Effectiveness of Interventions to Improve Occupational Performance of People With Cognitive Impairments After Stroke: An Evidence-Based Review

Glen Gillen, Dawn M. Nilsen, Jessica Attridge, Erasmia Banakos, Marie Morgan, Lauren Winterbottom, Wesley York

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- stroke

This evidence-based review was conducted to determine which interventions are effective in improving occupational performance after stroke. Forty-six articles met the inclusion criteria and were examined. Interventions for the following impairments were reviewed: general cognitive deficits, executive dysfunction, apraxia, memory loss, attention deficits, visual field deficits (included because of their close relationship with neglect), and unilateral neglect. Evidence is available from a variety of clinical trials to guide interventions regarding general cognition, apraxia, and neglect. The evidence regarding interventions for executive dysfunction and memory loss is limited. There is insufficient evidence regarding impairments of attention and mixed evidence regarding interventions for visual field deficits. The effective interventions have some commonalities, including being performance focused, involving strategy training, and using a compensatory as opposed to a remediation approach. The implications of the findings for practice, research, and education are discussed.

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Glen Gillen, EdD, OTR, FAOTA, is Associate Professor of Rehabilitation and Regenerative Medicine (Occupational Therapy), Programs in Occupational Therapy, Columbia University Medical Center, Columbia University, New York, NY; GG50@Columbia.edu

Dawn M. Nilsen, EdD, OTL, is Assistant Professor of Rehabilitation and Regenerative Medicine (Occupational Therapy), Columbia University Medical Center, New York, NY.

Jessica Attridge, MS, OTR, Erasmia Banakos, MS, OTR, Marie Morgan, MS, OTR, Lauren Winterbottom, MS, OTR, and **Wesley York, MS, OTR,** were Graduate Students, Programs in Occupational Therapy, Columbia University, New York, NY, at the time of this review.

The purpose of this evidence-based review was to search the literature and critically appraise and synthesize the applicable evidence to address the focused question, What is the evidence for the effectiveness of interventions to improve occupational performance for those with cognitive impairment after stroke?

Background Literature and Statement of Problem

Cognition includes functions related to information processing, including attention, memory, executive functioning, calculation ability, visual perception, praxis, and comprehension and formation of speech. Cognition is a fundamental determinant of occupational performance and can also influence social participation and subjective well-being (American Occupational Therapy Association [AOTA], 2013). Estimates of incidence and prevalence of cerebral infarct resulting in cognitive impairment vary greatly in the literature. Estimates of overall prevalence range from 31% to 77% (Jaillard, Naegele, Trabucco-Miguel, LeBas, & Hommel, 2009). The large variance is partially explained by variability of diagnostic criteria for cognitive impairment, phase of recovery when assessment was done, and sensitivity of assessment tools.

Despite this variance, researchers using the Framingham Heart Study, a landmark longitudinal study in cardiovascular pathology, have consistently identified the rate of cognitive impairment after stroke as 46% (Kelly-Hayes et al., 2003). Moreover, the American Heart Association's 2013 update on stroke mortality

reported that from 1999 to 2009 the annual rate of stroke mortality decreased by 36.9% (Go et al., 2013).

Several research articles have concluded that impairments in cognition and perception associated with stroke have a significant impact on an individual's ability to live and function independently (Brown, Mapleston, Nairn, & Molloy, 2013; Jette, Keysor, Coster, Ni, & Haley, 2005; Kizony & Katz, 2002; Mercier, Audet, Hébert, Rochette, & Dubois, 2001). Jette et al. (2005) found that when cognitive deficits related to stroke are not targeted, they can lead to decreased independent participation in activities of daily living (ADLs). Similarly, Brown et al. (2013) determined that deficits in perception and cognition after a stroke have a significant impact on functional independence.

The last evidence-based review of stroke interventions for occupational therapists published by AOTA in 2008 included an appraisal of studies conducted up until 2003 (Sabari, 2008). To ensure best practice in stroke rehabilitation, it is vital that an updated appraisal of existing interventions be done.

Method for Conducting the Evidence-Based Review

This review was completed in collaboration with AOTA as part of an evidence-based literature review project for interventions for adults with stroke. The focused question addressed was, What is the evidence for the effectiveness of interventions to improve occupational performance for those with cognitive impairment after stroke? A detailed description of the methodology used in this review can be found in this issue (Arbesman, Lieberman, & Berlanstein, 2015). Because our focus was occupational performance, we included studies only if they used a measure of real or simulated occupational performance.

