
Background and Purpose. The presence of unilateral visual neglect (UVN) may adversely affect functional recovery, and rehabilitation strategies that are practical for use in clinical settings are needed. The purpose of this study was to evaluate the use of 2 approaches to reduce UVN in people who have had strokes. Subjects. Seven elderly patients with stroke and severe left UVN, aged 60 to 85 years, were recruited from a stroke rehabilitation unit. Methods. A nonconcurrent, multiple-baselines-across-subjects approach, with an A-B-A treatment-withdrawal single-subject experimental design, was used. Five subjects received a scanning and cueing approach, and 2 subjects received a contralesional limb activation approach, for 10 one-hour sessions. In the former approach, active scanning to the left was encouraged by the therapist, using visual and verbal cues and a mental imagery technique, during reading and copying tasks and simple board games. In the latter approach, functional and goal-oriented left upper-limb activities in neglected hemispace were encouraged. Unilateral visual neglect was examined by a masked (blinded) examiner throughout all phases using the Star Cancellation Test, the Line Bisection Test, and the Baking Tray Task. Data were analyzed using visual and inferential statistical techniques. Results. Both subjects who received limb activation and 3 of the 5 subjects who received scanning and cuing showed a reduction in UVN in one or more tests. This improvement was maintained during the withdrawal phase. Discussion and Conclusion. Both approaches had a positive effect of reducing aspects of UVN in some subjects relative to no-treatment baselines. However, causality cannot be assured in the absence of controls. The approaches are practical for use in rehabilitation settings. These procedures warrant further replication across subjects, settings, and therapists. [Bailey MJ, Riddoch MJ, Crome P. Treatment of visual neglect in elderly patients with stroke: a single-subject series using either a scanning and cueing strategy or a left-limb activation strategy. Phys Ther. 2002;82:782–797.]

Key Words: Hemi-inattention, Rehabilitation, Stroke, Unilateral visual neglect

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Unilateral visual neglect (UVN), a common perceptual deficit found after stroke, manifests as an inability to direct attention to stimuli when they are located on the side contralateral to the lesion. Unilateral visual neglect is a component of the “hemineglect syndrome,” which can include manifestations of neglect other than visual (eg, motor, sensory). Hemineglect is more severe and longer lasting following right-sided as opposed to left-sided brain damage, which has been attributed to the right hemisphere playing a primary role in spatial attention. The presence of UVN may adversely affect functional recovery, and it is associated with rehabilitation taking longer and being less complete than in patients without UVN.

Treatments thought to ameliorate UVN involving artificial manipulation of proprioceptive or visual input have been referred to in detail elsewhere. However, using such techniques, reduction of visual neglect has only been demonstrated during or immediately following such treatment sessions, and long-term carryover has not been demonstrated. Additionally, such treatments may require specialized equipment and technical support, and they do not easily lend themselves to application in real-life clinical situations. Robertson and colleagues found that sustained attention training appeared to be effective. The training involved the trainer first giving direct verbal feedback to the subject to attend to the task, progressing to the subject being required to provide his or her own verbal feedback to attend. However, the self-alerting procedures they used often required a degree of insight, memory, and cooperation from their subjects, which many elderly patients who have had strokes may not possess. Other strategies, which may be more practical for use in rehabilitation settings, include the use of scanning and cueing and limb activation. Scanning encourages the subject’s attention to be directed to neglected hemispace, and cueing, provided by the trainer or internally self-generated by the subject, facilitates such direction of attention.

In our study, we examined 2 different treatment approaches for patients with UVN, one using a scanning and cueing strategy and one using a left-limb activation (LLA) strategy. We used a series of single-system designs.

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The Use of Cues and Visual Scanning to Direct Attention to Left Hemispace

Gordon and colleagues\textsuperscript{15} contended that merely telling a patient to attend to the left visual field is ineffective in remediating faulty scanning habits. More systematic attempts to rehabilitate visual neglect by visual scanning training have been described.\textsuperscript{15–19} Typically, training involves visual scanning of rows of lights across a board using slow and systematic searches from left to right, with use of visual and verbal cues to direct attention to the left side of the board. Reduction of visual neglect has not been a consistent research finding across different studies, and there has been little or no generalization to untrained tasks.\textsuperscript{20}

Some researchers have successfully used cueing to reduce visual neglect immediately after a training session. Ladavas et al\textsuperscript{21} trained 12 elderly patients with stroke and stable UVN for 30 hours using computer-generated left-sided visual cues. There was no randomization, and there were only 4 subjects in each of the control and experimental groups, with no masking (blinding) of outcome. Riddoch et al\textsuperscript{22} used a left-sided colored sticker and the explicit reporting of this visual cue to reduce visual neglect in a single subject during a reading and copying task. Despite the negative results of some studies,\textsuperscript{20} other studies\textsuperscript{9,11} have shown that a combination of cueing and scanning methods reduced visual neglect, with generalization to some functional activities. These methods also were used by Paolucci and co-workers,\textsuperscript{10} who found improvement in activities of daily living in 2 groups of subjects with stroke and stable UVN. Improvements were “time-locked” to the period of specific, targeted training for neglect. They randomly assigned 23 elderly patients with stroke and stable UVN to immediate (mean age=68 years, SD=7.19) and delayed (mean age=70 years, SD=5.46) treatment groups. Forty hours of scanning and cueing training reduced visual neglect and improved function in both groups, compared with the subjects’ performance during a “general cognitive” intervention. Function was assessed by the Barthel Index\textsuperscript{23} (BI) (for activities of daily living) and the Rivermead Mobility Index\textsuperscript{24} (RMI) (for mobility in bed activities, transfers, standing, and walking). No information was given by Paolucci and colleagues as to which particular tasks in these batteries showed improvements in response to the specific treatment intervention. In general, no follow-up data have been reported following cueing studies, although Lennon\textsuperscript{25} successfully trained one patient with severe UVN to avoid left-sided collisions in the gymnasium by use of colored markers on edges to be avoided. Unfortunately, the patient required further retraining within his home environment. This retraining was successful, and eventually he did not need the visual cues.

