Right-Hemispheric Activation Approaches to Neglect Rehabilitation Poststroke

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Key Words: cerebrovascular disorders • laterality

Unilateral neglect is a common neurological syndrome resulting from right-hemisphere strokes and has important prognostic value for functional outcome. This article identifies three approaches to neglect rehabilitation that are based on right-hemispheric activation mechanisms: (a) the lateralized task approach, (b) the controlled sensory stimulation approach, and (c) the limb activation approach. Their theoretical bases, experimental findings, and practical implications for neglect remediations are discussed. Meta-analytic procedures were used to critically review and statistically combine the results from potentially relevant studies, including 9 group design studies and 22 single-subject studies. An overall mean effect size of .77 was found for the group design studies. For the studies with individual subjects as units of analysis, an overall mean r of .89 was obtained. This review provided empirical support for intervention in cases of unilateral neglect on the basis of brain activation mechanisms. Some appropriate areas for further research include evaluating treatment efficacy against functional criteria, refining intervention procedures in keeping with the advances in brain activation research, and identifying the optimal conditions for promoting generalized training.

The purpose of this article is to review three approaches that have emerged from studies of the management of unilateral neglect on the basis of brain activation mechanisms. The review appraises the procedures used in each approach, the rationale for using each procedure, and a quantitative analysis of the therapeutic effects associated with the procedures. Finally, the issue of training generalization as a result of the intervention procedures, which is of particular relevance to occupational therapy practice, is discussed.

Unilateral neglect is a disorder clinically characterized by the inability to perceive, respond, or orient to stimuli presented to the space contralateral to a brain lesion despite the absence of primary sensory or motor deficits (Heilman, Watson, & Valenstein, 1993). Unilateral neglect is a common result of a right-hemispheric lesion (Heilman, Valenstein, & Watson, 1985), although recent studies by Ogden (1987) and Stone, Halligan, and Greenwood (1993) have indicated that unilateral neglect may occur more frequently as a result of left hemispheric lesions than previously reported. The incidence of unilateral neglect after right hemisphere stroke varies greatly, ranging from 12% (Smith, Akhtar, & Garraway, 1983) to 90% (Schenkenberg, Bradford, & Ajax, 1980). This variation may reflect the sensitivity of the tests used to diagnose unilateral neglect (Ogden, 1987) and the selection criteria for the subject cohorts (Sunderland, Wade, & Hewer, 1987). Although the majority of lesions causing neglect occur in the temporoparietal lobe (Cappa, Guariglia, Messa, Pizzamiglio, & Zoccolotti, 1991), lesions of the frontal lobe (Maeshima, Funahashi, Ogura, Itakura, & Komai, 1994), inferior parietal lobe, lateral frontal lobe, cingulate gyrus, thalamus, and striatum may also result in unilateral neglect (Heilman et al., 1993).

A variety of neuropsychological tasks and daily activities can demonstrate unilateral neglect. For example, patients with unilateral neglect often bisect lines asymmetrically, do not attend to details in drawings in the contralesional (neglected) space, neglect to dress or groom on the contralesional side, leave out words on the neglected side while reading, or notice only one side of an open book while reading (Friedland & Weinstein, 1977). Unilateral neglect has been associated with poor recovery in everyday life functioning and has been singled out as a major disruptive factor impeding rehabilitation success (Chen Sea, Henderson, & Cermak, 1993; Denes, Serrenza, Stoppa, & Lis, 1982; Friedman, 1990a, 1990b, 1991; Hartman-Maeir, 1993; Kinsella, Oliver, Ng, Packer, & Stark, 1993; Maeshima et al., 1990; Nogak, 1992; Shiel, 1989; Stone, Patel, & Greenwood, 1993; Sunderland et al., 1987; Taylor, Ashburn, & Ward,
Clinicians tend to assume that the phenomenon is transient and of little therapeutic relevance (Robertson, Halligan, & Marshall, 1993). However, recent evidence suggests that although unilateral neglect may appear resolved according to clinical tests, subde deficits of visuospatial control may be demonstrated through kinematic analysis (Chiefi, Gentilucci, Allport, Sasso, & Rizzolatti, 1993; Goodale, Milner, Jakobson, & Carey, 1990; Harvey, Milner, & Roberts, 1994; Mattingley, Phillips, & Bradshaw, 1994). For example, a rightward orientational bias may remain even after apparent recovery from stroke. This residual bias has been implicated in poor functional outcomes (Mattingley, Bradshaw, Bradshaw, & Nettleton, 1994; Robertson, Tegner, Goodrich, & Wilson, 1994; Webster, Rapport, Godlewski, & Abadee, 1994). These findings indicate that clinicians should more actively remediate unilateral neglect.

