Rehabilitation Approaches to Hemineglect

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Background: Hemineglect is a difficult neurologic condition to rehabilitate. It arises predominantly from right brain injury, and manifests heterogeneously in clinical deficits such as poor visual exploration to the left, inaccurate assessment of the midpoint of a line, left limb hypokinesis, and anosognosia. Most of the cognitive dysfunction produced by hemineglect is because of an asymmetric distribution of attention, either with respect to extrapersonal space or to an object being viewed. Many treatments draw on hemineglect theory to attempt to mediate the basic asymmetry of attention.
Review Summary: Treatment approaches can be divided into 2 main categories. Extrinsic or "top-down" approaches require active participation of the patient under the guidance of a therapist. The most common approach of this type is visual scanning therapy in which the patient is continually instructed to move the gaze leftward into the neglected space. Intrinsic or "bottom-up" approaches manipulate stimulus characteristics, sensory input, or the brain directly in an attempt to alter the interhemispheral attentional imbalance. Examples of this approach include vestibular stimulation of the left side, sensory activation of the left limb, and transcranial magnetic stimulation of the overactive left hemisphere. Combined approaches such as prism adaptation have also shown good results.
Conclusions: Hemineglect is a complicated disorder that poses challenges to treatment. A paucity of clinical trial evidence limits our ability to extrapolate experimental mediation of hemineglect to globally improved functioning. Nonetheless, many treatment approaches appear promising. Underlying neuroscience may help guide future treatment approaches.

Key Words: hemineglect, rehabilitation, hemi-inattention, visual scanning therapy, prism adaptation

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Hemineglect is a heterogeneous syndrome that can produce major disability in patients who acquire the disorder from brain injury such as stroke. Its presence is vexing for rehabilitation specialists, as the elements of the syndrome often prevent full participation in therapy. Amelioration of hemineglect is crucial not only to reduce the basic visual-spatial dysfunction, but also to maximize engagement in other aspects of therapy such as motor recovery, gait training, and general functional recovery.[1–3] This review surveys the major treatment approaches to hemineglect, which have been tested over the last 50 years. Both rationally designed treatments based on underlying theories of neglect and purely empirical approaches will be discussed. Proof of efficacy has been difficult because few well-designed randomized clinical trials have been completed, but there is compelling evidence that several approaches to hemineglect treatment are useful.

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CLINICAL AND THEORETICAL ASPECTS OF HEMINEGLECT

The reported incidence of hemineglect in stroke patients is approximately 23%, ranging from 8% to 81%, depending on definitions, patient selection, and assessment tools.[4,5] Neglect is much more common in right brain injury than left[6]; right hemispheral predominance is most likely because of specialized functions of the right hemisphere as opposed to an inability to measure hemineglect due to aphasia produced by left hemisphere injury.

The underlying deficit in hemineglect is inattention to 1 hemispace. Clinically, one can identify a variety of deficits which may occur in isolation or in combination, but all arise from the basic asymmetry in attentional field. Hemineglect may manifest as "egocentric" (viewer-centered reference frame) or "allocentric" (object-centered reference frame). Examples of egocentric manifestations include unilateral extinction to double simultaneous sensory stimulation, thought to occur as the result of the inability of the left stimulus to compete for salience when the attention to the right hemispace contains an equivalent stimulus.[7] Asymmetric orienting response similarly occurs when a patient orients his or her gaze to the non-neglected field when stimuli are presented to both sides.[8] This obligatory shift in orientation may be because of both reduced attention to the neglected side as well as to an inability to disengage from stimuli in the non-neglected field.[9] Asymmetric drawing or copying and right-shifted marking of the midpoint on a line bisection test are examples of allocentric neglect. In such a deficit, the object is perceived asymmetrically regardless of its location in egocentric space. Another way of classifying the different deficits is by "sensory/perceptual" neglect versus "motor/exploratory" neglect.[10] Most manifestations of egocentric neglect are motor/exploratory, and those with an allocentric base are generally sensory. The terms "intentional" and "attentional," respectively have been applied to this dichotomy as well.[11,12] Unilateral limb hypokinesia is a demonstration of motor neglect that affects peripersonal space or body perception.[13,14] Asomatognosia is an another example of this type of distorted hemi-inattention of self.[15] For most patients the hemineglect syndrome clusters its individual deficits according to the basic divisions described here. Any single element or combination, however, may be seen in a given patient.

