

# Variability of Practice Effects in Transfer of Photoelectric Rotary Pursuit Task

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## Abstract

The purposes of this study were to investigate the effects of variability of training on the acquisition of motor skill of closed loop type tracking task using Rotary Pursuit, and to determine if there was a bilateral transfer effect to the non-dominant hand following practice with the dominant hand. Twelve healthy volunteer students (5 males and 7 females, aged 25 to 37) were randomly divided into a constant practice group and a variable practice group. A photoelectric rotary pursuit apparatus with stop clock and repeat cycle timer by Lafayette Instrumentation Co. was used for this study. Rotary pursuit is a closed loop task in which a subject attempts to keep a photoelectric stylus on a lighted target in motion. Subjects performed the clockwise circular pursuit task while standing. Experimental procedure was divided into three sessions, namely, pre-test, training, and post-test. The constant group practiced all 60 trials at 30 rpm. Variable practice group did a varied practice session with 15 trials at speeds of 20 rpm, 26 rpm, 34 rpm, and 46 rpm. No one in either group practiced with their non-dominant arm. A Mann-Whitney test and a Wilcoxon Signed Ranks test were used for statistical analyses. The results of this study showed no different training effect between groups on the post-test with the dominant hand. However, bilateral transfer effect of rotary pursuit task between hands was demonstrated. Possible mechanisms are discussed.

**Key Words:** Bilateral transfer; Motor learning; Rotary pursuit; Variability of practice.

## Introduction

Motor learning is a result of practice or experience, and there are many variables that influence the effectiveness of the practice such as viability and distribution of practice (Schmidt and Lee, 1999). Rotary pursuit, shown in figure 1, is a closed loop tracking task in which a subject attempts to keep a photoelectric stylus on a lighted target which is in motion (Bryd and Gibson, 1988; Dunham, 1978). To perform this task successfully, a continuous correction mechanism of motor program via visual and proprioceptive information is necessary. The direction, speed and shape of the target path of rotary pursuit task can be manipulated by the examiner. The timing apparatus measures the accuracy of performance by determining the amount of time the subject stays

on target. This allows quantifiable results and accurate feedback. The rotary pursuit apparatus may be useful in studies of following: coordination and limb control, attention to task, variable training schedules (Dunham, 1978), variable feedback schedules, bilateral transfer (Bryd and Gibson, 1988), and differences between left and right limb performance.

Viability of training is a factor that affects motor learning (Schmidt and Lee, 1999). In general, the motor training in a constant environment is effective in increasing the performance level during practice session and short term transfer session. However, practice in variable practice conditions is more effective than constant practice in long term retention and in transfer to novel situations.

In real motor performance, we face situations that require the capability to deal with unfamiliar sit-

uations; practicing only in constant situations would probably not be proper. According to schema theory, it is believed that transfer of learned motor skills to novel tasks would be enhanced after practicing in variable practice conditions as compared to constant practice conditions (Schmidt and Lee, 1999). Many experimental researches have confirmed that a constant practice group showed better performance of novel variations than those who had never performed the tasks previously (Shea and Kohl, 1991; Wrisberg and Ragsdale, 1979). Variable practice appeared to increase the applicability of the learning that occurred in the acquisition period of motor skills.

It is known that performance by an unpracticed limb improves after the contralateral limb has acquired the action by practice. Improvement in the unpracticed limb after practice with the contralateral limb is referred to as bilateral transfer or inter-manual transfer of skill (Cook, 1993; Gualtieri et al., 1983; Schmidt and Lee, 1999; Teixeira, 2000; Teixeira and Caminha, 2003). Many laboratory experiments have reported bilateral transfer effects in tasks such as mirror tracing, normal and mirror-image writing, continuous rotary pursuit tracking, rapid continuous tapping, drawing of non-meaningful figures, anticipatory timing, timing and force control, and linear positioning capability (Baguley et al, 1970; Cook, 1933; Milisen and Van Riper, 1939; Teixeira, 2000; Teixeira and Caminha, 2003).

The purposes of this study were to investigate the effects of variability of training on the acquisition of motor skill of closed loop type tracking task using rotary pursuit, and to access if there was a bilateral transfer effect to the non-dominant hand following practice with the dominant hand. The hypotheses were: 1) The subjects in both training groups would show improvement from pre-test to post-test with the dominant and non-dominant arms. 2) The constant practice group would perform better than variable practice group on the post-test with the dominant arm.

## Methods

Twelve healthy volunteer students (5 males and 7 females, aged 25 to 37) were randomly divided into a constant practice group and a variable practice group. A photoelectric rotary pursuit apparatus with stop clock and repeat cycle timer by Lafayette Instrumentation Co. was used for this study (Figure 1).