Results

Article abstracts ($N = 1{,}382$) were retrieved from Medline, PsycInfo, CINAHL, OTseeker, Ageline, the Cochrane Database of Systematic Reviews, DARE, and databases and abstracts found through hand searches of journals and bibliographies. Of those, 46 articles (27 Level I, 9 Level II, and 10 Level III) were included in this review. They were then abstracted using the evidence table format and summarized in a Critically Appraised Topic format (Gillen et al., 2014). The articles were divided into themes according to type of impairment limiting occupational performance: (1) general cognitive deficits, (2) executive dysfunction, (3) apraxia, (4) memory loss, (5) attention deficits, (6) visual field deficits (included because of the close relationship with neglect), and (7) unilateral neglect. Summaries of the findings follow. See Supplemental Table 1 (available online at http://otjournal.net; navigate to this article, and click on "Supplemental") for examples of selected studies included in this review. Full evidence tables are available in *Occupational Therapy Practice Guidelines for Adults With Stroke* (Wolf & Nilsen, 2015).

General Interventions for Cognition

Studies examining general deficits in cognition after stroke included 3 Level I studies and 1 Level III pilot study. Hoffmann, Bennett, Koh, and McKenna (2010) conducted a systematic review (Level I) of interventions for poststroke cognitive impairment that were provided or supervised by an occupational therapist, which yielded only 1 study. This randomized controlled trial (RCT) examined the effectiveness of cognitive remediation using the Thinking Skills Workbook versus treatment as usual. No significant difference was found between the groups after the intervention.

Bowen, Knapp, Gillespie, Nicolson, and Vail's (2011; Level I) systematic review and meta-analysis of 6 RCTs investigated evidence for ADL improvement 6 mo after a variety of interventions. No evidence supporting or refuting the effectiveness of perceptual interventions was stated.

Rohling, Faust, Beverly, and Demakis (2009; Level I) performed a meta-analysis of 101 articles from previously published systematic reviews on evidence for cognitive rehabilitation after acquired brain injury. The analysis found statistically significant evidence supporting the use of cognitive rehabilitation to improve global cognitive function for individuals with acquired brain injury, which includes stroke and traumatic brain injury (TBI). Visuospatial training was shown to have a medium to large effect on the global cognitive functioning of individuals after stroke. Because both stroke and TBI populations were included in the analysis, Rohling et al. found that variables of treatment domain, etiology (stroke vs. TBI), age, and recovery level (<1 yr vs. >1 yr) were highly confounded, making it difficult to draw conclusions from the data.

In a pre–post design pilot study (Level III), Pyun et al. (2009) found that an individualized home rehabilitation program consisting of cognitive remediation therapy, story retelling, cognition-enhancing games, and aerobic exercise was beneficial for instrumental activities of daily living performance of stroke survivors with cognitive dysfunction. After the intervention, participants showed significant improvement in scores on the Seoul–Instrumental Activities of Daily Living.

Evidence supports the use of general cognitive rehabilitation to improve global cognitive function for

individuals with acquired brain injury (including stroke) as well as visuospatial training poststroke. Evidence to support the use of an individualized home rehabilitation program with this population is insufficient.

Interventions for Executive Dysfunction

Three studies (1 Level I and 2 Level III studies) examined the efficacy of novel interventions aimed at addressing executive dysfunction. In an RCT (Level I), Winkens, Van Heugten, Wade, Habets, and Fasotti (2009) found evidence supporting the use of Time Pressure Management (TPM) to improve speed in daily task performance in stroke patients with mental slowness. However, this improvement was measured using simulated everyday tasks and cannot necessarily be generalized to real-life situations. In addition, the interventions administered to the usual-care group varied between sites, with some participants receiving treatment similar to TPM.

Rand, Weiss, and Katz (2009) conducted a Level III study and found potential for the use of VMall, a virtual supermarket that uses a video-capture virtual reality system, for people with poststroke multitasking impairments. The 4 participants in this Level III pre–post design study showed improvement on the Virtual Multiple Errands Test and the Multiple Errands Test–Hospital Version after ten 60-min sessions over 3 wk.