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In addition to the elements clearly caused by some sort of hemi-inattention, there are often additional, more global deficits of cognitive function that accompany hemineglect to make the treatment additionally challenging. Anosognosia is seen in hemineglect patients in up to 20% to 58% of cases.[16,17] A lack of self-monitoring because of the unawareness of the deficit makes cooperative, mindful work with a therapist difficult. Other higher order cognitive dysfunction also may occur from right brain injury. Personality change can range from apathy to disinhibition to agitation.[18] Emo-

tional dysregulation is common, often appearing in the setting of the impaired self-monitoring.[19] Inability to multitask has also been recently reported.[20] Finally, although patients' perception may be abnormal, and it can be pointed out to them (eg, this arm that you claim is not yours can be traced back to your body), they are often unable to reconcile logic of the situation with abnormal perceptions. One patient, for example, reported that his hospital room was the "only one to have telephones with 2 columns of numbers." On a line bisection task, a hemineglect patient may be trained to move the gaze leftward to identify a cue at the left extent of a line, confirming that the whole line is in view, and yet, that patient may still bisect the line to the right of midpoint as the gaze tracks rightward.[21,22] Furthermore, abnormal use information about stimuli depending on its context has been demonstrated.[23] Line bisection behavior on a given length line was shown to be altered by the introduction of different length lines—the perceived midpoint shifting leftward on that line when longer lines were mixed in the set and the perceived midpoint shifting rightward when shorter lines were mixed in. This "context effect" seems to be unique to right brain injury.

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Another demonstration of the dissociation between perception and logic was reported by Ramachandran et al.[24] Twelve patients with left hemineglect caused by right hemisphere stroke were approached at the bedside on their right side with a mirror. All patients were able to identify the object as a mirror. The investigator stood behind the mirror, holding it. A second investigator, standing on the patient's left side, held out a pen or a candy close enough that the patient would be able to reach it with the nonparetic right hand, but so that it could be seen in the mirror. When the patient affirmed that the object was seen, he or she was asked to reach out and grab it. A substantial subset of patients, despite acknowledging the presence of the mirror, repeatedly reached for the object's reflection on the right, even going so far as to say, "it's behind the mirror." Thus right brain injury results in more that just a hemi-inattention. The layering on of other cognitive deficits adds complexity to the syndrome, producing additional challenges to devising effective treatments.

The taxonomy of treatment approaches is based on the phenomenology and underlying theories of hemineglect. Brain (1941),[25] Denny-Brown et al (1954),[26] and Critchley (1950)[27] promoted the role of the parietal lobes in integrating and synthesizing sensory information. Bisiach et al (1983)[28] theorized the deficit as an abnormal internal representation, suggesting that hemineglect patients had a defect in transforming retinotopic to cephalocentric to corpocentric reference frames. Kinsbourne (1977)[29] and later Heilman and Van den Abell (1980),[30] Chatterjee (1995),[31] and Anderson (1996),[32] held that hemineglect was explained by an asymmetric orientation in extrapersonal space. The thought was that gaze and attention were asymmetrically represented, with the right hemisphere directing attention both contralaterally and ipislaterally, and the left hemisphere directing attention contralaterally only. Thus, with a left brain injury attention could still be directed to the right with the right hemisphere, but with right brain injury the left side of space could not be accessed ipsilaterally with the intact left hemisphere. Others have stressed the importance of poor general attentional arousal that occurs with right brain injury as an important component of the neglect syndrome.[33] Clinically, global inattention often appears as part of the syndrome and establishes itself as the most significant limitation on intervention. The dopaminergic system mediates general attention,[34] and its receptors seem to be asymmetrically lateralized to the right hemisphere.[35]

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As most clinical observations and psychophysic studies support the idea of asymmetric attention being the most important underlying deficit in hemineglect, the physiologic basis for hemispheral asymmetry has been elusive. In a functional imaging study by Corbetta et al, 11 patients with right ventral frontal brain injury and left hemineglect underwent imaging in the acute, impaired phase and upon recovery.[36] In-scanner performance of a directional cued target detection task resulted in an abnormal balance of activity in fronto-parietal regions remote from the lesions. Relative hyperactivity in the left superior parietal lobule compared with homologous regions in the right hemisphere correlated with missed targets and slowness of response in left visual space. As neglect spontaneously improved in these patients, a more normal balance of activity in both the dorsal and ventral regions was observed.

