Examining the Feasibility, Tolerability, and Preliminary Efficacy of Repetitive Task-Specific Practice for People With Unilateral Spatial Neglect

Emily S. Grattan, Catherine E. Lang, Rebecca Birkenmeier,
Margo Holm, Elaine Rubinstein, Jessie Van Swearingen,
Elizabeth R. Skidmore

MeSH TERMS

- perceptual disorders
- recovery of function
- stroke
- task performance and analysis
- upper extremity

OBJECTIVE. We examined the feasibility, tolerability, and preliminary efficacy of repetitive task-specific practice for people with unilateral spatial neglect (USN).

METHOD. People with USN ≥ 6 mo poststroke participated in a single-group, repeated-measures study. Attendance, total repetitions, and satisfaction indicated feasibility and pain indicated tolerability. Paired t tests and effect sizes were used to estimate changes in upper-extremity use (Motor Activity Log), function (Action Research Arm Test), and attention (Catherine Bergego Scale).

RESULTS. Twenty participants attended 99.4% of sessions and completed a high number of repetitions. Participants reported high satisfaction and low pain, and they demonstrated small, significant improvements in upper-extremity use (before Bonferroni corrections; $t = -2.1$, $p = .04$, $d = .30$), function ($t = -3.0$, $p < .01$, $d = .20$), and attention ($t = -3.4$, $p < .01$, $d = -.44$).

CONCLUSION. Repetitive task-specific practice is feasible and tolerable for people with USN. Improvements in upper-extremity use, function, and attention may be attainable.

Emily S. Grattan, PhD, OTR/L, is Postdoctoral Scholar, Department of Health Science and Research, Medical University of South Carolina, Charleston; grattan@musc.edu

Catherine E. Lang, PT, PhD, is Professor, Program in Physical Therapy and Program in Occupational Therapy, Department of Neurology, Washington University School of Medicine, St. Louis, MO.

Rebecca Birkenmeier, OTD, OTR/L, is Assistant Professor, Program of Occupational Therapy, Maryville University, St. Louis, MO.

Margo Holm, PhD, OTR/L, is Professor Emerita, Department of Occupational Therapy, University of Pittsburgh, Pittsburgh, PA.

Elaine Rubinstein, PhD, is Lecturer, Department of Psychology, Chatham University, and Senior Service Fellow, Office of Mine Safety and Health Research, Bruceton Research Center, National Institute for Occupational Safety and Health, Pittsburgh, PA.

Jessie Van Swearingen, PT, PhD, is Associate Professor, Department of Physical Therapy, University of Pittsburgh, Pittsburgh, PA.

Elizabeth R. Skidmore, PhD, OTR/L, is Associate Professor and Chair, Department of Occupational Therapy, University of Pittsburgh, Pittsburgh, PA.

Grattan, E. S., Lang, C. E., Birkenmeier, R., Holm, M., Rubinstein, E., Van Swearingen, J., & Skidmore, E. R. (2016). Examining the feasibility, tolerability, and preliminary efficacy of repetitive task-specific practice for people with unilateral spatial neglect. *American Journal of Occupational Therapy*, 70, 7004290020. <http://dx.doi.org/10.5014/ajot.2016.019471>

Unilateral spatial neglect (USN) contributes to poststroke disability. Estimates of the incidence of USN vary considerably, depending on the measure used to assess USN, but USN affects people with both right (13%–82%) and left (0%–76%) hemisphere lesions (Bowen, McKenna, & Tallis, 1999). USN is characterized by a person's inattention to one side of the body or the environment (Menon & Korner-Bitensky, 2004). As a result, people with USN may groom only one side of the body, miss food on one side of the plate, or walk into obstacles on one side of the field of vision (Buxbaum et al., 2004). People with USN also experience greater upper-extremity impairment than those without USN (Katz, Hartman-Maeir, Ring, & Soroker, 1999). People with USN sustain impairments in strength and motor control, and because of their inattention to the impaired upper extremity or hemispace, they do not use their impaired upper extremity in daily activities. This nonuse may result in greater long-term impairments in upper-extremity function.

