Visual and Auditory Feedback Differentially Modulate Feedforward and Feedback Learning During a Novel Upper Extremity Task

Ryan Spence, B.S.

Research Mentor and other collaborators:

Richard Shields PT, PhD, FAPTA, UI PTRS Research Mentor; Katie Laubscher, PT, DPT, ILEND Research Mentor

Objective:

Shoulder pathology is the third most common musculoskeletal complaint and is very common in the athletic population and those who work overhead. This study explores the associations between anthropometrics and motor learning and retention and determines if visual, auditory, or a combination of visual and auditory feedback differentially modulates motor learning. The primary study was completed as part of the University of Iowa DPT Program Research Requirement. An additional literature review and analysis for knowledge translation to individuals with disabilities was completed for the ILEND Program.

Methods:

59 right-hand dominant healthy young adults with no known shoulder pathology (30 females and 29 males) were recruited for this study. The study consisted of two visits over one week (pretest and post-test experiment). The motor task each participant performed was external rotation and internal rotation of the shoulder to follow a sinusoidal wave on a computer screen. Participants were randomly assigned to a different form of feedback (auditory, visual, and combined visual and auditory) during their training sessions. The first day consisted of the pretest and training sessions, and the second day consisted of the posttest followed by the NIH Toolbox Cognitive assessment and a measurement of their anthropometrics (body mass, height, weight, etc.). Descriptive statistics were performed on all participants data, and the statistical analysis performed was paired t-tests, split-plot anova, and Pearson correlations.

A literature review was completed to integrate current knowledge of motor learning and use of feedback with motor tasks for individuals with disabilities. Search terms utilized for literature review included: “motor learning,” “feedback,” “postural control,” and “developmental disabilities.” Seven articles were originally identified and three were narrowed for an in-depth review.

Results/Conclusions:

Coherence (how in sync two sets of data are) significantly improved from day 1 pretest to day 1 posttest showing that short term learning occurred in the visual and combined visual and sound groups. It is important to note that the way that one group responded from pre to post is not consistent with how another group responded. When comparing coherence from day 1 posttest to day 7 posttest there was no significant interaction between groups, however, there was improvement in coherence showing that there was learning with no practice.

When comparing how an unexpected perturbation changes user error to user error without an unexpected perturbation there is an increase in error when an unexpected perturbation occurs. However, after one day of training there was a statistical significance across all forms of feedback (no interaction across the different forms of feedback). Day 1 posttest and Day 7 posttest error rates were similar and showed no significant difference. However, since the two scores are similar, the implication is that the participants retained the skill they learned during the training session the week prior.

The only significant correlations were the pattern sequence and visual feedback for short term and long-term learning (positive correlations) and pattern comparison and auditory feedback and long-term learning (negative correlation). The two positive correlations suggest that a higher score on the picture sequence task of the NIH – the participants had less error following the unexpected perturbation. However, the negative correlation suggests that a high pattern comparison score along with auditory feedback increases the error the participants experience following an unexpected perturbation.

Translation of this information from a healthy population to individuals cannot be made directly. However, we can consider these findings in combination with the known impairments for individuals with disabilities to design effective physical therapy treatments to increase the function of these individuals to increase their quality of life. For example, children with cerebral palsy can have difficulties with direction specific activities (e.g., reaching while sitting). This can be caused by the atypical development in the capacity to recruit these direction-specific adjustments. Balance training has been shown to accelerate the development of postural control in typically developing infants, therefore, balance training with the inclusion of auditory or visual feedback could aid in the development of postural control during balance training. Also, individuals with Down Syndrome often have low tone, contributing to the difficulty in performing motor tasks. By pairing the learning of a motor task with various forms of feedback, you can potentially increase motor control to help increase the ability to perform functional motor tasks.