Effects of Contralesional Limb Activation on Hemineglect

In patients with right-hemisphere brain damage, motor responses are usually made using the right arm because most people are right-hand dominant and the left arm may be paralyzed. Kinsbourne\textsuperscript{26} proposed that visual neglect results from an attentional imbalance rather than an attentional deficit, with the right hemisphere being dominant for spatial attention. In addition, he argued that activation of one hemisphere would tend to inhibit the activity of the other hemisphere. Because the right arm is controlled by the intact left hemisphere, using this arm may exacerbate visual neglect, because activation of the left hemisphere (by right arm use) would tend to further inhibit the already damaged right hemisphere. Conversely, LLA would lead to increased activity in the right hemisphere. Hemispheric activation has been used to account for the reduction in visual neglect found in several studies\textsuperscript{12–14,27–30} where even quite small active movements of the left upper limb have reduced visual neglect on the left side of the subject in single cases. Robertson and North\textsuperscript{28} found that LLA on the left side, rather than the limb acting as a visual cue, was important in the reduction of visual neglect. In contrast, Cubelli and co-workers\textsuperscript{31} repeated the study by Robertson and North\textsuperscript{30} using a group design, rather than a single-subject design. Cubelli et al found that only 1 of 10 patients, the only patient with no proprioceptive loss had reduced omissions in both a reading task and a cancellation task. A randomized controlled trial by Kalra and colleagues\textsuperscript{32} showed that LLA, or “spatio-motor cueing,” combined with emphasis on functional activity, reduced visual neglect and length of hospital stay in a group of 25 elderly patients with stroke compared with a comparable control group of 25 patients who received more conventional therapy, in this case therapy based on the Bobath approach.

The hemispheric activation explanation has been challenged by the results from a study by Ladavas et al,\textsuperscript{33} who used a control group. They found that passive movement of the left index finger in left space (with vision of the hand reflected in a mirror that inverted right and left space) reduced visual neglect. This finding supported a proprioceptive, as opposed to visuospatial, cueing explanation. More recently, Samuel et al\textsuperscript{34} used LLA combined with use of the left arm as a “visual anchor” (subjects were trained to look at and move their left arm if they were unable to find the target in an exercise) during activity for a total of 18 hours during the 2-week treatment phases of an A-B-A-B design. The 2 subjects had reduction in their visual neglect, as well as improved functional ability, which had not improved with previous scanning training.
Many limb activation studies have included a “neglect alert device,” worn by the subject during different activities and therapies. This device buzzes at intervals and must be switched off by the subject, using the left arm, thus encouraging activation of the left limb. Other researchers have required the subject to tap in response to a command with the hand or fingers. Some authors have tested for visual neglect along with LLA. In other studies, limb activation was not implemented during testing.

Studies That May Lend Themselves to the Clinical Situation

In many studies, there was use of complex or specialized computer-based equipment for scanning and cueing. In our view, the use of such equipment limits the practical application of scanning and cueing. In other studies, researchers used interventions that took place in more strictly controlled laboratory situations.

A number of researchers exploring rehabilitation of visual neglect used scanning and cueing techniques that may be more applicable to clinical settings. Strategies used in all of these studies (in addition to the computer-based scanning training included by some researchers) involved searching for and describing objects in pictures, particularly in the left visual field; reading and copying activities; using left-sided cues; and the use of simple games and pencil-and-paper tasks. Visual imagery, consisting of asking patients to imagine their eyes as beams from a lighthouse, might be clinically useful to reinforce patients’ direction of attention. This compensatory strategy encourages them to generate cues (the mental image of the “lighthouse beam scanning the horizon”) for themselves. Measurements of outcome in this study, however, were not obtained by masked observers, and some of the measures used had no demonstrated validity or reliability. Reduction of visual neglect was maintained for 5 months posttreatment in 7 of the 13 patients followed up by Pizzamiglio and colleagues; however, no control group was used for comparison. Other researchers repeated and improved upon this study by randomly assigning subjects to experimental and control groups. However, maintenance of positive effects was not assessed after the subjects’ steady improvement that occurred during the 8-week treatment period.

Several limb activation strategies have been used in rehabilitation settings. The length of time for which treatment benefit lasted was assessed immediately after treatment at the end of the second baseline phase and at 12 weeks after treatment in 2 studies. Some researchers have demonstrated improvements in activities not directly used during training, including activities of daily living, which were maintained at 1-month follow-up. Some findings, we believe, must be interpreted with caution. For instance, in some studies, there was no evidence of masking of the individuals who took the outcome measurements, and in other studies, the reliability of the measurements was questionable. Kalra and colleagues gave no details of the limb activation approach used, precluding study replication. A further problem is that only 3 of the clinically based rehabilitation studies were on subjects who were, on average, over 70 years of age, an age group that is more likely to reflect those who have had stroke and UVN.

Some researchers have used subjects who were capable of only minimal upper-limb use and no isolated finger movements. Limb activation strategies, however, can be used only when there is an assumption of at least residual voluntary control of the left upper (or lower) limb and thus may not be appropriate for patients with no such recovery. For these patients, the use of scanning and cueing strategies may be the only approach possible. In addition, use of a “neglect alert” electronic device, as an adjunct to limb activation, may be difficult in some hospital situations and may not be readily available or acceptable for routine use.

More clinical trials are needed to investigate the effectiveness of techniques likely to reduce UVN. This need is particularly pressing because of the high incidence of UVN and the link with poor prognostic outcome, particularly following right-sided brain damage. We believe a variety of strategies may be used to overcome some of the shortcomings discussed. The person obtaining outcome measurements should be masked. To reduce the effects of confounding variables such as history and maturation, subjects should be randomly assigned to different baseline time periods. We also believe the strategies chosen for each approach should be clinically applicable and should use simple, low-cost, and easily available equipment. In our study, we attempted to address these issues via use of a series of single-subject designs to investigate whether scanning and cueing (for patients with no or only minimal recovery of upper-limb function following stroke) or an LLA strategy (for patients with some spared upper-limb voluntary activity) would reduce UVN in selected elderly patients with stroke.

Method

Experimental Design

We considered a single-subject experimental design to be appropriate for subjects in a rehabilitation setting due to the heterogeneity of the visual neglect syndrome.
and other features of stroke, such as movement ability and level of sensation, which can be confounding variables in group studies.\(^{38}\) Seven patients were studied. A nonconcurrent, multiple-baseline-across-subjects design was chosen\(^{39}\) because it was not possible for us to obtain more than one subject suitable for study at any one time. Varying the length of the first baseline phase (A1) controls for some threats to internal validity because of factors such as history, maturation, and the possibility of spontaneous recovery and is also appropriate when withdrawal of the intervention might not result in the outcome behavior returning to baseline levels,\(^{40}\) perhaps because of a permanent change in behavior due to the intervention. A second baseline (withdrawal) phase (A2) was included to establish whether any changes would be maintained. Ideally, baseline (A1) data should show stability so that a treatment effect, shown by a change in level, trend, or variability during the intervention (B) phase, would be clearly visible. In our study, the intervention (B) and second baseline/withdrawal (A2) phases each lasted approximately 3 weeks. We believe that this duration enabled sufficient data to be collected in each phase. A minimum of 10 data points per phase is recommended\(^{41}\) to be collected to enable subsequent statistical analysis.