Rand, Eng, Liu-Ambrose, and Tawashy (2010) conducted a pre–post design study (Level III) that examined the effectiveness of an exercise and recreation program for improving executive functioning and memory in community-dwelling people with chronic stroke. From baseline to 3 mo, they found significant improvements on the Walking While Talking assessment, which is a simulated dual-task activity used to measure cognitive flexibility and divided attention, as well as the Rey Auditory Verbal Learning Test–Long Delay, which measures learning, delayed recall, and long-term memory. Response inhibition, as assessed by the Stroop test, also improved significantly from baseline to 6 mo. The study was limited by a small heterogeneous sample and lack of control group. In addition, improvement on outcome measures was not necessarily generalizable to improvement in real-world function because of the contrived nature of the assessments.

Limited evidence supports the use of TPM for improvement in speed of daily task performance for adults with mental slowness poststroke. Similarly, the evidence to support either the use of VMall to remediate multitasking deficits or exercise and recreation programming to improve executive functioning and memory after stroke is limited.

Interventions for Apraxia

Three articles met the criteria to review the effectiveness of cognitive rehabilitation for apraxia secondary to stroke. All 3 articles satisfied the Level I evidence criteria. Two articles were RCTs, and 1 was a systematic review. The systematic review, by West, Bowen, Hesketh, and Vail (2008), determined that two studies that documented changes in ADL status using the Barthel Index (BI) showed a small and short-lived therapeutic effect. They determined that this change was not clinically significant and did not persist. They recommended that higher quality research be conducted.

Cognitive strategy training (CST) consists of teaching internal and external compensatory approaches to execute ADLs. Techniques include internal rehearsal, verbalizing actions during ADL execution, and external cueing. Building on the research of Donkervoort, Dekker, Stehmann-Saris, and Deelman (2001), Geusgens et al. (2006; Level I) examined their data to see whether CST had a greater transfer effect to nontrained tasks than usual occupational therapy alone. Although analysis showed both treatment groups improved on trained and nontrained tasks, the CST group showed greater improvement on nontrained tasks. These data indicate a greater transfer effect in the CST condition. The results of these studies show CST as a promising avenue of cognitive rehabilitation research with clinical applications.

To assess how gesture training affects functional independence in ADL, Smania et al. (2006; Level I) completed a study with 41 left-hemisphere stroke survivors. In addition to the neuropsychological test battery, they included a caregiver questionnaire regarding patient independence in ADLs. An additional 2-mo posttraining follow-up assessment was included. Results showed that the gesture-training group's performance improved significantly on ideational, ideomotor, and gesture comprehension tests. Performance on these tests and measures of ADL independence were correlated.

The results of these studies suggest that evidence exists for the effectiveness of cognitive rehabilitation in improving ADLs in people with apraxia after stroke.

Interventions for Memory Loss

Five articles met the inclusion criteria to review the effectiveness of cognitive rehabilitation of memory deficits secondary to stroke. Three articles satisfy Level I evidence criteria; two articles satisfy Level III evidence criteria. These articles are discussed by intervention strategy used.

Two studies examined the potential of computerized memory training programs. Westerberg et al. (2007; Level I)

examined the effects of a computerized working memory program among 18 adult stroke patients compared with a passive control group (no intervention). Assessment was conducted pre- and posttreatment, with results indicating significant improvement on nontrained tests for working memory and attention for stroke survivors compared with control participants. Additionally, a significant decrease in symptoms of everyday cognitive problems as measured by the Cognitive Failures Questionnaire (CFQ) was noted.

Hildebrandt, Gehrmann, Modden, and Eling (2011; Level I) compared the efficacy of a computer-based memory treatment with a group therapy approach that used various internal mnemonic memory strategies. All 27 participants had acquired brain lesions, with stroke being the predominant etiology. Neuropsychological testing and simulated measures of everyday memory were used as outcome measures. Results showed that, compared with the group therapy treatment, the computer-based treatment increased memory performance as measured by neuropsychological testing.

A systematic review (Level I) conducted by das Nair and Lincoln (2007) included two RCTs that used internal mnemonic strategies to treat memory deficits. Das Nair and Lincoln concluded that this type of strategy training had no significant effects on performance of objective memory tests or subjective and observer-rated measures of memory.

