2).

Conversely, grouping on the right side of the display significantly affected the magnitude of left neglect (i.e., how long it took before attention began to search the neglected side). Although the absolute number of items on the right side of the display was the same in random and grouped conditions, random clusters added over 2 s compared to grouped clusters before left sided search began. Grouped clusters on the right could be rejected 2 s faster than random clusters and thus allowed search of the neglected side to commence sooner.

One advantage of studies of unilateral neglect is that performance on one side can be compared as a within-subject factor to performance on the other. In this way, patients with neglect can act as their own control. But was search normal? Although the overall pattern of performance in Experiment 2 was different on the right as compared to the data from healthy participants (Experiment 1), this was mainly due to the complete lack of influence of grouping on the neglected side. It is also possible that any lesion in the right hemisphere would produce this pattern of results, whether neglect was present or not, but our goal here was to understand the role of grouping of neglected stimuli on response to stimuli that are not neglected, and not to isolate the brain regions that create such problems in the first place.

A final point, and one that is somewhat puzzling, concerns the difference in detecting targets on the left and right side in neglect patients even when there was an empty field on the right side. This finding is in contrast to an earlier study (Eglin et al., 1989), where contralesional target detection was the same as ipsilesional target detection in unilateral displays. Here this equality was not present even for patients who clearly had full fields (WH, AK) as well as for those with homonymous hemianopsia (ML, RM, BA, UW). In fact, every patient showed a similar pattern. It could be argued that only grouped displays should have produced this function due to the pop out associated with one of the clusters. However, even in these displays, search on the left side was slower than on the right (0.3 s for patients with full fields and 0.7 for those without). On the other hand, the longer response times for contralesional targets may simply reflect the time required to move the ipsilesional response

hand into contralesional hemispace. Whatever the case, this finding does not detract from the main result that grouped clusters on the left side of the display were ignored to the same degree as random clusters or even an empty field.

When these results are compared to other findings in the literature showing that grouping can effect visual search (e.g., Grabowecky et al., 1993), an interesting picture emerges. Grouping appears to modulate the magnitude of neglect as long as grouping connects right and left sides into a perceptual whole. When items on the left are grouped with items on the right such that one unit is perceived, neglect is ameliorated. These types of effects have been discussed mostly in terms of attention to objects. When configurations are presented that can be perceptually organized into an object in the display, then the left side of the object is less likely to be neglected. Conversely, the present findings demonstrate that individually grouped clusters on the left side do not attract attention when they are grouped independent of ipsilesional clusters. They do not draw attention any more than random clusters under such conditions and therefore do not affect right sided search.

The present results are also consistent with the literature showing that grouping manipulations affect visual search time for normal participants (Treisman & Gelade, 1980). Targets in grouped clusters were found sooner than targets in random clusters, consistent with attention being guided by grouping (Wolfe, 1994). When features are grouped into clusters, finding a conjunction target (e.g., the blue circle in our displays) is guided by these clusters. This guidance is consistent with perceptual organization of the stimulus occurring before attentional search begins (Treisman, 1982). This organization is by definition “pre-attentive,” meaning that attention is not required for it to occur. The data for the patients also shows an influence of preattentive grouping. Consistent with previous evidence (Gilchrist et al., 1996), grouping features into clusters on the same side as the target speeded target detection compared to random displays whether the target was on the left or right side.

One could argue that the basis for this difference was due to the substantially longer response times of the patients. In order to evaluate this possibility, we tested whether the change from baseline (empty opposite-side conditions) was similar for the two groups. We simply calculated the percent increase in response time for grouped opposite side clusters by subtracting the empty from grouped opposite-side response time and dividing by the baseline response time (empty side condition). Likewise we subtracted the empty from the random opposite-side response time and calculated a percentage change from baseline in the same way.

Table 3a presents the results of this exercise for healthy participants (collapsed over target side, since there were no differences for left and right targets), and Table 3b presents the results for each target side separately for neglect participants. Table 3 clearly shows that the differences on the left in neglect patients were magnified compared to the healthy group. It took proportionately longer for neglect patients to reject a right sided cluster as containing the target whether grouped or random.

Table 3 also shows how little effect the configuration of left sided clusters had on finding targets on the right side for patients with neglect. The largest proportional change for finding right sided targets was 13% for patients and 36.7% for the healthy group. For right grouped clusters the percent change was only 3% for patients and 10.5% for the healthy group. This is the opposite pattern that would be expected if grouped clusters on the left attracted attention to the left side. Both grouped and random clusters were virtually ignored when they appeared on the left.