Subjects were randomly assigned to a 2-, 3-, or 4-week baseline phase (A1) as they became available for evaluation. In this way, subjects 1, 4, and 6 were assigned to a 4-week baseline phase; subjects 2 and 3 were assigned to a 3-week baseline phase; and subjects 5 and 7 were assigned to a 2-week baseline phase. All subjects continued to receive their usual occupational therapy and physical therapy on the ward throughout all phases, which consisted of approximately 30 minutes each weekday for each type of therapy. The therapists were aware of the presence of visual neglect in all subjects, and although treatment focused on this problem was not given to the subjects, all subjects were encouraged to look toward their neglected side during activities such as dressing, self-care, and physical rehabilitation exercises.

### Subjects

Subjects were all patients between 60 and 85 years of age (Tab. 1) who were admitted from an acute care hospital to a stroke rehabilitation unit over a 12-month period. Inclusion criteria were: right-sided brain damage (determined by computed tomography scan results), first stroke, moderate to severe left-sided UVN on screening, and cognition and physical ability sufficient to allow inclusion in the testing and treatment program. Subject details are shown in Table 1. Subjects who had minimal or no left upper-limb voluntary movement were treated using the scanning/cueing approach. Subjects with some left upper-limb voluntary control (at least enough to lift the arm and place it on a table in front of them) and at least minimal voluntary finger movement were treated using the LLA approach. It must be emphasized that the aim was not to compare these 2 approaches, but to separately evaluate the efficacy of each approach in the clinical setting.

### Screening and Testing Procedures

Testing was always carried out at the same time in the morning, prior to training, so any changes in behavior resulting from training that could be measured needed to last at least 24 hours. For logistical reasons, the same person undertaking the training, which normally occurred on alternate weekdays, assessed the first 2 subjects (subjects 1 and 2). To reduce the possibility of observer bias, all testing sessions for UVN for these 2 subjects were videotaped and later independently analyzed in an effort to ensure that test administration was standardized. For all other subjects, testing and training were carried out by 2 different individuals, and the assessor was

<table>
<thead>
<tr>
<th>Subject No.</th>
<th>Sex</th>
<th>Age (y)</th>
<th>Computed Tomography Scan Result</th>
<th>Days Poststroke (Start of A1 Phase)</th>
<th>Days Poststroke (Start of B Phase)</th>
<th>Days Poststroke (Start of A2 Phase)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Female</td>
<td>79</td>
<td>Right posterior frontal and basal ganglia infarct</td>
<td>31</td>
<td>61</td>
<td>82</td>
</tr>
<tr>
<td>2</td>
<td>Female</td>
<td>72</td>
<td>Large infarct in right middle cerebral artery territory</td>
<td>46</td>
<td>68</td>
<td>91</td>
</tr>
<tr>
<td>3</td>
<td>Male</td>
<td>85</td>
<td>Right temporo-parieto-occipital infarct</td>
<td>42</td>
<td>62</td>
<td>90</td>
</tr>
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<td>25</td>
<td>55</td>
<td>69</td>
</tr>
<tr>
<td>5</td>
<td>Female</td>
<td>78</td>
<td>Large infarct in right middle cerebral artery territory and basal ganglia</td>
<td>19</td>
<td>65</td>
<td>89</td>
</tr>
<tr>
<td>6</td>
<td>Male</td>
<td>72</td>
<td>Large infarct in right middle cerebral artery territory</td>
<td>20</td>
<td>48</td>
<td>76</td>
</tr>
<tr>
<td>7</td>
<td>Female</td>
<td>60</td>
<td>Right parietal infarct</td>
<td>13</td>
<td>26</td>
<td>33</td>
</tr>
</tbody>
</table>
masked to which phase of the single-subject design was in effect in each test session. Testing for UVN was normally undertaken daily or on alternate days during weekdays throughout all study phases (depending on subject availability). Other tests (for stroke severity, sensation, and function) were carried out weekly throughout all phases.

**Tests for UVN.** The initial screening of suitable patients involved the same 3 standardized tests for UVN that would be used in the study. These tests were the Line Bisection Test (LBT) and Star Cancellation Test (SCT), both from the Behavioural Inattention Test battery, and the Baking Tray Task (BTT). The LBT and SCT have been shown to have concurrent validity \(^42\) (Pearson \(r = .92\)) when the test scores were compared with scores from the behavioral battery subtests of the Behavioural Inattention Test \(^42\) and intrarater and interrater reliability \(^42\) (Pearson \(r = .99\)) based on scores from 80 patients with stroke (54 with right brain damage and 26 with left brain damage). Marsh and Kersel \(^44\) considered the SCT to be particularly responsive for visual neglect. The BTT was recently developed and was described \(^43\) as a quick, yet sensitive, test that may not be subject to practice effects and therefore could be useful for repeated measurements. In an unpublished study, \(^8\) we have demonstrated test-retest reliability for all 3 tests for UVN. Several tests were chosen for UVN because of the heterogeneity of the syndrome \(^45\) and to enable “capture” of a wider range of lateralized performance deficits.

The SCT consists of a page containing 52 large stars, 10 short words, and 13 letters, randomly positioned, with 56 small stars interspersed among them. Subjects were instructed to cross out (with a black pen) all of the small stars interspersed among them. Subjects were asked to find and mark the center of each line in turn. Errors away from true midline were measured, and an average error score (in centimeters) was calculated, with leftward errors being given a negative sign and rightward errors being given a positive sign. For the BTT, the equipment used was a white board (75 cm), which was the “baking tray,” and sixteen 3.5-cm cubes of brown wood (the “buns”). Subjects were asked to “place the blocks as symmetrically as possible as if they were ‘buns’ being placed on a baking tray to be put in the oven.” All 16 cubes had to be used, and subjects were reminded if any were omitted. For ease of data analysis and to give a laterality index, the BTT ratio of “buns” placed on the left side of the “baking tray” to the total of 16 was calculated, thus giving a potential range of scores of 0 to 1, with a score of 0.5 indicating normal symmetry.