Along with the rapid proliferation of research on the underlying mechanisms of unilateral neglect (e.g., Jeannerod, 1987; Kinsbourne, 1993; Mesulam, 1985), studies that examine the effects of neglect intervention are growing (see Bohannon, 1993; Cooke, 1992; Ladavas, Menghini, & Umltira, 1994; Lin & Cermak, 1991; Robertson, 1994). The traditional approach to unilateral neglect intervention involves perceptual retraining (e.g., Gordon et al., 1985; Weinberg et al., 1977, 1979)—the teaching of scanning habits to compensate for left neglect. Another intervention approach, which is based on right-hemispheric activation mechanisms, appears to be quite promising according to a growing body of literature. This article critically analyzes the theory-based approaches used in neglect intervention that are based on brain activation mechanisms and provides a look into the future development of these approaches.

**Conventional Approach to Neglect Rehabilitation**

The conventional approach to neglect rehabilitation involves retraining, with the goal of generalization beyond the immediate training materials. Gordon et al. (1985) and Weinberg et al. (1977, 1979) used a combination of visual scanning and attentional training as well as structured practice on a number of graded visuospatial tasks that resulted in immediate improvements on these tasks in subjects with right brain damage and unilateral neglect. In other investigations of whether the effects of visual scanning and attentional training could be generalized to untrained tasks, three groups of researchers observed training effects more consistently in tasks similar to those used for treatment (Gouvier, Bua, Blanton, & Urey, 1987; Gouvier, Cottam, Webster, Beissel, & Wofford, 1984; Webster et al., 1984). Young, Collins, and Hrean (1983) found that a combination of visual scanning training and perceptual retraining with the use of a block design task reduced unilateral neglect to a greater degree than did routine occupational therapy procedures that emphasized either functional training or scanning and cancellation training alone.

On the other hand, with computerized versions of visual scanning and attentional training, Robertson, Gray, and McKenzie (1988) and Robertson, Gray, Pentland, and Waite (1990) reported inconsistent results concerning the transfer effect of saturational verbal cuing (i.e., self-directed plus clinician-directed cuing) and immediate feedback to functional measures (e.g., reading). The evidence of treatment effects on the basis of computerized training is thus inconclusive.

Results of these studies reveal that intervention effects tend to be restricted to measures that share stimulus characteristics with the training materials. This finding indicates the need for including in their retraining functionally relevant tasks that involve the everyday lives of patients with unilateral neglect.

**Toward a Theory-Based Approach to Neglect Rehabilitation**

The remediation approaches used in the studies just discussed were, implicitly or explicitly, based on principles of behavior theory and thus may not have targeted the underlying deficits of neglect. In recent years, a theory-based approach to the remediation of neglect has been called for (Cermak & Lin, 1994; Herman, 1992; Robertson et al., 1993; Seron, Deloche, & Coyette, 1989; Van Deusen, 1988). Two prevailing theories of unilateral neglect (cf., Heilman, Bowers, Valenstein, & Watson, 1987; Kinsbourne, 1987, 1993, 1994) posit that interhemispheric imbalance in orientation tendencies underlies unilateral neglect; therefore, neglect can be modified by reducing the imbalance via activation of the right brain hemisphere. Studies of neglect attenuation through activation of the right hemisphere can be grouped into three categories: (a) those that use the lateralized task approach, (b) those that use the controlled sensory stimulation approach, and (c) those that use the limb activation approach.