The combination of impaired upper-extremity use and function and inattention has a compounding negative effect on the ability to perform everyday activities. In fact, people with USN experience more significant disability than those without USN (Katz et al., 1999). A recent systematic review reported that USN was predictive of poor functional outcomes in 25 out of 26 studies

(Jehkonen, Laihosalo, & Kettunen, 2006). Given the significant role of USN in poststroke disability, effective interventions that address USN have the potential to greatly reduce stroke-associated costs and disability.

Repetitive task-specific practice is a promising intervention to address impaired upper-extremity use, impaired upper-extremity function, and inattention. This intervention encourages high-intensity functional motor task practice using the impaired upper extremity. Robust evidence has suggested that it is effective in promoting improved upper-extremity use and function after stroke (Birkenmeier, Prager, & Lang, 2010; Taub et al., 2006; Wolf et al., 2006). A recent evidence-based review that is part of the American Occupational Therapy Association's Evidence-Based Practice Project supports the use of repetitive task-specific practice to improve occupational performance of people with motor impairments after stroke (Nilsen et al., 2015). Despite the evidence to support the use of this intervention, however, people with USN have largely been excluded from studies.

Neurobiological, conceptual, and anecdotal factors support the efficacy of repetitive task-specific practice to improve upper-extremity use and function and attention in people with USN; however, the evidence is limited. Two studies showed that behavioral therapies that require active movement of the affected upper extremity, and thus share some of the same intervention components with repetitive task-specific practice, may improve attention in people with USN (Kalra, Perez, Gupta, & Wittink, 1997; Robertson, McMillan, MacLeod, Edgeworth, & Brock, 2002). Similarly, two post hoc analyses that examined small subsamples of people with USN suggested that repetitive task-specific practice may improve upper-extremity use and function (Grattan & Skidmore, 2011; van der Lee et al., 1999). Only one prospective study has examined a repetitive task-specific practice program for people with USN. This program, delivered by occupational therapists, found that participants demonstrated improved attention (Wu et al., 2013). However, the intensity of practice was not specified; therefore, it is unclear whether an intensive program is feasible and tolerable for people with USN.

Collectively, these studies support repetitive task-specific practice for addressing the sequelae of USN (i.e., impaired upper-extremity use, impaired upper-extremity function, and inattention). However, the effect of this intervention on the sequelae of USN has not been examined. In addition, no studies have robustly examined the effectiveness of repetitive task-specific practice in people with USN, partly because of questions regarding whether rigorous repetitive task-specific practice is feasible and tolerable for this population.

We conducted a prospective pilot study that examined a 6-wk individualized, progressive repetitive task-specific practice program for people with chronic poststroke USN. The primary purpose was to examine the feasibility and tolerability and the secondary purpose was to examine the preliminary effects of repetitive task-specific practice on upper-extremity use, upper-extremity function, and attention. We predicted that it would be feasible and tolerable for people with USN to participate in the repetitive task-specific practice program. We used the following indicators to establish feasibility and tolerability: for feasibility, recruitment and retention of $\geq 95\%$ of the targeted sample size ($n = 20$) for the entire protocol; for tolerability, little or no adverse effects (i.e., pain) reported by $\geq 90\%$ of participants and satisfaction scores of acceptable to high reported by $\geq 90\%$ of participants.

Method

Study Design

We conducted a single-group, repeated-measures, collaborative multisite pilot study. This design aligned with our research questions and could appropriately examine the feasibility, tolerability, and preliminary efficacy of an intervention.

Participants

Participants were recruited between June 2012 and December 2013 from two academic health centers and their respective research registries and from local stroke support groups. All procedures were approved by each institution's institutional review board, and all participants or designated proxies provided informed consent.

Participants were eligible if they met the following five criteria: (1) age ≥ 18 yr, (2) primary diagnosis of unilateral upper-extremity paresis after stroke ≥ 6 mo before the study, (3) presence of USN (impairment on ≥ 1 of the conventional subtests of the Behavioral Inattention Test; Wilson, Cockburn, & Halligan, 1987), (4) mild to moderate upper-extremity paresis (defined by Motricity Index scores of 48–92; Collin & Wade, 1990); and (5) English speaking. Participants were excluded if they had severe aphasia (i.e., unable to follow one-step directions 80% of the time) or were receiving concurrent therapy for the affected upper extremity. Other pilot studies have established tolerability and feasibility using a sample size of ≤ 20 participants (Birkenmeier et al., 2010; Waddell, Birkenmeier, Moore, Hornby, & Lang, 2014); therefore, our goal for this study was to recruit 20 participants.