Beyond the notion of hemisphereal asymmetry, intrahemispheric anatomic specificity has also been shown to apply to subtypes of hemineglect, with perceptual deficits correlating with posterior parietal injury and motor deficits correlating more with frontal lesions.[10,37,38] In 1 study, Binder et al[10] divided 35 patients with right brain injury into 2 behavioral categories, those who had markedly asymmetric performance on a target cancellation test but performed in the normal range on a line bisection task, and those who had an abnormal line bisection test and were relatively normal on the cancellation task. When the lesions of those with cancellation abnormality only were overlapped on an anatomic template and the lesions of those who did not fit in that category were subtracted from the overlap, the resulting lesion location was frontal opercular, anterior insular, and basal ganglia. When the group with line bisection abnormalities was assessed in the same way, the temporo-parietal-occipital junction was identified as relevant.

CATEGORIZATION OF TREATMENT APPROACHES

Proposed approaches to treat hemineglect have been available for more than 50 years. The treatment types can be divided into basic categories, each of which will be discussed in this review. One approach can be classified as extrinsic or "top-down," meaning that external cues and guidance are employed predominantly to engage the conscious and purposeful involvement of the patient. These treatments rely heavily on the participation of a therapist who provides continuous feedback, encouragement, and training. Cooperation and conscious effort on the part of the patient is required for success. Treatments that follow such an approach include visual scanning training (VST),[39–46] sustained attention training,[47,48] and mental imagery training.[49–51] A second approach to treatment attempts to affect the attentional system at a preconscious level by manipulating endogenous components of the neural axis, mostly sensory input. This approach follows the idea that a disordered perceptual and attentional system can be corrected without the

TABLE 1. Classification of Treatment Approaches

Treatment Approach	Examples of Therapy	References
Extrinsic of "top-down"	Visual scanning training (VST)	21,38–45
	Sustained attention training (SAT)	46,47
	Mental imagery training (MIT)	48–50
Intrinsic or "bottom-up"	Prism glasses	51
	Phasic alerting	84
	Trunk rotation	43,52,53
	Eye patching	54–56
	Limb activation	21,47,57–59,107–109
	Optokinetic/caloric stimulation	64,65,89–93
	Transcutaneous electrical stimulation	87,88
	Neck muscle vibration	60–63,94
	Direct brain stimulation (rTMS)	80–82
Combined	Prism adaptation	66–75,96,97
	Stimulation plus VST	63,110

conscious participation of the patient, and thus have been termed "intrinsic," or bottom-up, treatments. Such treatments may manipulate visual-spatial input such as with prism glasses,[52] trunk rotation,[44,53,54] or eye patching.[55–57] Others alter the somatosensory system such as with limb activation,[22,58–60] neck muscle vibration,[61–64] and optokinetic stimulation.[65,66] A combination of top-down and bottom-up approaches has also been used, exemplified by the prism adaptation approach,[67–76] which will be discussed in more detail below. A final treatment approach attempts to alter brain function directly, either with pharmacologic agents[77–80] or with brain stimulation using repetitive trancranial magnetic stimulation (rTMS).[81–83] A Table 1 of treatment approach classification is provided below. Individual treatments warrant particular attention.

