NeurologySection

Online Journal Club-Article Review

Background/Overview	
Article Citation	Boyd L, Winstein C. Explicit information interferes with implicit motor learning of both continuous and discrete movement tasks after stroke. *J Neurol Phys Ther.* 2006;30(2):46-57.
Study Objective/Purpose (hypothesis)	Previous studies have found that delivery of explicit instructions to people with stroke involving the sensorimotor areas or basal ganglia disrupts implicit motor learning. This study was performed to determine if these results could be replicated for both discrete and continuous tasks.
Brief Background (why issue is important; summary of previous literature)	Learning and memory are comprised of both explicit and implicit processes. Explicit learning entails the conscious verbalization of knowledge, while implicit learning involves changes in skilled behavior that may not be easily verbalized by the learner. The delivery of verbal instructions to guide performance and learning assume that explicit and implicit learning mechanisms are intact. The explicit and implicit memory systems are anatomically different, with the implicit system being largely dispersed and the explicit system being localized to the hippocampus and medial temporal lobe. Explicit and implicit memories occasionally form in parallel; however, it has been suggested that the two systems may compete for resources during the learning of new skills. A previous study by these authors in 2003 suggests that discovering a motor solution through practice, thus relying primarily upon the implicit system, is more beneficial for motor learning than receiving explicit information for people with lesions affecting their sensorimotor cortex.
Methods	
Study Design (type of trial, randomization, blinding, controls, study groups, length of study, follow-up)	This is a randomized control trial looking at differences in explicit and implicit learning in ten individuals with stroke affecting the basal ganglia (BG), ten with stroke affecting the unilateral sensory motor cortex (SMC), and ten age matched volunteers serving as controls (HC). Patients were randomized into groups receiving either explicit information (EI) or no explicit information (No-EI). Each group completed 3 days of practice of a discrete and a continuous task and returned on a fourth day for a retention test to measure learning.
Target Population (dx, acuity, inclusion/exclusion criteria)	Participants included ten patients with basal ganglia stroke, ten patients with unilateral sensorimotor cortical stroke, and ten age-matched volunteers. Patients with stroke were all classified as having chronic stroke (> 6 months since CVA).
Interventions (if applicable): (specificity of interventions, ability to replicate, frequency, duration)	All participants practiced a serial reaction time (SRT) test and a continuous tracking (CT) task. The participants with CVA used the less-affected, or ipsilesional hand. For each task, participants practiced 50 trials of both tasks on each of three days and returned on a fourth day for retention testing.

	<u>Serial Reaction Time Task:</u> Four different colored circles could be displayed on a computer screen directly in front of the participant with a keyboard equipped with capped keys corresponding to the four colors. Only one circle appeared on the screen at a time and each color was always displayed in its same location. Participants were allowed to place one finger of their less involved extremity on each corresponding key to limit the amount of excursion required for a response. The practice pattern repeated over the three day course was as follows: one random block, four sequence blocks, one random block, one sequence block. A retention test measured performance of the sequenced block. <u>Continuous Tracking Task:</u> A lever attached to a vertical axle was secured to a table. A white cursor moved across a black screen. The participant's task was to track the path of the target by moving the lever. Participants saw their movements in relation to the target on the screen in front of them. Unknown to the participants, the middle third of each tracking pattern was identical and repeated across trials (thus implicit). <u>Explicit Information Groups:</u> Across the three days of practice, the EI group was given progressively more explicit information about the task. Explicit knowledge was assessed through varied means during practice days and no information or reminders were provided on day four at retention testing. <u>No-Explicit Information Groups:</u> Participants were asked to respond/track as accurately as possible and neutral responses were given if participants verbalized knowledge of sequencing.
Outcome Measures (relevant to purpose of the study; reliable, valid, clinical utility)	SRT Task: Primary outcome measure was response time (response time=reaction time + movement time), calculated as time between stimulus onset and completion of response. Median response times were calculated for each 10-element sequence trial and then summarized by calculating mean median for each block of responses. CT Task: Measured using root mean squared error (RMSE), which reflects tracking errors and is an average of the difference between the target movement pattern and the actual movement of the participant. Calculated separately for random and repeating trials. To allow for comparison across the different tasks a percent change score was calculated to reflect difference between performances for the repeated task compared with the random sequence. Explicit knowledge was calculated by subjective and recognition memory.
Statistical Analysis (statistics used, appropriate application)	Group (HC, SMC, BG) by Task (SRT, CT) by Information (EI, No-EI) by Block (1-15) Analysis of Variance (ANOVA) with repeated measures correction using percent change as dependent measure. Retention test data was evaluated with a multivariate Group by Information by Task ANOVA. Level of significance set at $p \leq 0.05$.
Results	
Enrollment/Subject Characteristics (sample size, gender, age, functional	Participant Characteristics: - All participants were Right hand dominant