Measures

Assessments were administered to determine participant baseline conditions (Table 1). In addition, a battery of assessments was administered before and after intervention by two independent evaluators trained to competency in the administration and scoring of each measure. Interrater reliability was established for all measures (intraclass correlation coefficient, $\geq .95$), and the evaluators were blinded to the aims of the study.

Baseline Measures. We administered the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS; Randolph, Tierney, Mohr, & Chase, 1998) to assess baseline cognition. The RBANS is a battery of neuropsychological tests designed to assess attention, immediate recall, delayed recall, language processing, and visuospatial and constructional processing. We used age-adjusted total index scores to describe the sample. Age-adjusted scores have a mean of 100 and a standard deviation of 15 (Randolph et al., 1998); therefore, scores <85 indicate impaired cognition. The National Institutes of Health Stroke Scale (Brott et al., 1989) was used to measure stroke severity. Ratings from its 13 items were summed to describe the sample, with higher scores indicating greater neurological impairment. The Patient Health Questionnaire-9 (Kroenke, Spitzer, & Williams, 2001)

was used to measure depressive symptoms and severity. Each of its 9 items is scored on a scale from 0 to 3, and the item scores are summed. Higher scores indicate greater depressive severity.

Feasibility Measure. We assessed feasibility by examining the total percentage of sessions that participants attended (18 sessions scheduled) and the mean number of repetitions completed (with the goal of ≥ 300 repetitions per session) during the intervention sessions. The eight-item Client Satisfaction Questionnaire-8 (CSQ-8; Nguyen, Attkisson, & Stegner, 1983) was used to evaluate participants' satisfaction with the intervention. Each item is scored on a scale from 1 to 4, and item scores are summed. Total scores on the CSQ-8 range from 8 to 32, with higher scores indicating greater satisfaction. We used the total score to assess satisfaction by calculating the percentage of participants who reported total satisfaction scores of acceptable to high (i.e., CSQ-8 total score of 24–32).

Tolerability Measure. We measured tolerability by assessing pain in the affected upper extremity. Participants were interviewed at the beginning and end of each session using the Wong-Baker FACES Pain Rating Scale (Wong & Baker, 1988). Pain scores ranged from 0 to 10, with higher scores indicating greater pain (i.e., 0–2 points = *no/mild pain*, 3–6 points = *moderate pain*, and 7–10 points = *severe pain*; Kelly, 2001). Side effects (i.e., an increase in pain) were identified by comparing participant responses before and after intervention. We calculated the percentage of participants who reported side effects and collected descriptive data on side effect number, type, and severity. We also calculated the mean change score for each session and for all sessions combined. We examined each session to determine whether participants experienced an increase in pain and whether that increase was an *adverse event*, that is, an increase from a lower pain category to a higher one.

Secondary Outcome Measures. We used the Motor Activity Log (MAL; Uswatte, Taub, Morris, Light, & Thompson, 2006), the Action Research Arm Test (ARAT; Lyle, 1981), and the Catherine Bergego Scale (CBS; Azouvi, 1996) as secondary outcome measures of preliminary efficacy. The MAL is a self-report measure of the amount of use of the impaired upper extremity during 30 activities of daily living (Uswatte et al., 2006). Each activity is scored on a scale that ranges from 0 (*did not use weaker arm for activity*) to 5 (*used weaker arm as much as did prestroke*). Higher mean scores indicate greater upper-extremity use.

The ARAT measures upper-extremity grasp, grip, pinch, and gross movement through 19 items (Lyle, 1981). Each item is scored on a scale that ranges from 0 to 3, yielding a total score of 0–57. Higher scores indicate better

Table 1. Participant Demographics ($N = 20$)

Characteristic	n (%) or M (SD)
Age, yr	66.7 (11.7)
Male	10 (50.0)
White	14 (70.0)
Stroke etiology: ischemic	17 (85.0)
Stroke hemisphere: right	11 (55.0)
Stroke location	
Cortical	13 (65.0)
Subcortical	1 (5.0)
Cortical/subcortical	5 (25.0)
Posterior circulation	1 (5.0)
Number of strokes	
One	13 (65.0)
Two	5 (25.0)
Three or more	2 (10.0)
Dominant limb affected	7 (35.0)
Assessment baseline score	
NIHSS	7.2 (3.6)
PHQ-9 ($n = 16$)	6.9 (5.9)
RBANS total scale index	68.6 (13.1)
Wong-Baker FACES Pain Rating Scale	1.0 (2.3)