For the purposes of our study, patients with moderate to severe visual neglect were included because they were more likely to show change in response to treatment. \(^19, \(^36\) Screening cutoff scores for inclusion, therefore, were more strict than those originally recommended, \(^42, \(^43\) being set at fewer than 20 stars cancelled, a mean line bisection error of more than 2.5 cm, and a ratio of 0.25 or less for the BTT (which equates to 4 “buns” or less placed on the left side of the tray).

**Tests for sensation, function, and stroke severity.** Both position sense and light touch for affected upper and lower limbs were tested, with the subjects blindfolded, using the Nottingham Sensory Assessment scales. \(^46\) The Nottingham Sensory Assessment scales have a total maximum possible score of 24 for position sense and 20 for light touch (full details are given elsewhere \(^46\)). Mobility in bed, transfers, and walking was assessed using the RMI \(^24\) (maximum mobility score = 15), and activities of daily living were assessed using the BI \(^23\) (maximum functional score = 100). These 2 tests were chosen to reflect different aspects of everyday function. Stroke severity was monitored with the Canadian Neurological Scale \(^47\) (maximum score = 11.5, with lower scores indicating more severe symptoms). Criteria and scoring details are given elsewhere \(^23, \(^24, \(^47\). All of these tests for sensation, function, and stroke severity have been validated for use in elderly patients with stroke and have demonstrated good to excellent reliability (kappa > .6) in patients (studies included subjects with stroke over 60 years of age). \(^24, \(^46--49\)

**Procedures.** Testing procedures were not directly used for intervention, nor were intervention procedures implemented during testing. A minimum of 10 data points per phase were normally collected for all 3 tests for UVN. Fewer data points were collected for the other tests. Intervention, given during the B phases, always took place during the morning and occurred, when possible, on alternate weekdays for a minimum of 10 sessions, each lasting for 1 hour. All testing and interventions took place in a quiet area on the ward. The subjects were seated for all activities. We designed the interventions to be clinically feasible in terms of time spent, equipment available, and activities performed.

**Instructions given to all subjects.** During the first treatment session of the intervention (B) phase, the problem of UVN was thoroughly explained to the subjects. Manifestations (omission of objects on the left during visual search or words or letters on the left during reading)

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* For a sample of 57 elderly patients with stroke and UVN, intraclass correlation coefficients for the SCT, LBT, and BTT were .96, .94, and .87, respectively, indicating good to excellent reliability.
were demonstrated to the subjects during activities such as reading, copying, drawing, and finding named objects in pictures or in the surrounding ward.

**Intervention using scanning and cueing techniques.** Because the subjects in this study had no voluntary left upper-limb movement, the right (unaffected) upper limb was used, where necessary. The following strategies were applied:

- Subjects were encouraged to actively scan from left to right of the visual field so that they could correctly respond in reading, copying, drawing, or description tasks. Scanning was to the sides of the table for near-space activities and to the sides of the room or ward for far-space activities.
- Left-sided visual cues were used (attention being drawn to the left arm or to a red shiny ribbon placed on the left) to help the subjects to actively make a left start in visual search tasks.
- All activities progressed from simple to complex over the course of the intervention phase (eg, reading only one line on a page, then reading 2 lines, then 3 lines, and so on) in terms of stimuli presented for reading, copying, drawing, and finding objects within the visual field.
- Activities progressed in terms of complexity, with addition of distracting material, only when the preceding tasks had been successfully achieved.
- The subjects were given feedback about performance success in each task, and praise was given for each correct response.

Some tasks (ie, reading and copying tasks using newspaper headlines and handwritten sentences, copying of line drawings on a dot matrix, and description of scenes in pictures) were based on those used in previous studies.9–11 The following tasks were undertaken:

- During the first treatment, the subjects were shown a simple line drawing of a lighthouse and told “Imagine you are a lighthouse like this one. Imagine your eyes are like the lights inside the top, sweeping all the way to the left and right of the horizon to guide the ships at sea to safety. Use your ‘lighthouse beam’ to sweep and scan across the table top/book/newspaper/around the ward. Especially remember to sweep your beam and scan to the left side.” Over the period of the intervention phase, the subjects were encouraged to self-cue, using this lighthouse strategy,35 especially if they were having difficulty in finding objects on the left of their midline.
- Both visual and verbal cues were used to facilitate attention to the left, and the subjects were verbally cued where necessary by the therapist (“look for the red ribbon,” “find your left arm,” “remember to sweep that lighthouse beam of your eyes all around to the left to find what you are looking for,” or, during picture description, “can you find anything else?”). The therapist gave tactile cues by tapping on the subjects’ left arm (if they had sufficient sensation to appreciate the stimulus).
- Reading and copying tasks made use of books, magazines, and newspapers. Subjects also were asked to copy line drawings of various objects, presented on the left side of a white board (75 × 50 cm) placed on a table in front of them, onto the right side of the board. About 15 minutes per session was devoted to these activities.
- Copying of line drawings on a dot matrix also was used. Two identical dot matrices (black dots on a sheet of white A4 paper, varying from 4 to 20 points) were used; on the left, some dots (progressively increasing in number) were connected by solid lines. Subjects were asked to copy this line drawing onto the right matrix. A cross indicated the starting point. About 10 minutes per session was devoted to this activity.
- Color pictures from magazines were used as stimuli, and the subjects were asked to describe the scene in the picture or to find various named objects in the picture. Pictures were progressed from simple to complex in terms of number, size and complexity of items, and amount of distracting information. About 20 minutes per session was devoted to this activity.
- Subjects were asked to identify and describe various items they could see around the ward. About 5 minutes per session was devoted to this activity.
- Simple board games (eg, Snakes and Ladders, Scrabble,Dominoes, finding words embedded in word puzzles), placed and played progressively into left-sided space, were used to encourage scanning to the left. About 10 minutes per session was devoted to this activity.

**Intervention using LLA techniques.** Subjects were told that research showed that moving the left limb (preferably the upper limb, but also the lower limb) on the left side of their body space had been shown to reduce visual neglect and to possibly improve function. They were told that this approach would be adopted in the intervention sessions. The following activities took place:

- Subjects were asked to concentrate on moving only their left upper limb during the sessions and not to additionally use their right upper limb.
- Where possible, activities involved voluntary active

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1 JW Spear & Sons PLC, subsidiary of Mattel (UK) Ltd, Mattel House, Vanwall Business Park, Vanwall Rd, Maidenhead, Berkshire, SL6 4UB, United Kingdom.
movement of the left upper and lower limbs. If a subject was unable to actively achieve a particular functional goal, then the therapist assisted the action.