A single-group, pre- and posttreatment comparison (Level III) examined the differential response to memory rehabilitation among a neurological population stratified by diagnosis (i.e., 15 patients with TBI, 12 with stroke, and 6 with other neurological conditions) and severity of memory impairment (Stringer & Small, 2011). All patients received *Ecologically Oriented Neurorehabilitation of Memory*™, a treatment program that provides a four-step compensatory strategy based on the acronym WOPR: *w*rite–*o*rganize–*p*icture–*r*ehearse. Performance measures on everyday memory simulations for six declarative memory tasks and one prospective memory task were used as outcome measures. Patients in all three diagnostic groups and at all levels of severity showed significant improvement in memory performance.

Rand et al. (2010; Level III) examined executive function and memory in 11 ambulatory participants with chronic stroke. These participants undertook a 6-mo combined exercise and recreational program, with assessment of executive function and memory conducted at baseline, 3-mo, and 6-mo intervals. Results indicated significant improvements for executive function and memory at both 3 mo and 6 mo postintervention.

Currently, the evidence related to improving ADLs for people with memory loss after stroke is limited.

Interventions for Attention Deficits

Barker-Collo et al. (2009) used a single blinded RCT (Level I) to determine whether Attention Process Training (APT) improved attention and secondarily to ascertain APT's effect on everyday cognition and quality of life. Differences on measures of attention and the CFQ were not significant between the two groups. Thus, the evidence to support APT as an effective treatment of deficits in attention after stroke is insufficient.

Interventions for Visual Field Deficits

Eight research articles investigated interventions to improve occupational performance for those with visual field defects secondary to stroke. These interventions include compensatory exploratory saccade training (EST), perimetry training, Dynavision training, computerized visual perception training, audiovisual training, and a systematic treatment program to restore visual field deficits. Of these studies, 6 provided Level I evidence, 1 provided Level II evidence, and 1 provided Level III evidence.

A recent systematic review by Pollock et al. (2011; Level I) evaluated the effect of interventions for people with visual field defects after stroke. After reviewing 13 studies that met the inclusion criteria, Pollock et al. concluded that the evidence to support the use of interventions for visual field defects to improve functional performance is mixed.

Two studies chose to examine a compensatory approach, testing the use of intact functions such as eye movements to compensate for visual field impairments and improve occupational performance (Keller & Lefin-Rank, 2010; Roth et al., 2009). Roth et al. (2009; Level I) examined the compensatory approach of EST, which involves a computerized explorative saccadic-search task aimed at improving visual search in the blind hemifield. Reading speed did not improve with EST, which Roth et al. said would require training with smaller saccades. However, their findings showed substantial benefits of compensatory exploration training, including subjective improvements in mastering daily-life activities, especially in the social domain.

Keller and Lefin-Rank (2010; Level I) examined compensatory eye movements via audiovisual stimulation training or visual stimulation training. Comparisons between the two forms of training revealed a significantly greater improvement for all outcome variables (e.g., reading speed and an occupational therapist–administered questionnaire of ADLs) for the audiovisual group.

Mödden et al. (2012; Level I) explored the use of a computer-based compensatory therapy (CT) and computerized restorative training (RT) in comparison with standard occupational therapy. No statistically significant

difference was found between the groups on any of the outcome measures postintervention. However, intragroup comparisons posttreatment revealed that the CT group only showed a significant improvement in reading errors and conjunction search. Finally, intragroup comparisons posttreatment revealed that all three interventions (CT, RT, and occupational therapy) led to improvements in ADLs.

Several studies aimed to retrain vision skills to improve functional outcomes. Crotty and George (2009; Level I) evaluated the effectiveness of the Dynavision Light Training Board 2000 in retraining visual processing skills related to driving performance after stroke. They found no significant improvement in driving ability, response time, or visual scanning with the use of the Dynavision. Kang et al. (2009; Level I) investigated the effectiveness of a computerized visual perception rehabilitation program with motion-tracking technology as treatment for visual perception impairment compared with visual–perceptual training portions of a commonly used cognitive computer training program. Both groups showed significant improvements on the Mini-Mental State Examination, Motor-Free Visual Perception Test, and the Korean version of the Modified Barthel Index.