level; were groups similar on important variables prior to application of the intervention)	- There were no statistically significant differences in age, education, MMSE scores, or UE Fugl-Meyer scores between groups
	- BG Group: 10 people with chronic, unilateral stroke affecting the putamen (5 in each group)
	    o Explicit Instructions: 4 with Right-side lesion, 4 men, mean age 51, mean duration since stroke 27.8 months, mean UE Fugl-Meyer 47.8
	    o No Explicit Instructions: 4 with Right-side lesion, 3 men, mean age 58.2, mean duration since stroke 10.4 months, mean UE Fugl-Meyer 44.4
	- SMC Group: 10 people with chronic, unilateral stroke affecting the sensorimotor cortex (5 in each group)
	    o Explicit Instructions: 3 with Right-side lesion, 2 men, mean age 59.0, mean duration since stroke 33.4 months, mean UE Fugl-Meyer 30.2
	    o No Explicit Instructions: 1 with Right-side lesion, 4 men, mean age 58.6, mean duration since stroke 48.0 months, mean UE Fugl-Meyer 26.8
	- HC Group: 10 age-matched controls without brain damage (5 in each group)
	    o Explicit Instructions: 1 man, mean age 55.4
	    o No Explicit Instructions: 2 men, mean age 57.4

Summary of Primary and Secondary Outcomes (include aggregate and sub-group findings if reported); note results that were statistically significant; How many reached a level of clinical significance (exceed MCID if known); Was there retention of changes following intervention (if studied)	All participants improved performance on both tasks with practice. For individuals with stroke affecting the basal ganglia or sensorimotor cortex, the provision of explicit instructions interfered with learning of both the continuous and discrete tasks compared to individuals who received no explicit instructions. In contrast, individuals without brain damage benefitted from explicit instructions, demonstrating greater changes in performance at the time of retention testing if they had received explicit instructions. Among the groups that received explicit information, the group without brain damage gained the most explicit knowledge.
Authors' Discussion and Conclusions	
Brief Summary of Authors' Main Discussion Points; Authors' Conclusion	For individuals without brain damage, receiving explicit information enhanced implicit motor learning. In contrast, for individuals with damage to the basal ganglia or sensorimotor areas due to stroke, receiving explicit information interfered with implicit motor learning. These findings have implications for clinicians structuring practice of motor skills. Allowing individuals with damage to the basal ganglia or sensorimotor cortex to discover a solution through practice as opposed to providing them with explicit instructions may enhance motor learning. The opposite seems to hold true for individuals without damage to these regions.
Reviewer's Discussion and Conclusion	
Study Strengths	- Participants were randomly assigned to receive explicit instructions or no explicit instructions, thus minimizing bias.

	- Potential non-specific learning factors were minimized by comparing retention test performance to performance on the second block of random practice on the first day. - A retention test was performed to assess learning, rather than just performance. - Corrections were made for multiple comparisons to reduce the chance of type I statistical error. - There were homogenous groups with respect to lesion location, diagnosis, age, and severity of stroke.
Study Limitations and Potential for Bias	- This study had a small sample size (30, with 10 in each group) - The generalizability of the results may be limited by the small sample size, the specificity of the tasks practiced, and the specific lesion locations studied.
Applicability: • Types of patients (dx) that results apply to • Types of settings or patient acuity that the results apply to • Can interventions be reproduced? Can results be applied to other pt populations?	- This study examined effects of training the less-affected arm following stroke, which may not be clinically meaningful for people with stroke - This study cannot be applied to all people with stroke, as only people with MCA stroke > 6 months prior, affecting the basal ganglia or sensorimotor cortex were included. Participants had moderately severe strokes, which may limit applicability to less-impaired or more impaired individuals. - This study investigated learning of largely non-functional, computer-based tasks involving one UE and the findings may not apply to movements such as sit-to-stand, ambulation, etc., which are commonly practiced in physical therapy . - The average age of participants in each group was < 60 years old and results may not apply to older individuals with stroke. - All participants were right-handed, but not all participants with stroke were more impaired in their Right UE. - It is unknown if these results apply to other individuals with damage to their basal ganglia or sensorimotor areas (e.g. Parkinson's disease, multiple sclerosis).
How will study results impact PT management of this patient population?; List suggestions for how to implement changes in your clinic/department to integrate study findings into patient care	Many tasks practiced during physical therapy are motor skills that rely on implicit learning to improve performance. This study, supported by previous research, provides evidence that explicit instructions during practice can interfere with implicit motor learning in individuals with damage to the basal ganglia or sensorimotor areas. Instead, allowing people with damage to these regions to problem-solve and discover a solution to achieve the movement goal may be more beneficial for learning. In contrast, individuals without damage to these areas seem to benefit from explicit instructions and may learn a movement better if given explicit information about optimal performance. These results suggest one needs to consider whether or not someone has damage to their basal ganglia or sensorimotor cortex when structuring practice. For example, when asking someone with an MCA stroke to practice sit-to-stand, it may limit their future performance if the therapist explains the proper sequence step-by-step prior to attempting the movement. It may be best to provide feedback if needed after several practice attempts.