Extrinsic or Top-Down Treatments

VST is the most popular and widely used treatment for hemineglect. Part of its appeal is the obvious relationship between an observable deficit—inability to find and identify objects in the neglected hemispace and the intervention—active directions to search the left hemispace. Family members and caretakers can easily grasp the concept and are able to assist in the effort. This approach can be done with no special equipment or setting, working on the principle that a preserved verbal language system in the intact left hemisphere can be engaged to mediate the visual-spatial deficits created by the injured right hemisphere. At its most basic, the technique involves a therapist sitting to the patient's neglected side to issue instructions urging scanning of the eyes leftward throughout training. As with most extrinsic therapy, the program is methodical and progressive. In a reading exercises, for example, an anchoring cue such as a red line is placed on the left side of the page, and the patient is asked to look at the cue before beginning the text reading.[22] The text advances from simple to complex, with repeated scanning instructions and visual cues used throughout. Mental imagery is often employed, such as the instructions: "Imagine you are a lighthouse like the one you see in this picture. Let your eyes sweep the environment like a lighthouse beam from right to left (Fig. 1)." Patients are encouraged to self-direct the imagery, verbally repeating the lighthouse strategy during the course of therapy. The lighthouse strategy was tested formally by Niemeier et al.[51] Sixteen patients with left hemineglect from right brain stroke were given the lighthouse strategy over the course of therapy and compared with

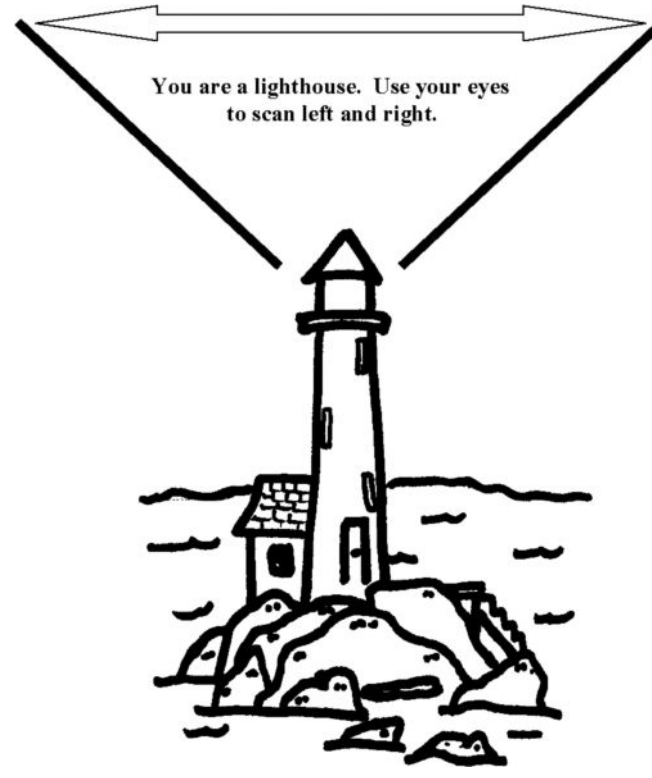

FIGURE 1. Lighthouse strategy of mental imagery for use with visual scanning therapy.

identical patients who were not given this training. The investigators showed that the patients trained with lighthouse strategy were significantly better on the Mesulam target cancellation test as well as on the attention item on the Functional Autonomy Rating Scale ($P < 0.007$ on repeated measures ANOVA). Another study combined VSTwith trunk rotation.[44] In this study by Wiart et al, 22 hemineglect patients were subject to either traditional physical and occupational training or VST with "trunk rotation." For the trunk rotation, patients wore a harness with a pointer attached to an arm that extended from the back up over the head and down to a point just above the visual horizontal meridian. Patients in the experimental group were instructed in a scanning strategy to bring both the eyes (retinocentric frame) and the pointer (body-centric frame) to the left in search of objects to the left of midline. Compared with controls, patients receiving the visual scanning and trunk rotation improved on 3 neglects tests and the Functional Independence Measure (FIM), and these results seemed to persist after completing the 1 month of training (Fig 1., lighthouse).

VST is the most popular and widely used treatment for hemineglect.

Intrinsic or Bottom-Up Approaches

Unlike the top-down approaches, bottom-up strategies take advantage of the brain's automatic responses to stimuli. The appeal

of this approach is that it is not therapist-dependent, and can be set up in a standardized way in a variety of settings—as home therapy or in the rehabilitation clinic.