Note. M = mean; NIHSS = National Institutes of Health Stroke Scale; PHQ-9 = Patient Health Questionnaire-9; RBANS, Repeatable Battery for the Assessment of Neuropsychological Status; SD = standard deviation. Chronicity median is 19 mo (interquartile range, 9.8–67.3 mo). Assessment score ranges: NIHSS, 0–42; PHQ-9, 0–27; RBANS, 40–160; Wong-Baker FACES Pain Rating Scale, 0–10.

function. We used the summed total score for hypothesis testing. The CBS measures USN through observation of 10 activities, such as eating, grooming, and mobility (Azouvi, 1996). Each item is scored on a 4-point scale, yielding a total score of 0–30. Higher scores indicate greater USN. We used the summed total score for hypothesis testing.

Intervention

Intervention sessions were delivered by experienced occupational or physical therapists who were trained to administer the manualized intervention. The intervention was an existing protocol developed to provide a rigorous and standardized repetitive task-specific practice program to people with chronic stroke (Birkenmeier et al., 2010; Lang & Birkenmeier, 2013). This individualized, progressive program involves high doses of repetitive training in functional tasks for the impaired upper extremity. It was administered 3 days/wk for 1 hr/day over 6 wk. In each 1-hr session, the participant’s goal was to achieve at least 300 repetitions of practice for each of three therapist-selected tasks (Birkenmeier et al., 2010; Lang & Birkenmeier, 2013). The research therapist graded the tasks (according to procedures in Birkenmeier et al., 2010) for each participant throughout the 6-wk intervention by increasing or decreasing task complexity on the basis of upper-extremity function.

Analyses

Study data were collected and managed using REDCap electronic data capture tools (Harris et al., 2009) hosted at both academic health centers. We analyzed data using IBM SPSS Statistics (Version 21; IBM Corp., Armonk, NY). Descriptive analyses were conducted for

all variables. To assess the preliminary effects of the program, we conducted paired *t* tests or nonparametric Wilcoxon signed-rank tests with Bonferroni corrections to compare baseline and follow-up scores. We also determined the magnitude of the change in the outcome variables after treatment and standard deviation of change with Cohen’s *d* effect size calculations (Cohen, 1988). Effect sizes were calculated by dividing the change scores by the standard deviations and were interpreted as follows: .20 = small effect, .50 = moderate effect, .80 = large effect (Cohen, 1988).

Results

Eighty-eight people provided informed consent, but 68 were ineligible (48 people did not have USN, and 11 of these had insufficient motor function; 18 had USN but insufficient motor function; 1 had bilateral hemiparesis; and 1 was participating in concurrent therapy). Twenty participants were enrolled in the study, but 1 participant was lost during follow-up as a result of a change in medical status unrelated to study participation. Therefore, complete data were available for 19 participants. Participant demographic information (Table 1) was collected through interviews.

Feasibility and Tolerability

Participants attended 99.4% of the 18 scheduled sessions. Two participants attended 17 intervention sessions instead of 18 because they missed a scheduled session. On average, participants completed 290 (standard deviation [*SD*] = 44) repetitions per session (Figure 1; total repetitions across all sessions: mean [*M*] = 5,152.9, *SD* = 515.9) with a wide range of repetitions (3,457–5,807) among participants. Fifty percent of participants achieved an average of

Figure 1. Mean repetitions completed per session.

Note. Error bars indicate standard deviation.

300 or more repetitions per session. Participants expressed high satisfaction (CSQ-8: $M = 29.5$, $SD = 3.1$) with the intervention, with 95% reporting moderate to high satisfaction.