**Lateralized Task Approach**

The lateralized task approach involves the use of hemisphere-specific tasks to modify the interhemispheric imbalance in orienting tendencies (Caplan, 1985; Cermak, Trombly, Hauser, & Tiernan, 1991; Heilman & Watson,
1978; Hommel et al., 1990). Perceptual or cognitive tasks may be used to change the level of right-hemispheric or left-hemispheric activation.

According to Kinsbourne (1977), the attentional mechanisms of each hemisphere are activated by cognitive and perceptual tasks for which the hemisphere is preferentially responsible. For example, verbal stimuli lead to activation of the left hemisphere, thus further aggravating the imbalance, whereas spatial stimuli activate the right hemisphere, thus tending to counteract the imbalance. Experimental evidence has confirmed Kinsbourne's postulations. Helman and Watson (1978) provided subjects with unilateral neglect with two cancellation tasks: (a) a verbal cancellation task to find target words from an array of different words and (b) a visuospatial task to detect lines tilted at a certain angle from an array of slanted lines. Better performance was found on the visuospatial task relative to the verbal task. Caplan (1983), however, did not replicate this reported difference in the severity of neglect observed on verbal and visuospatial tasks. Factors that may account for the discrepancy between the two studies include stimulus complexity, heterogeneity of lesion locus, and differences in neglect severity and chronicity among the subjects.

Hommel et al. (1990) found that both musical and white noise auditory stimuli, relative to no stimulation, produced an obvious modification of neglect as measured by a drawing task. They attributed this improvement in task performance to the nonverbal stimuli activating the right hemisphere. Cermak et al. (1991) subsequently tested patients with left neglect on a line bisection task after they were given hemisphere-specific tasks. To activate the right hemisphere, the researchers used a stereognosis task with abstract shapes, a jigsaw puzzle, and classical or jazz music; to activate the left hemisphere, they used a stereognosis task with three-dimensional alphabet letters, a crossword puzzle, and reading of an article aloud. The authors found that performance on the line bisection task was not clearly related to hemisphere-specific tasks. However, the tasks used to differentially activate a single hemisphere may not have because complex conceptual or cognitive tasks typically involve activation of both hemispheres. In addition, the subjects may have used idiosyncratic strategies in responding to task demands.

Controlled Sensory Stimulation Approach

In contrast to the lateralized task approach, the controlled sensory stimulation approach does not involve perceptual or cognitive tasks. Rather, it involves the use of a technique associated with a reflexive and unconscious shift of attention and is based on research on neural systems that control orientation and attention (see LaBerge, 1995). The findings of this research suggest that spatially directed orientation and attention are controlled by a neural system that includes the brainsrem components (Butter, 1987). Thus, unilateral neglect may be attenuated by stimuli that activate the intact brainsrem components of the spatial attention system, that is, the superior colliculus on the side ipsilateral to the lesion.

In their pioneering work, Butter, Kirsch, and Reeves (1990) presented static and dynamic visual stimuli in the hemispace contralateral to the lesion side to subjects with stroke and unilateral neglect while the subjects performed a line bisection task. The rationale underlying the use of dynamic stimuli was that transient stimuli activate neurons in deeper layers of the superior colliculus. The authors found that although both dynamic and static visual stimuli reduced neglect in line bisection, use of dynamic visual stimuli improved bisection performance to a greater extent than did static visual stimulation.

More recently, Butter and Kirsch (1992) investigated the effects of patching the eye ipsilateral to the lesion alone or in combination with lateralized visual stimulation on reducing neglect in line bisection. The rationale for this procedure was that the retinal inflow to the superior colliculus arises predominantly from the contralateral eye. Thus, patching the right eye should have diminished retinal inflow to the left superior colliculus and therefore lessened the hemispheric imbalance by reducing the activation level of the left hemisphere. The authors found that patching the right eye led to improved performance on the line bisection task. Furthermore, the combined use of patching and lateralized visual stimulation resulted in significantly larger benefits than when either was used alone.