- Subjects were taught to activate their left arm (eg, by tapping their hand or fingers on an adjacent left surface, as described by Wilson et al\textsuperscript{41}) prior to and while performing activities that involved directing attention to the neglected hemispace, such as the playing of simple board games (eg, Scrabble,\textsuperscript{1} Dominoes, Snakes and Ladders) or word games. About 15 minutes per session was devoted to this activity.

- Activities chosen were functional and goal oriented where possible and included activities such as combing the hair, shaving (for men), applying makeup (women), putting on upper-body garments, picking items out of a basket and placing them on the table in front of the subject, undoing tops and caps of containers (any necessary steadying done by the therapist to ensure only left upper-limb use), pouring out a drink, and drinking from a beaker or cup. Various sized and shaped objects were used. About 30 minutes per session was devoted to this activity.

- Subjects also used a cloth, held in the left hand, to rub off words, letters, drawings, and so on made on the left side of the white board by the therapist. About 15 minutes per session was devoted to this activity.

Subjects 1 through 5 received the scanning and cueing approach, and subjects 6 and 7 received the LLA approach. All subjects were given written and verbal explanations about the study, and all subjects gave written informed consent before taking part in the study.

**Data Analysis**

**Tests for unilateral visual neglect.** A combination of visual and statistical analysis was used, as visual inspection alone, in our view, cannot be used to test a hypothesis and weak treatment effects may be overlooked.\textsuperscript{50} Successive observations in a time series tend to be correlated\textsuperscript{39}; therefore, all of the UVN data series were examined for serial dependency using the method described by Ottenbacher.\textsuperscript{41} Where autocorrelations were found in any phase for any test, the C-statistic method\textsuperscript{39} was used for subsequent data analysis for that test for the subject in question to look for significant differences between phases (P<.05). When serial dependency was not found, standard inferential analysis proceeded (using SPSS software\textsuperscript{3}). The Kruskal-Wallis test for differences was applied across the 3 phases, and if the result was significant (P<.05), the Mann-Whitney test was used for post hoc testing\textsuperscript{52} of where the differences lay. A Bonferroni adjustment was used to set the alpha level at .025 for post hoc comparisons of the A1 and B phases and the B and A2 phases to compensate for the alpha-level inflation that occurs in multiple tests. The following null hypothesis was used for each subject’s set of data: there will be no difference between first baseline and intervention (A1 to B) phases or between the intervention and second baseline (B to A2) phases for the SCT, LBT, and BTT tests for UVN (P<.05). Graphs of the raw data were generated\textsuperscript{54} using Microsoft Excel.\textsuperscript{8} These graphs showed celeration and trend lines for each phase, computed using the split-middle technique,\textsuperscript{39} enabling further visual inspection. It should be emphasized that (1) only 9 of a possible total of 21 graphs are presented here to illustrate the only instances of reduction of visual neglect and (2) of these 9 graphs, 7 graphs display data from only 3 subjects.

**Tests for stroke severity, function, mobility, and sensation.** Because there were only 3 data points for each of these tests per phase, insufficient for subsequent inferential analysis, the data will be presented descriptively. Tests of sensation, function, mobility, or stroke severity were examined to determine whether any score change coincided with phase change (ie, between the A1 and B phases and the B and A2 phases).

**Results**

Over a 12-month period, 141 patients were admitted to the unit; 29 patients (21%) (all with left-sided brain damage and communication problems) were not testable. Of the remaining 112 patients, 64 (57%) had right-sided brain damage; 39 (61%) of the patients with right-sided brain damage had UVN. From this group of 39 patients, a total of only 7 patients (Tab. 1) fulfilled the inclusion criteria during the course of the study. Data, including mean and range for each phase for each of the 3 tests for UVN, for each subject, are shown in Table 2. Results of all statistical tests performed on the time series data for UVN tests are presented in Tables 3 through 5. The range of scores for tests of severity, function, mobility, and sensation for each phase, for each subject, are shown in Table 6. Results in the remainder of this section will be summarized on a case-by-case basis.

**Subjects Receiving Scanning and Cueing Training (Subjects 1–5)**

Subject 1 (Tab. 1) had severe left-sided motor and sensory loss, was only occasionally continent, and fell to the left during unsupported sitting. She had left homonymous hemianopsia; severe reading impairment; and severe visuospatial neglect, with eyes and head usually

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\textsuperscript{1} SPSS Inc. 233 S Wacker Dr, Chicago, IL 60606.

\textsuperscript{8} Microsoft Corp, One Microsoft Way, Redmond, WA 98052.
turned to the right. She was lethargic and drowsy, with flat affect throughout most testing and treatment sessions. She was assigned to a 4-week baseline phase. Intervention was commenced at 61 days poststroke. Ten treatment sessions were conducted. The SCT score was the only one to show a change between the A1 and B phases (Tab. 3). This change is illustrated in Figure 1, which shows an increase in level between the A1 and B phases and a change in slope and trend between the B and A2 phases, indicating that the improvement was maintained or slightly increased. Although there were some small changes in motor, sensory, and functional scores (Tab. 6), none of these were coincident with any phase change and or related to the timing of the intervention.

Subject 2 (Tab. 1) had severe left-sided motor and sensory loss, with the upper limb more affected than the lower limb and with minimal sensation and active movement in the left lower limb. She was occasionally incontinent and was able to maintain unsupported sitting. She had left homonymous hemianopsia; mild reading impairment; and severe UVN (Tab. 2), with eyes and head usually turned to the right. She was usually alert but sometimes drowsy, occasionally losing concentration. She was assigned to a 3-week baseline phase. Intervention was commenced at 68 days poststroke. Ten treatment sessions were conducted. The SCT and BTT showed a change only between the A1 and B phases (Tabs. 3 and 5). These changes are illustrated in Figures 2 and 3. Figure 2 shows improvement in SCT scores during the intervention.
Table 4.
Statistical Analysis Results for Line Bisection Test for All Subjects