Treatments of General Arousal

Dopamine agonists have been shown to ameliorate rightward bias on letter cancellation and line bisection tests in small case series,[77,79,80] but evidence exists on the other side that dopamine agonists may worsen exploratory bias in hemineglect,[84] possibly because the increased dopamine activates the undamaged hemisphere and increases the exploratory bias from the intact hemisphere.[78]

Behavioral methods have also been used to mediate the general arousal deficit of hemineglect. In a study of "phasic alerting," Robertson et al[85] studied 8 patients with left hemineglect who were asked to judge whether a visual stimulus on the left preceded or followed a stimulus on the right. On average, perception of left stimuli occurred 500 milliseconds after stimuli on the right. This delayed perception was lessened significantly by presenting an auditory warning in the form of a 300-millisecond tone-burst. On trials in which the warning occurred, each patient reduced the rightward bias. The effect occurred regardless of whether the auditory stimulus was presented to the left or right, thus demonstrating that increasing general alertness can ameliorate a lateralizing visuospatial bias.

Another interesting study was conducted with 7 stroke patients engaged in a car racing computer game requiring increasing alertness to avoid obstacles.[86] The investigators showed that patients improved on several alertness measures and neglect tests, but the performance reverted to pretreatment levels by 4 weeks post-treatment. Interestingly, there was an fMRI correlate which, showed increased activity in the right angular gyrus, bilateral anterior cingulate cortex, and precuneus, but which also faded along with reversion of performance at the later time.

Sensory Activation

Based on the theory that hemineglect is a state of asymmetric sensory and motor attention, many treatment strategies have focused on increasing the sensory input to the contralesional left body in an attempt to give the damaged right hemisphere additional activation.[48,58–60] Wilson et al, for example, showed improvements on a self-care program and a picture scanning task in 2 patients tested before and after a limb activation treatment.[48] The technique works simply by asking the patient to move the left limb (upper preferred) during the performance of other tasks. Although the technique has theoretical merit if personal body representation does indeed share a neural network with peripersonal space,[87] this approach may have limitations for severely paretic patients. Further, movement of the nonparetic right hand could work against the desired activation of the right hemisphere by activating the left preferentially. More deliberate activation of left body sensory input has been tested in the form of neck muscle vibration with transcutaneous electrical stimulation,[88,89] or the induction of left nystagmus with optokinetic stimulation[90–92] or caloric stimulation.[93,94] In 1 experiment, Karnath et al showed that a visual search pattern could be shifted leftward by cold water irrigation of the left ear or left sided neck muscle vibration.[95] Either stimulation seemed to have the effect of shifting egocentric reference frame leftward such that left hemineglect patients acquired the search pattern of normal controls, and control subjects had a leftward search bias induced so that they appeared to have right hemineglect. Such techniques have been shown to alter performance on neglect tasks, but seem to have limited persistence beyond the therapy session, and do not seem to generalize to improved performance on activities of daily living.

Direct Brain Stimulation

After hemispheral activity imbalance theory, techniques have been devised to alter the balance of activity in the 2 hemispheres directly. rTMS has been used over the left parietal lobe to try to deactivate that hemisphere and bring the attentional bias into balance. In 1 experiment by Oliveri et al, rTMS administered over the unaffected (left) parietal cortex reduced the line bisection abnormality during the testing session, but the results did not persist.[81] Other rTMS studies have found similar results.[82,83]

Visual Remapping

It has been known for more than a century that prism lenses can remap visual space onto the retina to result in a systematic shift of retiontopic coordinates. Fresnel lenses have been used with some success to create a shift of objects that appear further to the right than they actually are, thus shifting retinotopic space onto new coordinates of body-centered space. This technique improved performance in a group of hemineglect patients who wore the lenses for 4 weeks during therapy and also during testing before and after the treatment.[52] Eye patching of the right eye has also been attempted to alter the visual perceptual input in an attempt to shift attentional bias. This approach is based on the rationale that each superior colliculus receives input from the contralateral hemifield of each eye, but predominantly from the contralateral eye.[96] In 1 study of 22 stroke patients comparing the eye-patching technique with the wearing of glasses that blocked the right hemifield in each eye, both groups improved on 3 tests of neglect,[57] but it is uncertain whether this approach can result in improved function of activities of daily living.