Limb Activation Approach

Interventions for reducing neglect that involve limb activation can be divided into two categories, depending on which limb was used for task performance: (a) contralateral-limb based therapy and (b) ipsilesional-limb-based therapy. The rationale of this approach was that patient-initiated action within the contralateral neglected field may activate the lesioned hemisphere that mediates intentional activation toward the contralesional field.

Contralateral-limb-based therapy. The results of studies comparing the effects of left arm versus right arm activation on manual pointing (Joanette & Brouchon, 1984; Joanette, Brouchon, Gauthier, & Samson, 1986) and on line bisection, cancellation, and reading tasks (Halligan, Manning, & Marshall, 1991; Halligan &
spatial attention is associated with the organization of a closely linked, and therefore activation of one system. The authors found that circling the digit plus finger tracing was reduced when the left paretic hand was crossed to the hemisphere associated with the use of the left hand. A severe hemiplegia, ipsilesional-limb-based therapy is an alternative. Lin, Cermak, Kinsbourne, and Trombly (in press) compared patient performance on a line bisection task under four conditions: (a) no cuing; (b) visual cuing, that is, reporting a digit placed at the left end of the line to be bisected; (c) circling the digit; and (d) circling the digit plus tracing the line with the right index finger from the left end toward its midpoint before bisection. The authors found that circling the digit plus finger tracing with the ipsilesional hand was more effective in reducing left neglect on line bisection than circling alone, followed by visual cuing alone. The therapeutic merit of digit circling and finger tracing was confirmed in a series of single-subject studies on a functional task that involved text reading (Lin, 1994). The effect of activating the ipsilesional limb (such as the digit circling procedure) on reducing left neglect during a line bisection task was previously reported by Roeltgen, Roeltgen, and Heilman (1989) and Mattingley, Pierson, Bradshaw, Phillips, and Bradshaw (1993). Mattingley et al. observed attenuation of left neglect on line bisection when subjects were asked to mark the left end of the line before bisection. Furthermore, the effect of marking with the right hand existed even when the subject was asked to make an invisible mark. This finding supports the notion that the motor act of marking improved task performance.

The findings of ipsilesional-limb-based therapy studies are consistent with the prediction of the activation of intentional mechanisms (Heilman & Valenstein, 1979; Kinsbourne, 1970). Heilman, Bowers, and Watson (1984) proposed that intentional mechanisms are invoked when directing a particular hand into the contralateral field; that is, the left hemisphere intends the left hand to the right of the midline, and the right hemisphere intends the right hand to the left of the midline. Because each hemisphere may be important for mediating intentional activation within and toward the contralateral field (independent of the limb used) (Heilman et al., 1984), the movement of the right hand toward the contralaterally located target activates the right hemisphere, which in turn leads to an orienting shift toward the left. Recent evidence (Jäncke, 1993) supports the view that a right-arm movement leftward involves activation of the right hemisphere.

In addition to shedding light on how left-hand use within the right hemisphere does not effectively reduce neglect (Halligan et al., 1993), the intentional theory (Heilman et al., 1984) also explains the seemingly puzzling interaction between the hand deployed and the position of the hand in space. According to intentional theory, left-hand use toward the ipsilesional side activates the left hemisphere, thereby canceling out the advantage of left-hand use in the contralateral field.

Assumptions Underlying the Remedial Procedures

Taken together, these three hemispheric activation approaches are, implicitly or explicitly, based on the theoretical position that left neglect is due to imbalance of the activational level of the two hemispheres after an insult to the right hemisphere. Postulated theories suggest that the imbalance may be reduced by providing lateralized stimulation via the lateralized task approach and via the controlled sensory stimulation approach. Alternatively, the imbalance may be reduced by directing mo-
Although the former intervention may activate the frontal regions and frontal eye fields seem to be particularly important for spatial attention (Robinson & Petersen, 1986), tasks that reliably activate these regions may be used to reduce neglect.