Minimal changes in pain were reported by participants over the 18 sessions (Wong-Baker FACES Pain Rating Scale: $M = 0.04$, $SD = 0.9$; Figure 2). Given the small data set, the confidence intervals were driven by two outliers on both ends of the scale. One participant demonstrated increases in pain in Sessions 12, 16, and 18. The other participant demonstrated decreases in pain in 8 out of 18 sessions, and these decreases were the largest and most common during the later sessions. Eight participants (40%) experienced an increase in pain in 1 or more sessions. Seven (35%) participants experienced a reduction in pain in 1 or more sessions. Overall, participants experienced an increase in pain in 5% of the sessions and a reduction in pain in 4% of the sessions. Five participants experienced an adverse event in 1 or more sessions. A total of 9 (3%) adverse events occurred over all the treatment sessions. Three participants reported reductions in pain, switching pain categories in at least 1 session. No other adverse events occurred.

Preliminary Efficacy

Secondary outcome data are presented in Table 2. At baseline, participants reported using their affected upper extremity (MAL Amount of Use Scale: $M = 2.5$, $SD = 1.3$) rarely to half as much as before stroke. Participants had moderate impairments in upper-extremity function (ARAT: $M = 31.2$, $SD = 15.7$) and mild impairments in

attention (CBS: $M = 6.1$, $SD = 4.6$). At follow-up, small improvements in upper-extremity use were seen on the MAL Amount of Use Scale. However, the amount of change ($p = .03$) was not statistically significant after Bonferroni correction ($p < .05/3 = .016$). Although statistically significant changes were not observed, the lower limit of the 95% confidence interval indicates that the true change could have been as high as 0.7 points (see Table 2). Participants continued to report using their affected upper extremity approximately half as much as before stroke. They also showed small but statistically significant improvements on the ARAT and the CBS.

Discussion

Preliminary data from this pilot study suggest that repetitive task-specific practice is feasible and tolerable for people with chronic USN and that they can experience small improvements in upper-extremity use, upper-extremity function, and attention. However, we determined that repetitive task-specific practice may not be generalizable to all people with USN. Although a large percentage of people who were screened had USN, only 53% with USN met the study motor function criterion and were eligible to participate. Thus, approximately half of people with chronic USN may not be able to participate in a repetitive task-specific practice program because of severe hemiparesis, and other interventions should be explored for them.

Overall, attendance was excellent. All participants attended all 18 sessions except 2 participants, who attended only 17 sessions because they were not present at a

Figure 2. Mean change on Wong-Baker FACES Pain Rating Scale scores per session.

Note. Error bars indicate standard deviation.

Table 2. Secondary Outcomes (*N* = 19)

Assessment	<i>M</i> (<i>SD</i>)			95% CI	Test Statistic, <i>t</i> ₁₉	Effect Size, <i>d</i>
	Baseline	Follow-Up	Difference			
MAL Amount of Use Scale	2.5 (1.3)	2.9 (1.5)	−0.4 (0.7)	[−0.7, −0.03]	−2.1*	.30
ARAT	31.2 (15.7)	34.6 (17.6)	−3.4 (3.9)	[−5.2, −1.4]	−3.0**	.20
CBS ^a	6.1 (4.6)	4.4 (3.2)	1.7 (2.0)	[0.9, 2.8]	−3.4**	−.44

Note. ARAT = Action Research Arm Test; CBS = Catherine Bergego Scale; CI = confidence interval; *M* = mean; MAL = Motor Activity Log; *SD* = standard deviation. Assessment score ranges: MAL Amount of Use Scale, 0–5; ARAT, 0–57; CBS, 0–30.

^aLower scores = better performance.

p* < .05, not significant after Bonferroni correction. *p* < .01.

scheduled session and did not cancel in advance. Before the start of the study, we determined that uncanceled sessions would not be rescheduled. Although participants completed a high number of repetitions in this study, the mean number of repetitions completed was fewer than the number in a previous feasibility study of people poststroke who did not have USN (repetitions completed: *M* = 5,476, *SD* = 1,088; Birkenmeier et al., 2010). The majority of participants (95%) were satisfied with the intervention. Although many participants reported pain in their affected upper extremity at baseline, participants tolerated the sessions well without substantial changes in pain.

Participants with USN demonstrated small but statistically significant improvements in upper-extremity function and attention and less improvement in upper-extremity use. Although these changes were small, the upper limits of the confidence intervals reported suggest that some participants made larger gains and that the intervention used may be efficacious for a portion of the study sample. However, a larger, adequately powered trial that controls for various characteristics (e.g., time since stroke, dominant side affected by stroke) is needed to further investigate the efficacy of the intervention for people with USN.