Combined Top-Down and Bottom-Up Approaches

One promising method that combines therapist driven extrinisic and sensory-motor transformation intrinsic systems is prism adaptation. This interesting approach, introduced by Rosetti et al in 1998,[76] takes advantage of the well-known short-term adaptation that takes place when subjects are exposed to prism lenses that produce a shift of the visual field. In this study, 8 patients with left hemineglect and 6 controls were asked to make 10 straight ahead pointing movements while blindfolded. Hemineglect patients pointed to the right of true midline. Patients and controls were then fitted with base-left prism glasses that shifted their visual fields 10 degrees to the right. During the adaptation period they were asked to make 50 pointing movements at objects presented 10 degrees to the left or right of the body midline. The training occurred as the hand of the subject appeared in the second half of the pointing movement, and a leftward correction was made, under the guidance and instructions of the investigator/therapist. Following this 2- to 5-minute training period, the prism goggles were removed and the subjects again pointed straight ahead while blindfolded. The resulting adaptation training produced a leftward shift on the subjective midpoint, correcting the rightward bias of the hemineglect patients to normal, and shifting the normal midpoint to the left in controls (see Fig. 2). In a separate experiment, 3 tests of hemineglect (line bisection, line cancellation, and a copying task) showed improvements on all 3 tasks following prism adaptation, a result which, interestingly, persisted 2 hours after the goggles had been removed. Subsequent studies have shown that exposures as brief as 5 to 7 minutes can produce amelioration of hemineglect that lasts up to 24 hours,[97] and twice daily adaptation sessions over a 2-week period can result in improvements in neglect of up to 5 weeks duration.[74] This prism adaptation has theoretical appeal because it cannot be due simply to a sensory or perceptual shift, but rather must alter in a lasting way central processes related to sensorimotor correspondences, perhaps stimulating the left

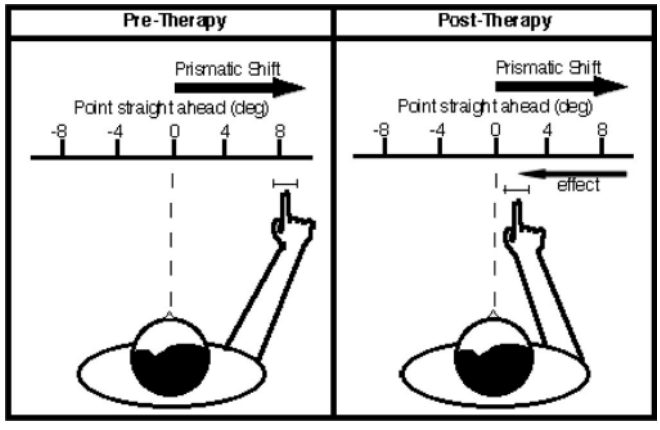

FIGURE 2. Prism adaptation. Patients wear prisms that shift images rightward. Pretherapy patients' straight-ahead pointing results in a shift to the right. During therapy with the prisms on, patients are trained to point straight ahead under visual guidance. When prisms are removed post-therapy, straight-ahead pointing is shifted leftward toward the true midline.

hemisphere networks demonstrated to be active in a recovery of hemineglect.[36] As dramatic as the results seem in prism adaptation, the treatment even so may work on only a component of hemineglect. As shown by a study by Ferber et al,[98] prism adaptation improved the exploratory eye movements of a chimeric face, but did not change the abnormal perception of the unitary object. Patients still made judgments based on the right side of the face predominantly, and also noted nothing unusual about the chimeric faces, nor of the experience of prism adaptation. The limited treatment effect speaks once again to the complex, multifaceted nature of the condition, and demonstrates how difficult hemineglect can be to treat.

One promising method that combines therapist driven extrinisic and sensory-motor transformation intrinsic systems is prism adaptation.