Brain imaging techniques such as positron emission tomography (PET) contribute to the identification of brain activation patterns caused by different tasks (see Deutsch, Bourbon, Papanicolaou, & Eisenberg, 1988; Gur et al., 1994; Roland, 1993; Weder et al., 1994). PET can provide the basis for innovative rehabilitation on the basis of brain activation mechanisms. For example, PET identified that the superior parietal region was activated when stimuli at peripheral locations were attended to (with the use of cognitive and sensory cues), even without the subject executing an overt response (Corbetta, Miezin, Shulman, & Petersen, 1993). PET identified that the frontal region, however, was activated only when overt responses were made to stimuli at peripheral locations (Corbetta et al., 1993). The practical implication of this information seems to be that cuing procedures that require a motor response to a visual cue (e.g., circling a letter on the left side of a line to be bisected) might be more effective in reducing unilateral neglect than visual cuing (e.g., reporting a left-sided letter) alone. Although the former intervention may activate the frontal regions as well as the parietal regions, the latter may recruit only the superior parietal region. Consistent with this prediction, Lin et al. (in press) found that circling a digit placed to the left of a line before bisection was more effective in reducing unilateral neglect than merely reporting the digit. Given the major advances in neuroimaging activation studies, the development of intervention strategies on the basis of the discussed theories is a challenging task for occupational therapists.

Efficacy of the Hemispheric Activation Approaches: A Quantitative Analysis

Establishing efficacy of these three remedial approaches is important. To better understand the extent to which these approaches reduce left neglect, I calculated effect size estimates for each study that reported sufficient data. Effect size measures that are free of sample size influence can play a vital role in determining the extent to which a treatment exerts an effect on a population (Ottenbacher, 1982). The effect size was used to indicate the degree to which the null hypothesis was false (Cohen, 1988). Friedman (1968) has presented formulas for computing the effect sizes on the basis of traditional inferential statistics. According to Cohen, a large effect is represented by an r of at least .50, a moderate effect by an r of .30, and a small effect by an r of .10.

Among the 13 investigations analyzed, 6 used a group design, and 7 studied individual subjects, which included 3 reports consisting of 10 single-case studies and 4 consisting of 12 repeated-measures experiments, with one subject per experiment (see Table 1). All the effect size estimates were positive, suggesting that the intervention used reduced left neglect (see Table 1).

I then used the meta-analytic procedures suggested by Rosenthal (1991) to statistically combine the results of the investigations. To reduce dependency of data, effect sizes within each study that tested more than one hypothesis were averaged. In group design research involving multiple studies (Butter & Kirsch, 1992; Mattingley et al., 1993), each study was treated as one unit of analysis. For reports presenting multiple single-subject studies (Cermak et al., 1991; Lin, 1994; Robertson et al., 1992), each subject was considered an independent unit of analysis. For research involving analysis of individual subjects by use of a repeated-measures design (Halligan et al., 1991; Robertson & North, 1992, 1993, 1994), each subject was treated as a unit of analysis.

Meta-analyses were performed separately for group design studies and for individual subject studies because of the differential units of analysis for each design. An unweighted mean r of .77 found for group design studies indicated an increase in improvement rate (see Rosenthal, 1991) from 11.5% for the control condition to 88.5% for the experimental condition. For single-subject design studies, an unweighted overall mean r of .89 was obtained, suggesting impressive improvements associated with the interventions.