On the basis of the preliminary findings, several factors may need to be considered when using repetitive task-specific practice for people with USN, including the intervention dose. Higher doses than those used in the current study may be indicated for people with USN. In this study, the participants received 18 hr of unilateral and bilateral training, whereas van der Lee et al. (1999) offered 60 hr of unilateral training (repetitions not reported) to a sample of participants with chronic stroke. Birkenmeier et al. (2010) used the same intervention protocol and number of hours as the current study, but higher doses of repetitions per session were completed (current study: *M* = 5,152, *SD* = 515.9; Birkenmeier et al., 2010: *M* = 5,476, *SD* = 1,088). In both cases, the differences in training (hours, repetitions) may explain the differences between the small effect sizes in our study and the moderate and large effect sizes in the other two studies.

However, differences in the samples may also explain the differences in effect sizes. Participants in both van der Lee et al. (1999) and Birkenmeier et al. (2010) were in the chronic phase of stroke, but only 10% of the participants in the former study had USN and none in the latter study had USN, although the participants in the Birkenmeier et al. (2010) study had lower baseline ARAT scores (*M* = 21.7, *SD* = 3.3) than our participants (*M* = 31.2, *SD* = 15.7). In the current study, participants were encouraged to perform as many repetitions as possible (following Birkenmeier et al.'s protocol), thus suggesting that they performed what they could tolerate or could complete in an hour-long session. If true, perhaps a combination of more hours and high repetitions may be needed for people with USN to obtain the same level of gains as in van der Lee et al. (1999) and Birkenmeier et al. (2010).

Consideration of measurement issues may be needed in future studies and may be a limitation of our study. In this study, we used physical measures and performance observation to assess upper-extremity function and attention. In addition, we used the MAL Amount of Use Scale, which is a self-report instrument. Because the sequelae of stroke may affect a person's ability to accurately reflect on the amount of use of their affected extremity, self-report measures may be subject to bias. Therefore, a more objective measure may be more appropriate. For example, accelerometers may provide a more accurate measure of upper-extremity activity and use, although they have some limitations (e.g., use compliance; Bailey & Lang, 2013).

We used the CBS—one of the only assessments that examines USN in the context of activities of daily living—as a secondary outcome (attention). Although this assessment is more relevant than pencil-and-paper assessments, we believe that the CBS may not contain sufficiently difficult items and that more complex instrumental activities of daily living may be more relevant, particularly for community-dwelling people with chronic USN. Future studies should examine the ability of the CBS to comprehensively reflect attention in performance of daily activities for people with chronic USN.

The intent of this study was to test the feasibility and tolerability of repetitive task-specific practice in people with USN; therefore, it cannot detect the true effect of the intervention used. However, now that the feasibility and tolerability of the intervention have been established, a larger study that is adequately powered to detect the true effects of the intervention can be designed.

Implications for Occupational Therapy Practice

The results of this study have the following implications for occupational therapy practice:

- Repetitive task-specific practice is feasible and tolerable for people with chronic USN and hemiparesis.
- People with USN may benefit from participating in a repetitive task-specific practice program.
- Occupational therapy practitioners may consider using an intensive, individualized repetitive task-specific practice program for people with USN.

Conclusion

We demonstrated the feasibility and tolerability of repetitive task-specific practice for people with chronic USN. In addition, participants experienced small, but statistically significant, gains in upper-extremity function and attention and less improvement in upper-extremity use. Our data suggest that repetitive task-specific practice may be a promising intervention for people with USN, but further examination is necessary to determine efficacy. Therefore, the findings of this pilot study may be useful in informing future trials of interventions for people with USN poststroke. ▲

Acknowledgments

This study was supported by the National Institutes of Health (Grants UL1 RR024153, UL1 TR000005, UL1 TR000448, and R01 HD068290) and the University of Pittsburgh's School of Health and Rehabilitation Science (Research Development Fund). We certify that we do not have a direct interest in the results of the research supporting this article and have identified all financial support for this research.