Taylor, Poland, Harrison, and Stephenson (2011; Level II) evaluated a systematic treatment program targeted at restoration of visual field deficits in comparison with standard occupational therapy. The experimental group had significant improvement on the Nottingham Adjustment Scale, but no difference was found on the BI or the Behavioral Inattention Test (BIT). One study investigated the effectiveness of visual field restoration training, involving stimulation of the blind hemifield using a Goldmann perimeter, in improving occupational performance (Bergsma & van der Wildt, 2010; Level III). They found evidence that visual stimulus detection training can lead to visual field enlargement and its training effects can be generalized to the everyday activity of reading. Therefore, the findings for visual field restoration training were inconclusive but showed some limited evidence of improvement in occupational performance.

The results indicate that evidence exists to conclude that interventions for visual dysfunction will lead to improvement in functional measures. Each study examining interventions for visual dysfunction had varying levels of evidence, and the findings are inconsistent as a result of different outcome measures.

Interventions for Unilateral Neglect

We identified 23 studies investigating interventions to improve occupational performance for people with unilateral neglect. Eleven studies were evaluated as Level I; 8, as Level II; and 4, as Level III.

We found 1 systematic review and meta-analysis (Bowen & Lincoln, 2007; Level I) analyzing the research on cognitive rehabilitation as a means of treating unilateral neglect. This study included 12 RCTs utilizing cognitive interventions (protocols included structured therapy, computerized therapy, prescription of aids, and modification of environment), and the analysis found inconclusive evidence to support or refute a particular approach.

Prisms. Prism adaptation, the optical shift induced with prismatic lenses, has been studied as a treatment for unilateral spatial neglect (USN) after stroke, as have traditional prisms. We identified 10 studies, 3 providing Level I evidence (Mizuno et al., 2011; Nys, de Haan, Kunneman, de Kort, & Dijkerman, 2008; Turton, O'Leary, Gabb, Woodward, & Gilchrist, 2010), 5 providing Level II evidence (Angeli, Benassi, & Làdavas, 2004; Fortis et al., 2010; Rousseaux, Bernati, Saj, & Kozlowski, 2006; Serino, Angeli, Frassinetti, & Làdavas, 2006; Watanabe & Amimoto, 2010), and 2 providing Level III evidence (Keller, Lefin-Rank, Lösch, & Kerkhoff, 2009; Shiraishi, Muraki, Ayaka Itou, & Hirayama, 2010).

Collectively, these results offer mixed evidence regarding the effectiveness of prism adaptation and prisms to enhance treatment for improvement of functional measures such as reading (Angeli et al., 2004; Serino et al., 2006), wheelchair mobility (Watanabe & Amimoto, 2010), and nonfunctional measures of USN (Keller et al., 2009; Shiraishi et al., 2010).

Visual Scanning Training. Five studies (3 Level I RCTs and 2 Level II non-RCTs) examined interventions that involved either a comparison with or a supplement to visual scanning training (VST) programs. Three studies (Katz et al., 2005; Kerkhoff, Keller, Ritter, & Marquardt, 2006; Luukkainen-Markkula, Tarkka, Pitkänen, Sivenius, & Hämäläinen, 2009) compared alternative interventions (e.g., left arm activation therapy, repetitive optokinetic stimulation, virtual environment training) with visual scanning, and 2 studies (Pizzamiglio et al., 2004; Polanowska, Seniów, Paprot, Leśniak, & Członkowska, 2009) investigated supplementing with either repetitive optokinetic stimulation or electrical stimulation of the left hand, respectively. With the exception of Kerkhoff et al. (2006), all studies demonstrated improvement in outcome measures as a result of VST and thus provide evidence in support of VST.

Mirror Therapy. Two Level I studies evaluated mirror therapy (MT; Dohle et al., 2009; Thieme et al., 2013). Dohle et al. (2009) concluded that people who received MT demonstrated significant improvement on measures of USN. However, they found no between-group differences on measures of ADL function. Similarly, Thieme

et al. (2013) found that those who received individual (as opposed to group) MT improved on a measure of neglect (cancellation test). There were no between-group differences on measures of activity or participation. Together, these studies offer insufficient evidence to support MT to improve USN because of the limited number of participants with USN included in each study.