A scrutiny of the dependent variables revealed two types of outcome measures: (a) neuropsychological tests of unilateral neglect and (b) tests of functional skills related to activities of daily living (see Table 2). Examples of
Table 1
Studies Investigating the Effects of Intervention on the Basis of Hemispheric Activation Mechanisms on Left Neglect

<table>
<thead>
<tr>
<th>Approaches and Studies</th>
<th>Dependent Variable</th>
<th>Control Condition</th>
<th>Experimental or Training Condition</th>
<th>Effect Size (z)</th>
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<tbody>
<tr>
<td><strong>Lateralized task</strong></td>
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<tr>
<td>Cermak et al. (1991)</td>
<td>Line bisection</td>
<td>No stimulation</td>
<td>Right-hemispheric tasks</td>
<td>.13</td>
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<tr>
<td>Subject 1</td>
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<td>Subject 2</td>
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<td>Subject 3</td>
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<tr>
<td>Heilman &amp; Watson (1978)</td>
<td>Copy of drawings^</td>
<td>No stimulation^</td>
<td>Visuospatial task</td>
<td>.65</td>
</tr>
<tr>
<td>Hoerr et al. (1990)</td>
<td>Cancellation task</td>
<td>Verbal task</td>
<td>Musical stimulation</td>
<td>.80</td>
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<tr>
<td>Butter et al. (1990)</td>
<td>Line bisection</td>
<td>No stimulation^</td>
<td>Tactile stimulation of the left cheek</td>
<td>.77</td>
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<tr>
<td>Experiment 1</td>
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<td>.88</td>
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<td>Experiment 2</td>
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<td>Experiment 2a (n = 1)</td>
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<td>Experiment 2b (n = 1)</td>
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<tr>
<td>Lin et al. (1994)</td>
<td>Line bisection</td>
<td>Right-hand use</td>
<td>Left-hand use</td>
<td>.57</td>
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<tr>
<td>Lim activation approach</td>
<td>Line bisection</td>
<td>Right-hand use</td>
<td>Left-hand use</td>
<td>.88</td>
</tr>
<tr>
<td>Halligan et al. (1991)</td>
<td>Line bisection</td>
<td>Right-hand use</td>
<td>Left-hand use</td>
<td>.84</td>
</tr>
<tr>
<td>Experiment 1 (n = 1)</td>
<td>Line bisection</td>
<td>Right-hand, right side</td>
<td>Right-hand, left side</td>
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<tr>
<td>Experiment 2a (n = 1)</td>
<td>Line bisection</td>
<td>Right-hand, right side</td>
<td>Right-hand, left side</td>
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<td>Experiment 2b (n = 1)</td>
<td>Line bisection</td>
<td>Right-hand, right side</td>
<td>Right-hand, left side</td>
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<tr>
<td>Lin et al. (1994)</td>
<td>Line bisection</td>
<td>Right hand, right side</td>
<td>Right hand, leftward move for circling a digit placed to the left of the line before bisection</td>
<td>.87</td>
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<tr>
<td>Test reading</td>
<td>Right hand, right side</td>
<td>Right hand, leftward move for circling a digit placed to the left of each line of text plus finger tracing from the leftmost character toward the right during reading</td>
<td>.97</td>
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<tr>
<td>Lin (1994)</td>
<td>Line bisection</td>
<td>Right hand, right side</td>
<td>Right hand, leftward move for making a visible mark as the left end of the line before bisection</td>
<td>.95</td>
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<td>Subject 1</td>
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<td>Subject 2</td>
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<td>Subject 4</td>
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<td>Subject 5</td>
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<tr>
<td>Martingley et al. (1993)</td>
<td>Line bisection</td>
<td>Right hand, right side</td>
<td>Left-arm activation with the Neglect Alert Device</td>
<td>.68</td>
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<tr>
<td>Experiment 1</td>
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<td>Experiment 2</td>
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<tr>
<td>Robertson et al. (1992)</td>
<td>Star cancellation</td>
<td>No training^</td>
<td>Left-arm activation with the Neglect Alert Device</td>
<td>.77</td>
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<tr>
<td>Subject 2</td>
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<td>.25</td>
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<tr>
<td>Star cancellation</td>
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<td>.83</td>
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<tr>
<td>Star cancellation by touch</td>
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<td>Star cancellation by touch</td>
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<td>Star cancellation</td>
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<td>Star cancellation by touch</td>
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<td>Star cancellation by touch</td>
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<td>Left orientation</td>
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(Table 1 continues)
measurements used for the former category included performance on line bisection, letter or star cancellation, copy of drawings, and so forth. Only two single-subject studies included functional tests: Lin (1994) measured performance on text reading, and Robertson et al. (1992) used mobility ratings. Impressive effects were obtained in the six single-subject studies that used functional outcome measures. It is interesting to note that studies that involved limb activation yielded a larger effect size than those that involved lateralized tasks or controlled sensory stimulation.