<table>
<thead>
<tr>
<th>Subject No.</th>
<th>Kruskal-Wallis Test Across Phases (P&lt;.05)</th>
<th>Mann-Whitney Post Hoc Test Between A1 and B Phases (P&lt;.025)</th>
<th>Mann-Whitney Post Hoc Test Between B and A2 Phases (P&lt;.025)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>P=.707</td>
<td>P=.003</td>
<td>P=.003</td>
</tr>
<tr>
<td>2</td>
<td>P=.868</td>
<td>P=.003</td>
<td>P=.003</td>
</tr>
<tr>
<td>3</td>
<td>Not applicable** P&lt;.01* (z=4.065)</td>
<td>P&lt;.01* (z=4.026)</td>
<td>P&lt;.01* (z=4.026)</td>
</tr>
<tr>
<td>4</td>
<td>P=.041*</td>
<td>P=.098</td>
<td>P=.934</td>
</tr>
<tr>
<td>5</td>
<td>P=.651</td>
<td>P=.03</td>
<td>P=.03</td>
</tr>
<tr>
<td>6</td>
<td>P=.003*</td>
<td>P=.003</td>
<td>P=.006</td>
</tr>
<tr>
<td>7</td>
<td>Not applicable** NS (z=-1.32)</td>
<td>Too few data points</td>
<td>Too few data points</td>
</tr>
</tbody>
</table>

*If the Kruskal-Wallis Test result is nonsignificant, further post hoc testing is unnecessary. Asterisk indicates a significant difference at the stated P value. Double asterisk indicates serial dependency in data and analysis by C statistic. For significance at P<.05, z must be >1.64. NS=not significant. A1=first baseline phase, B=intervention phase, A2=second baseline phase.

Table 5.
Statistical Analysis Results for Baking Tray Task for All Subjects

<table>
<thead>
<tr>
<th>Subject No.</th>
<th>Kruskal-Wallis Test Across Phases (P&lt;.05)</th>
<th>Mann-Whitney Post Hoc Test Between A1 and B Phases (P&lt;.025)</th>
<th>Mann-Whitney Post Hoc Test Between B and A2 Phases (P&lt;.025)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>P=.03*</td>
<td>P=.051</td>
<td>P=.245</td>
</tr>
<tr>
<td>2</td>
<td>P=.015*</td>
<td>P=.010</td>
<td>P=.761</td>
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<td>3</td>
<td>P=.362</td>
<td>P=.340</td>
<td>P=.071</td>
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<td>4</td>
<td>P=.023*</td>
<td>P=.406</td>
<td>P=.046</td>
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<td>5</td>
<td>P=.441</td>
<td>P=.003</td>
<td>P=.006</td>
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<tr>
<td>6</td>
<td>P=.001*</td>
<td>NS (z=1.057)</td>
<td>Too few data points</td>
</tr>
<tr>
<td>7</td>
<td>Not applicable** NS (z=1.057)</td>
<td>Too few data points</td>
<td>Too few data points</td>
</tr>
</tbody>
</table>

*If the Kruskal-Wallis Test result is nonsignificant, further post hoc testing is unnecessary. Asterisk indicates a significant difference at the stated P value. Double asterisk indicates serial dependency in data and analysis by C statistic. For significance at P<.05, z must be >1.64. NS=not significant. A1=first baseline phase, B=intervention phase, A2=second baseline phase.

phase, which continued through the treatment phase, and improvement was maintained during the A2 phase. The changes in trend lines for the BTT (Fig. 3) indicate better symmetry and less variability in “bun” placement during the B phase, which was partly maintained during the A2 phase. Small changes in BI scores were due to improvements in continence (Tab. 6) and were not related to the timing of the intervention. The subject reported that she was now able to find medications and refreshments placed on the table in front of her or to her left, which previously she had missed.

Subject 3 (Tab. 1) had moderate left-sided motor loss, which was worse in the upper limb than in the lower limb, and mild left-side sensory loss; was incontinent; and had good sitting balance. He had a severe hearing deficit and used a hearing aid. He had moderate reading impairment and severe UVN (Tab. 2), with eyes and head turned to the right. He was frequently drowsy but was more alert during testing and treatment sessions. He was assigned to a 3-week baseline phase. Intervention commenced at 62 days poststroke. Ten treatment sessions took place. He showed improvement in SCT scores and reduction in line bisection error between the A1 and B phases and between the B and A2 phases (Tabs. 3 and 4). These changes are illustrated in Figures 4 and 5. Figure 4 shows changes in trend and slope for the SCT between the A1 and B phases, with a leveling off of the trend line in the A2 phase. This leveling off of the trend line indicated large improvement coinciding with treatment, which was maintained during the A2 phase. Figure 5 shows a sharp decrease in line bisection error during the B phase, with continued but less dramatic improvement during the A2 phase. The small changes in BI scores were due to improvements in his ability to transfer (Tab. 6) and were not related to the timing of the intervention. However, there were small changes in both position sense and touch during the B phase, which were maintained during the A2 phase (Tab. 6).

Subject 4 (Tab. 1) was incontinent and had moderate left-sided motor and sensory loss, with some sparing of sensation and fair active movement in the left lower limb. She had good sitting balance. She had severe left UVN (Tab. 2) and severe reading impairment. She was frequently drowsy during testing and treatment sessions, frequently needing to be aroused during testing in order to complete tasks. She was assigned to a 4-week baseline phase. Intervention commenced at 55 days poststroke. Ten treatment sessions were conducted. No changes in score in any tests for UVN between phases were found (Tabs. 5–5). There were minor changes in motor control, function, mobility, and sensation (Tab. 6), none of which were related to the timing of the intervention.

Subject 5 (Tab. 1) had left-sided hemiplegia, with severe motor and sensory loss. She was incontinent and very drowsy during all testing and treatment sessions, such that she required frequent rousing to complete any task. She was unable to sit without support. She had severe left-sided UVN (Tab. 2), with head and eyes deviated to the right. She was assigned to a 2-week baseline phase; however, the baseline phase turned out to be much longer than planned due to a period of patient illness. Intervention commenced at 65 days poststroke, and 10
treatment sessions were conducted. No changes in score in any tests for UVN between phases were found (Tabs. 3–5). There was a small change in her BI scores (Tab. 6) due to improvement in continence, but this change was not related to any phase change.