Efficacy of Neglect Treatments

Most of the studies described in this review have had strong theoretical foundations and were carefully designed. Results are compelling for the small case series and single subject comparisons. Efficacy, however, based on controlled clinical trials, and demonstrating lasting improvements at the level of impairment, and generalization to tasks of daily living, has been more difficult to prove. A few critical, systematic reviews of hemineglect treatments have been published in the last few years.[99–101] These reviews set criteria for efficacy that included: (1) the impact of treatment on disability as measured by general disability scales such as the FIM, the behavioral subtests of the behavioral inattention test (BIT),[102] and the Barthel Index;[103,104] (2) the long-term effects of the treatment beyond the therapy program, and (3) the quality of evidence [eg, level 1 is a well-designed randomized controlled trial (RCT); level 2 a cohort study with a comparison group; level 3 a case-control, cross-over, or well-designed single-case study; level 4 are studies without specific assessment of recovery or long-term effect). In the review by Luaute et al,[99] 116 articles were reviewed, 54 of which were included in the analysis. They noted 6 level 1 studies supporting the use of VST as demonstrating improvement on functional skills such as reading and writing,[39,42,45,46,105] and demonstrating generalization of training to other activities of daily living.[39,105,106] A study by Wiart et al combining VST and trunk rotation was a level 1 study that demonstrated both functional improvement on the FIM and a lasting effect.[44] Limb activation was supported by 2 level 1 RCTs and 6 level 3 articles. The RCTs showed that motor function was improved by LA,[107] but the results did not translate to ADL measures. All the single case studies showed that LA produced gains in ADL areas such as reading, walking, dressing, and feeding, and a long-term effect was reported in 4 studies.[48,108–110] Sensory stimulation and direct brain stimulation were found to produce only a within-therapy improvement of hemineglect, and were therefore not recommended as isolated treatment modalities. The efficacy of stimulation techniques may be realized, however, when combined with VST, which may enhance VST's effect.[64,111] Mental imagery[49] and feedback training[112,113] had no level 1 studies to support their use, but lower-level studies seemed strong enough to warrant further investigation in RCTs. Prism adaptation was also cited as a potentially beneficial treatment, warranting further study. Several subsequent studies have shown more lasting and generalizing effects. In addition, neuroimaging studies have proposed an anatomic substrate for the effects of prism adaptation.[70,114] Luaute et al studied 5 hemineglect patients who performed a line judgment task and a simple observation task during a PET scan before and after 2 to 5 minutes of prism adaptation.[70] The right cerebellum, left thalamus, and left temporo-occipital regions correlated positively with BIT scores, and left medial temporal and right posterior parietal regions correlated negatively with BIT improvement, suggesting involvement of these regions in the adaptation process.

A recent Cochrane meta-analysis by Bowen and Lincoln focused on controlled clinical trials, evaluating 400 patients in 15 studies. Eight of the 15 were randomized controlled trials; the others had unclear or no randomization. They found that only 6 of the studies addressed functional recovery, and only 3 of them demonstrated favorable outcomes in the treatment group. Showing benefit in their opinion were a visual cuing intervention by Kalra et al,[107] a VST study by Paolucci,[105] and the combined VST and trunk rotation study by Wiart et al.[44] This last study was the only 1 they cited that showed persistent effects over time, although results were questioned because of poor case matching (experimental group was younger and had a higher baseline FIM than the control group). The overall conclusion of this Cochrane review was that the effectiveness of cognitive rehabilitation for neglect remains unproven, but that there is enough compelling evidence to warrant further investigation with well-designed controlled clinical trials.

CONCLUSIONS

Hemineglect is a heterogeneous disorder that requires tailored treatment strategies. Most clinicians who treat hemineglect take a practical approach to treatment that involves assessing the individual deficits of the patient and devising a treatment strategy that addresses the individual's syndrome. Complete treatment approaches generally involve a combination of top-down and bottom-up approaches, with robust involvement of a therapist during the course of therapy. Some form of VST seems to be effective in most cases of neglect as long as the hemineglect includes difficulty exploring leftward into the neglected hemispace. Prism adaptation may be

recommended for exploratory/gaze abnormalities as well, and alertness or sustained attention training may be useful for perceptual dysfunction. Further RCTs are warranted, but with restricted inclusion/exclusion criteria and outcome measures that match the appropriate syndrome subset.

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