

AGE-RELATED DIFFERENCES IN BALANCE AFTER TASK-SPECIFIC TRAINING

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INTRODUCTION

Falls are a leading source of injury and death in adults over the age of 65 [1]. Numerous exercise interventions have been proposed to help reduce falls in older adults, but do not consistently result in a decrease in falls [2]. This may be due to the fact that the vast majority of these exercises are general in nature and not specifically focused on the motor and sensory skills directly involved in preventing falls. Task-specific training is an alternative intervention approach that may prove beneficial in preventing falls in older adults. However, it is unclear how increased age may influence any beneficial effects from task-specific training.

Based upon this, the main purpose of this study was to investigate how age influences the beneficial effects of task-specific training on balance. It was hypothesized task-specific training would improve balance in both young and older adults, but older adults would experience less improvement and poor retention of these improvements compared to young adults.

METHODS

Six young (mean age $22.8 \pm SD 2.6$ years) and six older (73.2 ± 2.2 years) adults were recruited to participate in the study from the university population and surrounding community, and informed consent was obtained prior to participation. A single subject experimental design was used where participants served as their own controls using multiple baseline measurements prior to the task-specific training intervention. The experiment consisted of four baseline tests, each separated by one week, four weeks of training, and three follow-up tests up to three months later.

Testing and training were performed on a pneumatic instrumented moving platform (PIMP) (Figure 1). At the start of each test, participants stood on the PIMP relaxed while looking straight



Figure 1: Experimental set-up of the PIMP. The PIMP translated a maximum of 0.15 m forward and 0.25 m backward at an average velocity of 0.45 m/s. A force platform is integrated with the PIMP and used to quantify balance.

ahead. Prior to the first baseline test, each participant's maximum displacement that could be withstood without stepping was determined. Each baseline and follow-up test consisted of six trials using this maximum displacement (including three forward and three backward translations). Training consisted of three sessions per week for four weeks, and 50 trials per session. Throughout the training, the direction of the PIMP was varied randomly and distance traveled of the PIMP was varied based on the participant's performance.

During all testing sessions, ground reaction forces were sampled at 1000 Hz from a force platform mounted on the PIMP, and the center of pressure (COP) was determined. Balance was quantified using the time to stabilization of the center of pressure (TTS COP) [2]. TTS COP was defined as the time for the COP velocity to return below a threshold velocity that was common across all participants. This threshold was based upon the mean and standard deviation of COP data prior to PIMP movement from all participants. A two-way mixed-model ANCOVA was conducted on TTS COP with age (young or old) and session (before training, 1 wk. post-training, 1 mo. post-training, 3 mo. post-training) as independent variables, and absolute value of PIMP displacement as a covariate. In the event of an age x session interaction, post hoc Student's *t* tests were conducted. Translation

direction did not have an effect on TTS COP, and therefore was not included in the analysis.

RESULTS AND DISCUSSION

TTS COP exhibited a significant age x session interaction ($p=0.001$) indicating differences in how task-specific training influenced young and older adults (Figure 2).

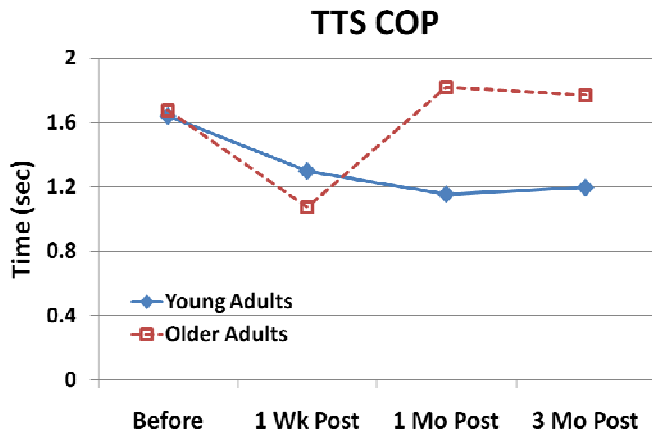


Figure 2: Mean TTS COP values for young and older adults before training, one week, one month, and three months post-training. Solid blue line represents young adults; dotted red line represents older adults.

Both young and older adults decreased their TTS COP after four weeks of training an average of 20.8% and 34.5%, respectively ($p<0.05$). One month post-training, young adults were able to maintain this reduction (mean value was 25.7% lower than before training; $p<0.05$) while older adults were not (mean value was 9.0% higher than before training; $p>0.05$). Three months post-training, young adults maintained improvements from training (mean value was 20.7% lower than before training; $p<0.05$).

Based upon the assumption that decreases in COP TTS correspond to improved balance, our results support the hypothesis that task-specific training would improve balance in both young and older adults. Repeated exposure to a postural perturbation alters sensory information processing [3]. By training participants on the PIMP, improvements in balance were possibly due to accessing stored information obtained due to repeated practice. Pai et al. (2007) also demonstrated older adults have the ability to improve balance recovery skills similar to young adults after a single session of repeated exposures to a simulated slip [4].

While young adults were able to retain the improvements up to three months post-training, older adults were unable to retain the improvements one month post-training. One explanation may be age-related declines in the central nervous system. Improvements in balance after training may involve a shift from longer reflex pathways starting at the spinal cord to shorter reflex pathways in the cortical and subcortical region [3] which older adults were not able to form with four weeks of training.

With the current training protocol, both young and older adult were able to improve their balance with task-specific training, but older adults did not maintain these improvements. This suggests the training protocol used here was sufficient to improve balance in older adults one week later, but not for one month later. As such, more training is likely needed for older adults by either increasing the number of trials performed each day of training, the number of training days per week, or the number of weeks of training.

CONCLUSIONS

An improvement in balance was seen after four weeks of task-specific training in both young and older adults. This improvement was retained for three months in young adults but was not maintained for one month in older adults.

Although the results showed beneficial effects of task-specific training on balance, future studies should determine the optimal training to allow for improvements to be retained in older adults.

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