**Subjects Receiving Limb Activation Training (Subjects 6 and 7)**

Subject 6 (Tab. 1) had left-sided moderate hemiplegia, with left homonymous hemianopia. He had some reduced sensation; position sense worse than light touch, with sensory extinction; and moderate active control of his left upper and lower limbs. He was continent, was able to transfer with supervision, and was able to walk with the help of one person. He had severe left-sided UVN (Tab. 2) omitted left parts of garments during dressing, and had severe reading impairment. He was alert and cooperative. He was assigned to a 4-week baseline phase. Intervention started at 48 days poststroke. Ten treatment sessions were conducted. He showed improvements only between the A1 and B phases for all 3 tests for UVN (Tabs. 3–5). Figure 6 shows continual improvement in SCT scores throughout the B phase, and improvement was maintained during the A2 phase. Figure 7 shows a general trend of reduction in line bisection error, with a small trend of increasing errors during the A2 phase. Figure 8 shows a clear trend for improved symmetry (a score of 0.5 indicates symmetry), with more “buns” being placed on the left, the change being coincident with the intervention, and the improvement partly maintained during the A2 phase. However, the graphs show, for all 3 tests, that there were indications of improvements in scores at the end of the baseline (A1) phase, before intervention began. Table 6 shows that, although there were changes in scores in severity, function, mobility, and sensation, only changes in the BI and the light touch scores were coincident with the change from the A1 phase to the B phase. The increase in BI scores from 30 to 45 was due to improvements in continence, dressing ability, and balance (ability to transfer with help). Improvements continued during the A2 phase. Light touch appreciation improved from 14 to 17 in the forearm and hand during the B phase, and improvement was maintained during the A2 phase. He reported that he was now able to find medications and refreshments placed on the table in front of him or to his left, which previously he had missed.

Subject 7 (Tab. 1) had left-sided, mild hemiplegia, with left hemianopia and severe left UVN, with head and eyes deviated to the right. She had good sensation and only mild left-sided weakness, with some incoordination. She was able to stand and walk but required assistance with mobility and self-care activities due to balance problems. She was continent and alert. She was assigned to a 2-week baseline phase. Intervention commenced at 26 days poststroke. Seven test sessions were conducted during the A1 phase, and 7 intervention and testing sessions were conducted during the B phase. Only 2 testing sessions were completed during the A2 phase because the subject was discharged home. She showed improvement in SCT scores between the A1 and B phases (Tab. 3). Figure 9 shows that this improvement

<table>
<thead>
<tr>
<th>Subject No.</th>
<th>Canadian Neurological Scale Score (0–11.5)</th>
<th>Barthel Index Score (0–100)</th>
<th>Rivermead Mobility Index Score (0–15)</th>
<th>Position Sense Score (0–24)</th>
<th>Light Touch Score (0–20)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A1 3.5–7.0</td>
<td>0.0–15.0</td>
<td>0.0–0.0</td>
<td>0.0–3.0</td>
<td>0.0–1.0</td>
</tr>
<tr>
<td></td>
<td>A2 7.0–7.0</td>
<td>15.0–15.0</td>
<td>1.0–1.0</td>
<td>3.0–3.0</td>
<td>1.0–1.0</td>
</tr>
<tr>
<td>2</td>
<td>A1 6.5–6.5</td>
<td>20.0–20.0</td>
<td>1.0–1.0</td>
<td>4.0–4.0</td>
<td>4.0–4.0</td>
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<tr>
<td></td>
<td>A2 6.5–6.5</td>
<td>25.0–30.0</td>
<td>1.0–1.0</td>
<td>4.0–4.0</td>
<td>4.0–4.0</td>
</tr>
<tr>
<td>3</td>
<td>A1 7.0–7.0</td>
<td>5.0–15.0</td>
<td>1.0–1.0</td>
<td>11.0–14.0</td>
<td>11.0–14.0</td>
</tr>
<tr>
<td></td>
<td>A2 7.0–7.0</td>
<td>20.0–20.0</td>
<td>1.0–1.0</td>
<td>14.0–16.0</td>
<td>14.0–17.0</td>
</tr>
<tr>
<td>4</td>
<td>A1 7.0–7.0</td>
<td>10.0–25.0</td>
<td>1.0–0.0</td>
<td>10.0–12.0</td>
<td>10.0–12.0</td>
</tr>
<tr>
<td></td>
<td>A2 8.0–8.5</td>
<td>25.0–30.0</td>
<td>1.0–3.0</td>
<td>14.0–15.0</td>
<td>14.0–15.0</td>
</tr>
<tr>
<td>5</td>
<td>A1 5.0–6.5</td>
<td>15.0–20.0</td>
<td>0.0–0.0</td>
<td>4.0–5.0</td>
<td>3.0–4.0</td>
</tr>
<tr>
<td></td>
<td>A2 5.0–5.0</td>
<td>20.0–20.0</td>
<td>0.0–0.0</td>
<td>3.0–4.0</td>
<td>4.0–4.0</td>
</tr>
<tr>
<td>6</td>
<td>A1 8.5–9.5</td>
<td>20.0–30.0</td>
<td>1.0–2.0</td>
<td>13.0–13.0</td>
<td>14.0–14.0</td>
</tr>
<tr>
<td></td>
<td>A2 9.5–9.5</td>
<td>45.0–60.0</td>
<td>2.0–6.0</td>
<td>13.0–13.0</td>
<td>14.0–17.0</td>
</tr>
<tr>
<td>7</td>
<td>A1 9.5–9.5</td>
<td>55.0–60.0</td>
<td>4.0–5.0</td>
<td>16.0–16.0</td>
<td>16.0–16.0</td>
</tr>
<tr>
<td></td>
<td>A2 9.5</td>
<td>60.0–70.0</td>
<td>5.0–6.0</td>
<td>16.0–16.0</td>
<td>16.0–16.0</td>
</tr>
</tbody>
</table>

* A1 = first baseline phase, B = intervention phase, A2 = second baseline phase.
occurred during, and was coincident with, the intervention phase. Table 6 indicates that, although there were some changes in function and mobility scores (BI and RMI), these were not coincident with change from the A1 phase to the B phase. She reported that she was now able to find medications and refreshments placed on the table in front of her or to her left, which previously she had missed.

**Discussion**

Our results indicate that both subjects who were treated using the limb activation approach and 3 of the 5 subjects who were taught scanning and cueing strategies demonstrated reduction in UVN ($P<.05$) between the baseline and intervention phases in one or more of the 3 tests. This finding allows the null hypothesis to be rejected in these cases. However, in the absence of true control (although some control was provided by the use of no-treatment baseline phases), alternative explanations to the intervention causing reduction of visual neglect (eg, spontaneous recovery) also should be considered. Two subjects showed no improvements in any of the tests for UVN and no change in sensation, stroke severity, function, or mobility relating to any change of phase. These 2 subjects had extremely low levels of arousal and were usually drowsy during both testing and treatment sessions. Unilateral visual neglect is strongly related to self-maintained arousal, and this may explain the failure of these 2 subjects to respond. Unless sustained attention can be maintained or improved (eg, by use of a “neglect alert” device), patients are unlikely to
respond to specific treatment that focuses on improving the ability to orient attention contralesionally.