References

Azouvi, P. (1996). Functional consequences and awareness of unilateral neglect: Study of an evaluation scale. *Neuropsychological Rehabilitation*, 6, 133–150. <http://dx.doi.org/10.1080/713755501>

Bailey, R. R., & Lang, C. E. (2013). Upper-limb activity in adults: Referent values using accelerometry. *Journal of*

Rehabilitation Research and Development, 50, 1213–1222. <http://dx.doi.org/10.1682/JRRD.2012.12.0222>

Birkenmeier, R. L., Prager, E. M., & Lang, C. E. (2010). Translating animal doses of task-specific training to people with chronic stroke in 1-hour therapy sessions: A proof-of-concept study. *Neurorehabilitation and Neural Repair*, 24, 620–635. <http://dx.doi.org/10.1177/1545968310361957>

Bowen, A., McKenna, K., & Tallis, R. C. (1999). Reasons for variability in the reported rate of occurrence of unilateral spatial neglect after stroke. *Stroke*, 30, 1196–1202. <http://dx.doi.org/10.1161/01.STR.30.6.1196>

Brott, T., Adams, H. P., Jr., Olinger, C. P., Marler, J. R., Barsan, W. G., Biller, J., . . . Hertzberg, V. (1989). Measurements of acute cerebral infarction: A clinical examination scale. *Stroke*, 20, 864–870. <http://dx.doi.org/10.1161/01.STR.20.7.864>

Buxbaum, L. J., Ferraro, M. K., Veramonti, T., Farne, A., Whyte, J., Ladavas, E., . . . Coslett, H. B. (2004). Hemispatial neglect: Subtypes, neuroanatomy, and disability. *Neurology*, 62, 749–756. <http://dx.doi.org/10.1212/01.WNL.0000113730.73031.F4>

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Erlbaum.

Collin, C., & Wade, D. (1990). Assessing motor impairment after stroke: A pilot reliability study. *Journal of Neurology, Neurosurgery, and Psychiatry*, 53, 576–579. <http://dx.doi.org/10.1136/jnnp.53.7.576>

Grattan, E., & Skidmore, E. (2011). Poster 61: Unilateral spatial neglect may not impede upper extremity recovery in individuals with sub-acute stroke. *Archives of Physical Medicine and Rehabilitation*, 92, 1710. <http://dx.doi.org/10.1016/j.apmr.2011.07.086>

Harris, P. A., Taylor, R., Thielke, R., Payne, J., Gonzalez, N., & Conde, J. G. (2009). Research electronic data capture (REDCap)—A metadata-driven methodology and workflow process for providing translational research informatics support. *Journal of Biomedical Informatics*, 42, 377–381. <http://dx.doi.org/10.1016/j.jbi.2008.08.010>

Jehkonen, M., Laihosalo, M., & Kettunen, J. E. (2006). Impact of neglect on functional outcome after stroke: A review of methodological issues and recent research findings. *Restorative Neurology and Neuroscience*, 24, 209–215.

Kalra, L., Perez, I., Gupta, S., & Wittink, M. (1997). The influence of visual neglect on stroke rehabilitation. *Stroke*, 28, 1386–1391. <http://dx.doi.org/10.1161/01.STR.28.7.1386>

Katz, N., Hartman-Maeir, A., Ring, H., & Soroker, N. (1999). Functional disability and rehabilitation outcome in right hemisphere damaged patients with and without unilateral spatial neglect. *Archives of Physical Medicine and Rehabilitation*, 80, 379–384. [http://dx.doi.org/10.1016/S0003-9993\(99\)90273-3](http://dx.doi.org/10.1016/S0003-9993(99)90273-3)

Kelly, A. M. (2001). The minimum clinically significant difference in visual analogue scale pain score does not differ with severity of pain. *Emergency Medicine Journal*, 18, 205–207. <http://dx.doi.org/10.1136/emj.18.3.205>

Kroenke, K., Spitzer, R. L., & Williams, J. B. (2001). The PHQ-9: Validity of a brief depression severity measure. *Journal of General Internal Medicine*, 16, 606–613. <http://dx.doi.org/10.1046/j.1525-1497.2001.016009606.x>