In summary, the results of this meta-analysis supported the use of the intervention procedures for neglect remediation. Similar meta-analytic reviews are needed to investigate substantive or methodological factors that may influence the treatment effects. For the clinician, these potential moderating factors (e.g., patient characteristics such as neglect severity and chronicity) may be important for selecting the optimal strategy for a particular patient with unilateral neglect.

**Generalization of Neglect Remediation**

Not surprisingly, a critical area of concern that is commonly encountered in neurorehabilitation is the generalizability of therapeutic gains. In the remedial approach to the treatment of perceptual deficits, generalization of learning is a process that is generally assumed to occur automatically (Katz, 1994; Neistadt, 1988). In contrast, an adaptive, functional treatment approach emphasizes repetitive practice with specific functional activities rather than the transfer of learning to a variety of contexts (Davis & Radomski, 1989). Among the treatment studies reviewed, only Lin's (1994) work discussed the issue of generalization. In the single-case studies, desired changes in the outcome measures (i.e., line bisection, text reading) occurred only during the treatment phase, suggesting that therapeutic gains on one task (e.g., line bisection) did not generalize to the other task (e.g., text reading) without direct intervention. This lack of automatic generalization across tasks is consistent with other findings (e.g., Fantome, Lincoln, Drummond, Walker & Edmans, 1995; Gouvier et al., 1987; Lennon, 1994; Rossi et al., 1990; Wagenaar, van Wieringen, Netelenbos, Meijer & Kuik, 1992) but in disagreement with Robertson and Cashman's (1991) findings. In their case study of auditory feedback for treatment, Robertson and Cashman claimed generalization of improvements in neglect-related walking difficulties to everyday life and reported that transfer of the treatment effect was based on clinical impressions and was not carefully measured. It may be unwarranted, therefore, to expect that remedial training of unilateral neglect on highly structured neuropsychological tasks in a laboratory context would lead to an automatic improvement on untrained functional tasks in a natural context.
Toglia (1991a) has stressed that transfer is part of learning and should be required during treatment rather than at the end of treatment; that is, generalization is not a passive phenomenon that happens through mere expectations but should be facilitated through effective learning. Many patients with stroke show a generalized reduction of all learning modalities (Delisa, Miller, Melnick, & Mikulic, 1982) and do not necessarily relate each learning experience to previously learned material (Halperin & Cohen, 1971). Learning in different contexts, as advocated by Toglia (1991a, 1991b), seems particularly relevant to remediation of neglect.

In a similar vein, Diller and Riley (1993) advocated for a combination of what they called the “depth and the breadth training” (p. 297) approach to achieve the best possible outcome for neglect management. Depth training emphasizes overlearning, whereas breadth training emphasizes generalization. Diller and Riley proposed that adopting depth training in the early stages of recovery may establish the patient’s responsiveness to cuing through the use of repetitive and highly structured tasks. In the later stages of recovery, it may be more important to diversify the treatment tasks and the functional context (see also Webb, 1991). This perspective provides useful guidelines for restoring environment-relevant skills through progression from practicing component skills to applying learned strategies to functional tasks. For example, early in treatment, the patient may practice bisecting horizontal lines of varying lengths under visuomotor cuing (i.e., contralesionally directed movements of the right hand plus tactually guided scanning of visual stimuli) in a highly structured context (e.g., a quiet test room). This practice provides the opportunity to continue skill acquisition to the point of overlearning, that is, converting the visuomotor strategy into habits. In the breadth training condition, the patient should gradually be required to apply this generic skill (i.e., visuomotor strategy) to other tasks and environments (e.g., reading food items on a hospital menu, counting persons in a picture, identifying a row of items on a store shelf). The spatial environment in which the treatment occurs may vary according to the functional needs of the patient. With less uniform stimuli and task and environmental diversity, a wider degree of transfer and maintenance of skills over time may be sought (Diller & Riley, 1993). Toglia (1991a, 1991b) and Diller and Riley’s proposals should stimulate more research on the optimal conditions for promoting generalization of neglect treatment.