**Impact on Visual Neglect**
Of the 5 subjects who did improve, all showed improvements in SCT scores between the baseline and intervention phases. In addition, 2 subjects (subjects 3 and 6) showed reduction in error on the LBT, and 2 subjects (subjects 2 and 6) had better symmetry in BTT scores between the baseline and intervention phases. Improvements found during intervention for these 5 subjects were generally maintained during the second baseline phase (Figs. 1–4 and 6–9), which suggests to us a degree of permanent change. Only 1 subject (subject 6) who was alert and well-motivated showed improvement in UVN across all 3 tests, but his LBT scores worsened following withdrawal of treatment. Differential performance within subjects for the LBT and BTT may be because these tests involve complex spatial organizational and perceptual skills, in addition to visual search ability. Such tests may have been less susceptible to the type of visual scanning and search training emphasized in our study, which may have had a greater impact on the ability of the subjects to search for and cancel targets, as demonstrated by improved SCT scores. Additional support for the selectivity of the training effect is given by the fact that stroke severity, as measured by the Canadian Neurological Scale, was relatively stable within each subject across time (Tab. 6), a finding also noted by Paolucci and colleagues.

**Possibility of Spontaneous Recovery**
One subject (subject 7) had intervention only 26 days poststroke, another subject (subject 6) showed slight improvements prior to intervention, and a third subject
subject 3) showed continued improvement in SCT and LBT scores between the intervention and second base-line phases. Thus, spontaneous recovery cannot be entirely ruled out. However, random assignment of subjects to differing baseline phase lengths should have reduced this possibility. In addition, Zoccolotti et al. established stability of visual neglect at 1 month poststroke.

Possible Mechanisms Explaining Improvement

**Scanning and cueing.** Frontal lesions are thought to involve a defect in voluntary orienting, whereas parietal lesions involve a defect in automatic orienting. Such loss of automatic orienting, but the possibility of preserved voluntary orienting ability toward contralateral space, may assist in the rehabilitation of visual neglect. The reduction in UVN shown by 3 subjects (subjects 1–3) indicates that practice and repetition of activity that directed attention to the neglected hemispace may have encouraged these subjects to use spared voluntary orienting mechanisms. Incorporation of a self-alerting procedure using visual imagery may have further encouraged leftward orienting in these 3 subjects. The 2 subjects who did not respond (subjects 4 and 5) may have had insufficient levels of alertness to enable them to effectively use this procedure.

**Limb activation.** Reduction of visual neglect by LLA has been explained by 2 theories. One theory is that such use activates the lesioned hemisphere and thus improves attentional control toward contralesional space. Left limb activation, therefore, can be seen to act as a motor stimulus that activates the right hemisphere. A second theory is that left-limb movement activates a left personal space system and that this system modifies the abnormal spatial bias toward the ipsilesional side. We believe that the limb activation approach used in this study was more functionally based than the approaches used in many previous studies, including the use of finger tapping or turning off a buzzer activated at random intervals.

Generalization of training effect to nontrained tasks. Contrary to previous findings, only 2 subjects showed changed scores (coincident with intervention) on some tests of function (subject 3 showed improvements in touch and position sense, and subject 6 showed improvements in touch and BI scores). This problem of lack of generalization to functional activity has been noted previously, suggesting that scanning and cueing training should be incorporated into functional activities where possible, thus facilitating transfer. Some improvements in BI scores and sensation may be related to treatment and may be explained either by the subject’s improved ability to pay attention to the left, due to visual scanning training, or by position sense cueing using LLA. Touch discrimination apparently may improve when the patient pays attention and, conversely, may appear more impaired when the patient is distracted. The functional outcome measures chosen may not have been sufficiently sensitive to demonstrate any small changes in function that may have been related to a reduction in visual neglect, and outcome measures addressing this problem are needed. As found previously, increased use of the left limb was observed for subjects 6 and 7 following the training phase.

Unfortunately, some subjects who showed reduced visual neglect on formal testing still demonstrated visual neglect behavior in some everyday situations, as also found by Bergego et al. For example, they were unaware of a person approaching on their neglected side. This finding illustrates the continued inability to orient automatically, even though there may be improvements in the capacity to orient voluntarily. Even if visual neglect seems resolved in classic tests, the inability to elicit a leftward response in other, perhaps noisier, situations where there may be increased attentional demands may be due to continued failure to inhibit right-sided bias for novel objects. Nevertheless, 3 subjects (subjects 2, 6, and 7) reported that they were now able to find medications and refreshments placed on their table in front of them or to their left, which previously they had missed.

Our study was not designed to compare the relative effectiveness of the 2 approaches, and there is some evidence that each approach reduced aspects of visual neglect in some subjects. It may be that a combination of the approaches would produce an additive effect in alert
and motivated patients with sufficient upper-limb function. This possibility warrants further investigation. There is no way of knowing how much, if any, practice each subject did outside of training sessions, although it is possible that those who were more alert might have undertaken more practice. This practice effect may have contributed to differential effects on outcome. In clinical practice, maximization of training could be achieved by involving other health care professionals as well as relatives or friends of the patient in the use of one or other of the treatment approaches used in our study. Although external validity of the data obtained in this study is strengthened by replication across subjects, Hersen and Barlow62 have recommended 3 replications, in addition to the original demonstration of treatment effectiveness, in order to provide sufficient evidence. In the absence of control, it is also difficult to make causal statements and to show effectiveness of a treatment.

Conclusions
Both the scanning and cueing strategy and the LLA strategy appear to have reduced visual neglect, in at least 1 of the 3 tests, in 5 of the 7 subjects in this study, although inferences of causality must be viewed cautiously due to lack of a traditional control group (although a degree of control was provided by the use of no-treatment baseline phases) and the possibility of spontaneous recovery. In addition, we studied a small number of subjects. The design of this study precludes any judgment of relative efficacy of the 2 approaches. Some subjects appeared to be able to learn to voluntarily scan and pay attention to left-sided objects, although this ability did not seem to affect their automatic deficit in orienting. The strategies used appeared most successful in the more alert subjects, who were better able to cooperate. There was minimal evidence of generalization of reduction of visual neglect to nontrained tasks. The strategies used did not require complex or expensive equipment, and they would be easy to apply in the clinical setting by therapists or trained therapist assistants. The time allocated for these activities also was clinically feasible.

References


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