- Lang, C., & Birkenmeier, R. L. (2013). *Upper-extremity task-specific training after stroke or disability: A manual for occupational therapy and physical therapy*. Bethesda, MD: AOTA Press.
- Lyle, R. C. (1981). A performance test for assessment of upper limb function in physical rehabilitation treatment and research. *International Journal of Rehabilitation Research*, 4, 483–492. <http://dx.doi.org/10.1097/00004356-198112000-00001>
- Menon, A., & Korner-Bitensky, N. (2004). Evaluating unilateral spatial neglect post stroke: Working your way through the maze of assessment choices. *Topics in Stroke Rehabilitation*, 11, 41–66. <http://dx.doi.org/10.1310/KQWL-3HQL-4KNM-5F4U>
- Nguyen, T. D., Attkisson, C. C., & Stegner, B. L. (1983). Assessment of patient satisfaction: Development and refinement of a service evaluation questionnaire. *Evaluation and Program Planning*, 6, 299–313. [http://dx.doi.org/10.1016/0149-7189\(83\)90010-1](http://dx.doi.org/10.1016/0149-7189(83)90010-1)
- Nilsen, D. M., Gillen, G., Geller, D., Hreha, K., Osei, E., & Saleem, G. T. (2015). Effectiveness of interventions to improve occupational performance of people with motor impairments after stroke: An evidence-based review. *American Journal of Occupational Therapy*, 69, 6901180030. <http://dx.doi.org/10.5014/ajot.2015.011965>
- Randolph, C., Tierney, M. C., Mohr, E., & Chase, T. N. (1998). The Repeatable Battery for the Assessment of Neuropsychological Status (RBANS): Preliminary clinical validity. *Journal of Clinical and Experimental Neuropsychology*, 20, 310–319. <http://dx.doi.org/10.1076/jcen.20.3.310.823>
- Robertson, I. H., McMillan, T. M., MacLeod, E., Edgeworth, J., & Brock, D. (2002). Rehabilitation by limb activation training reduces left-sided motor impairment in unilateral neglect patients: A single-blind randomised control trial. *Neuropsychological Rehabilitation*, 12, 439–454. <http://dx.doi.org/10.1080/09602010244000228>
- Taub, E., Uswatte, G., King, D. K., Morris, D., Crago, J. E., & Chatterjee, A. (2006). A placebo-controlled trial of constraint-induced movement therapy for upper extremity after stroke. *Stroke*, 37, 1045–1049. <http://dx.doi.org/10.1161/01.STR.0000206463.66461.97>
- Uswatte, G., Taub, E., Morris, D., Light, K., & Thompson, P. A. (2006). The Motor Activity Log–28: Assessing daily use of the hemiparetic arm after stroke. *Neurology*, 67, 1189–1194. <http://dx.doi.org/10.1212/01.wnl.0000238164.90657.c2>
- van der Lee, J. H., Wagenaar, R. C., Lankhorst, G. J., Vogelaar, T. W., Devillé, W. L., & Bouter, L. M. (1999). Forced use of the upper extremity in chronic stroke patients: Results from a single-blind randomized clinical trial. *Stroke*, 30, 2369–2375. <http://dx.doi.org/10.1161/01.STR.30.11.2369>
- Waddell, K. J., Birkenmeier, R. L., Moore, J. L., Hornby, T. G., & Lang, C. E. (2014). Feasibility of high-repetition, task-specific training for individuals with upper-extremity paresis. *American Journal of Occupational Therapy*, 68, 444–453. <http://dx.doi.org/10.5014/ajot.2014.011619>
- Wilson, B., Cockburn, J., & Halligan, P. (1987). Development of a behavioral test of visuospatial neglect. *Archives of Physical Medicine and Rehabilitation*, 68, 98–102.
- Wolf, S. L., Winstein, C. J., Miller, J. P., Taub, E., Uswatte, G., Morris, D., . . . Nichols-Larsen, D.; EXCITE Investigators. (2006). Effect of constraint-induced movement therapy on upper extremity function 3 to 9 months after stroke: The EXCITE randomized clinical trial. *JAMA*, 296, 2095–2104. <http://dx.doi.org/10.1001/jama.296.17.2095>
- Wong, D. L., & Baker, C. M. (1988). Pain in children: Comparison of assessment scales. *Pediatric Nursing*, 14, 9–17.
- Wu, C. Y., Wang, T. N., Chen, Y. T., Lin, K. C., Chen, Y. A., Li, H. T., & Tsai, P. L. (2013). Effects of constraint-induced therapy combined with eye patching on functional outcomes and movement kinematics in poststroke neglect. *American Journal of Occupational Therapy*, 67, 236–245. <http://dx.doi.org/10.5014/ajot.2013.006486>