The values in Table 3 reinforce the reaction time results. However, caution should be taken when Experiment 1 and 2 are compared directly. Healthy participants saw the stimuli on a

computer monitor, and their response time was timed from stimulus onset to key release with the assumption that subjects followed instructions not to release the key until the target was located. The patients saw the stimuli on paper displays and were timed from the time the display was presented until they pointed to the correct location of the target. Although it is unlikely that these differences could account for the differences in results between Experiment 1 and 2, they must be acknowledged as a potential confound.

In sum, the present results demonstrate that grouping information on the ipsilesional or 'good' side of space dramatically affects the magnitude of neglect to contralesional information in patients with mild to moderate neglect. They also show that grouping processes on the neglected side need not attract attention away from the ipsilesional side of space. Groups may be formed preattentively on the neglected side but they do not automatically attract attention in patients with neglect. To the extent that grouping can ameliorate neglect, it appears that grouping is effective when it organizes items across the midline into a unified whole or when it allows items on the non-neglected side to be rapidly rejected.

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Fig. 1.

Example of a display with a target on the left (contralesional) side with 16 random distractors on the right (ipsilesional) side and 16 grouped distractors on the left (contralesional) side (not drawn to scale). Blank areas = red, shaded areas = blue.

Fig. 2.
Example of a patient's (U.W.) performance on the line cancellation task.

Fig. 3.
Means of the median reaction times for healthy participants as a function of distractor condition.

Fig. 4.
Means of the median reaction times for patients as a function of target side and distractor condition.

Table 1

Patient Demographics and Clinical Characteristics.

ID	Age/Sex	Etiology/Duration	Side	Visual Fields	* Lines	Lesion
ML	53/M	CVA/4 months	R	L-hemianopsia	86/61	CT not available
RM	66/M	CVA/1 month	R	L-hemianopsia	98/83	CT not available
WH	60/M	CVA/9 months	R	Full	100/98	Frontal
BA	54/M	CVA/1 month	R	L-hemianopsia	86/14	Parietal-temporal
HE	47/F	CVA/5 weeks	R	Questionable L-hemianopsia	89/46	Frontal-TPJ
JM	70/M	GLB/3 weeks	R	L visual Extinction	100/92	Frontal-parietal temporal
AK	67/M	CVA/1 week	R	Full	94/42	Frontal-parietal
UW	70/M	CVA/2 years	R	L-hemianopsia	66/4	Occipital-deep white matter below Parietal-temporal

Note. CVA = Cerebrovascular accident, GLB = Glioblastoma, R = Right hemisphere, L = Left.

* Percentage of lines cancelled on the ipsi-contralesional side of the page on the day of testing.

Table 2
Response Times Showing Similarity of Target Side by Opposite Side Effects Across Individuals (S).

Target side Opp. side	Left			Right		
	Empty	Grouped	Random	Empty	Grouped	Random
S1	3.0	4.0	8.3	1.4	1.7	1.5
S2	.7	.9	2.9	.7	.9	.9
S3	2.4	4.2	4.6	1.6	1.1	1.5
S4	.8	1.1	1.7	.6	.7	.7
S5	1.8	2.8	4.0	1.1	1.2	1.3
S6	1.5	2.5	4.0	.9	.9	.9
S7	1.4	1.3	3.0	1.2	1.0	1.1
S8	1.5	2.0	2.4	.8	.9	1.1

Table 3

Differences in Response Time From Baseline and Percent Increase.

Opposite side clusters					
	* G-E(ms)	G-E(%)	R-E(ms)	R-E(%)	Baseline (ms)
(a) Healthy participants					
Random	70	11	245	37	737
Grouped	59	11	174	32	550
(b) Neglect participants					
Targets (left)					
Random	.80	40	2.04	103	1.99
Grouped	.67	51	2.31	176	1.31
Opposite side (left) clusters					
	G-E(s)	G-E(%)	R-E(s)	R-E(%)	Baseline (s)
Targets (right)					
Random	.04	3	.15	13	1.20
Grouped	.01	1	.04	5	.87

Note.

* G-E refers to the difference in response time to find a target for grouped versus empty opposite side conditions. R-E refers to the difference in response time to find a target for random versus opposite side conditions. The table presents differences for both Random and Grouped same side distractors. The percentages refer to percent increase in response time over the baseline response time (empty opposite side condition).