Right Half-Field Eye Patching. Two Level I studies investigated the value of right half-field eye patching. Although both studies demonstrated improved neglect symptoms, neither provided conclusive evidence to support the intervention. Tsang, Sze, and Fong (2009) used a Level I RCT and included a total of 34 participants with unilateral neglect resulting from stroke. The participants were equally divided into two groups and received the same intervention except that the experimental group performed therapy with right half-field eye patching. The experimental group demonstrated greater strides in eating, dressing the lower body, and bathing.

In contrast, Fong et al. (2007) reported no significant differences between the groups at posttest or follow-up on any of the included outcome measures as a result of half-field eye patching combined with voluntary trunk rotation. The evidence regarding the use of right half-field patching to improve occupational performance is mixed.

Neck Muscle Vibration. One study investigated the effectiveness of neck muscle vibration given before occupational therapy sessions on unilateral spatial neglect. Kamada, Shimodozono, Hamada, and Kawahira (2011; Level III) implemented a multiple-baseline ABA design. Although the study demonstrated improved BIT and FIM™ scores after neck muscle vibration, the results were potentially influenced by the use of multiple evaluators and additional treatment because participants were receiving comprehensive rehabilitation throughout the study period. This study provides insufficient evidence to support the use of neck muscle vibration to improve USN.

Family Participation. Osawa and Maeshima (2010) examined whether family participation in therapy promoted improvement in unilateral spatial neglect versus a traditional therapy protocol via a Level II study. The study, which included 34 acute stroke survivors with documented USN, demonstrated improved BI and Rivermead Mobility Index scores and significantly improved BIT scores compared with the participants who received traditional occupational therapy. As well, family participation group members showed significant improvement in line crossing, letter cancellation, star cancellation, and line bisection. However, translation of results is limited because of the study's small sample size and because the experimental group, but not the control group, received additional mobility training. In summary, the evidence to support family participation therapy is insufficient because of the limited breadth of the studies investigating this intervention.

Spatial Cueing and Limb Activation. Punt, Kitadono, Hulleman, Humphreys, and Riddoch (2011) investigated the effect of spatial cueing and limb activation on wheelchair use. The study was a Level III pre–post design and included 2 experiments. The first experiment, which included 4 stroke survivors with neglect, investigated the difference of joystick placement (left vs. right) on a wheelchair. Findings resulted in a documented decrease in error when the joystick was placed on the left. The second experiment included 2 stroke survivors and used the doorway accuracy test to determine whether left or right placement improved wheelchair navigation. Punt et al. found improved midline navigation when the joystick was mounted on the contralesional side. Although results were positive, this study provides insufficient evidence because of its small sample size.

Summary. Evidence from several clinical trials showed that a variety of interventions are effective at improving occupational performance of those with unilateral neglect after stroke. Further research is warranted to examine whether combining these effective interventions would have an additive effect.

Discussion and Implications for Practice, Education, and Research

Evidence suggests that a variety of interventions are effective in improving occupational performance of adults with cognitive impairment after stroke. From a practice and education perspective, the effective interventions have some commonalities, including being performance focused, using strategy training techniques, and being compensatory. Examples include VST, CST, and TPM. In other words, this review highlights occupational therapy practitioners' need to work with clients on maintaining or improving occupational performance despite the presence of underlying cognitive impairment. It further highlights the need to use authentic occupations in the clinic as opposed to contrived cognitive activities and manipulations.

These approaches contrast with a cognitive remediation approach, which assumes that focusing on retraining underlying cognitive skills will generalize to occupational performance (see the earlier discussion of APT as an example). As this practice area continues to grow, future and further research on outcomes related to occupational performance and quality of life is required. The majority of studies used pen-and-paper measures of cognition. Although

multiple studies were included in this review, most focused on unilateral neglect ($n = 23$) as opposed to other areas, such as attention deficits ($n = 1$).

This review has several limitations: Many of the studies appraised had small sample sizes, and many studies used performance measures inconsistently. Several studies used simulation of ADLs or ADL questionnaires as opposed to actual observation of ADLs, and some examined heterogeneous groups such as people with stroke and TBI. Long-term effects have not been well studied. Our search was limited to journals published in English, and the possibility remains that studies were missed as a result of combinations of search terms and variations in terminology related to cognitive impairment. Finally, all interventions should be systematically reviewed in the future to determine how efficacious they are in improving occupational performance. ▲

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