A factor that may be crucial to transferring learned skills effectively from paper-and-pencil tasks to daily functional tasks is the degree of awareness of disabilities (Prigatano & Schacter, 1991). Decreased awareness or even denial of the disability may hinder engagement and responsiveness to neglect treatment (Diller & Riley, 1993). The fact that motivational and emotional factors may interact with neurological parameters in ways that could detract from cognitive remedial efforts underscores the need to include procedures that foster awareness of deficits in a neglect remediation program.

Recommendations for Future Research

This review highlighted three recently developed approaches for neglect therapy on the basis of scientific theories and documented the effects of various interventions. Taken in its entirety, this body of research suggests that unilateral neglect is amenable to modification via derivation of the right hemisphere. Despite the major advances, numerous issues still need to be addressed. First, the therapeutic merit of the intervention procedures that use functional outcome measures needs to be documented. For example, it may be beneficial to ascertain the effect of leftward motor actions on personal hygiene and other self-care activities. Directing the right hand leftward to tactually explore the hemiplegic, neglected left...
limbs or body surface may be a useful way to overcome body neglect. The need for including functional tasks that involve the everyday lives of patients with neglect in their retraining is especially true when the goal of intervention is to improve daily functioning. From a rehabilitation point of view, it is insufficient to teach such patients to improve performance on psychometric tests; improvement of functional skills for application in natural contexts would be in the best interests of the patient.

Second, a related issue that warrants consideration is the setting in which treatment is provided. The remedial strategies tested in the reviewed studies reflect much of the empirical rigor commensurate with laboratory measurement. To establish their ecological validity, these laboratory-based procedures may need to be modified to enhance their applicability in a noninstitutional setting, such as home and community, which involve the support of family members and friends.

Third, given the paucity of evidence that claims that neglect therapy has lasting positive effects on trained and untrained tasks (Halligan, Donegan, & Marshall, 1992), it would seem worthwhile to attempt the concurrent use of the therapeutic rigor maneuvers such as visuomotor cuing (Lin, 1994), eye patching (Butter & Kirsch, 1992), laterализed visual stimulation (Butter et al., 1990), and nonverbal musical stimulation (Hommel et al., 1990). Research should determine whether combinations of the maneuvers, and on what tasks, would lead to a greater or longer-lasting improvement of neglect than single maneuvers. In addition, patients with unilateral neglect may vary idiosyncratically in their responsiveness to different treatments. Further research is needed to unveil how intervention strategies may vary in effectiveness according to the type (e.g., Bisiach, Geminiani, Berti, & Rusconi, 1990; Liu, Bolton, Price, & Weintraub, 1992; Mesulam, 1994; Zoccolotti & Judica, 1991), severity, and chronicity of unilateral neglect.

Finally, use of brain imaging techniques refines remedial procedures that make the use of task-specific brain activation possible. For example, research of regional cerebral blood flow measures during task performance may lead to identifications of the tasks that reliably activate the right hemisphere or a particular region of that hemisphere. Neglect rehabilitation that involves these procedures has the advantage of being linked to a theoretical model. Results of efficacy research on the basis of such procedures would provide feedback to the conceptual framework that guides their development and may lead to more effective management of unilateral neglect.

Acknowledgment
I thank Ching-yi Wu, MS, OTR, of the Occupational Therapy Department, Boston University, for her involvement in the meta-analysis.

References