**Figure 1.** Rotary pursuit apparatus

The subjects performed the clockwise circular pursuit task while standing. The subject were asked to hold a stylus in their dominant hand and attempt to keep its tip in contact with the photoelectric target as the turntable rotated at various speeds. The test and practice procedures were identical for both the variable practice group and the constant practice group except the speed of the target rotating during the practice session varied.

Experimental procedure was divided into three sessions, namely, pre-test, training, and post-test. Prior to starting the pre-test, subjects were given three practice trials on each arm and told the results of each trial. The pre-test on each arm consisted of 10 trials at 30 rpm. The duration of all trials was 10 seconds with a 5 second rest between trials. The order of testing arms was randomized. No augmented feedback was given during the test, but the subjects were shown the results upon completion.

For both groups, the pre-test was immediately followed by a practice session of 60 trials only with the dominant arm. The constant practice group did all 60 trials at 30 rpm. The variable practice group had a varied practice session with 15 trials at speeds of 20 rpm, 26 rpm, 34 rpm, and 46 rpm. None is ei-

ther group practiced with their non-dominant arm. The variable practice group never practiced at 30 rpm. The subjects in both groups were given a one cycle (15 seconds) break after every 15 trials where the variable practice group had a change in speed. The subjects were told the time on target they achieved for each practice trial immediately following the trial. The total number of practice trials and total practice time were constant between groups.

The post-test was given 30 minutes after completion of the practice session. Again, two practice trials were given on each arm immediately preceding the test trials. Both groups were tested with the dominant arm at 30 rpm, then the non-dominant at 30 rpm.

Because of the small number of subjects, the data

were statistically analyzed using non-parametric tests. The Mann-Whitney test was used for each arm to compare the groups for the individual improvement of on target time, and the Wilcoxon Signed Ranks test was used to compare the on target time from the pre-test to post-test.

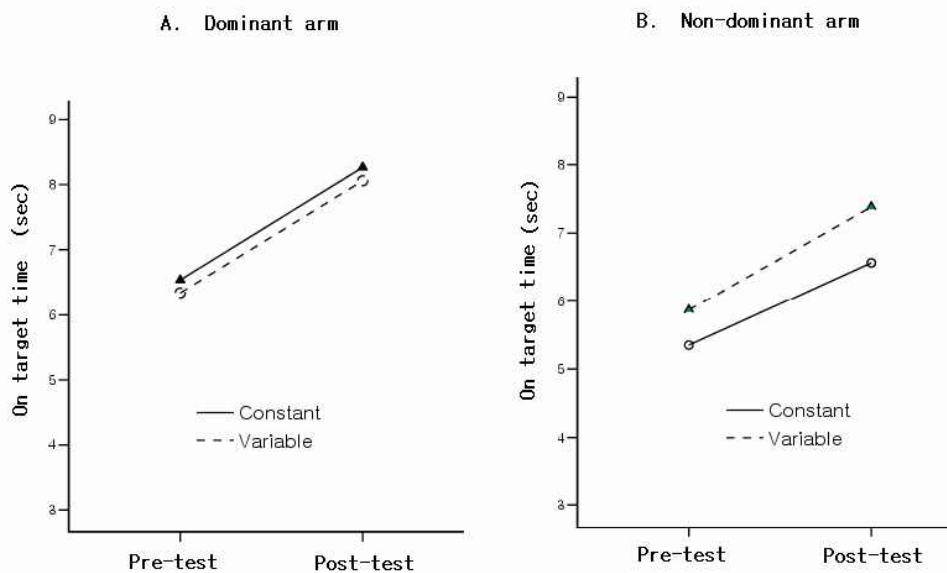
## Results

As expected, both groups of subjects demonstrated significant improvement in the on target time of the dominant hand. The constant training group showed an average improvement of 1.73 sec, and the variable practice group showed an average improvement of

**Table 1.** Mean on target time

(second)

Dominant hand				Non-dominant hand			
Constant training		Variable training		Constant training		Variable training	
Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
6.33±1.04	8.06±.57	6.53±1.10	8.27±.49	5.35±.84	6.57±1.00	5.87±.75	7.38±.68



**Figure 2.** On target time

1.74 sec on the post-test (Table 1) (Figure 2A).

Although initially it was proposed that there would be a different training effect between groups on the post-test with the dominant hand, there were no prominent statistical differences between the groups in this study (Figure 2A).

As indicated in figure 2B, both groups showed improvement in the on target times and there was no statistical difference between groups. Also, this was evident in all subjects in the study regardless of the practice type (Table 1) (Figure 2B).

### Discussion

As one would expect, the results of this experiment showed that the on target times of both groups were improved from pre-test to post-test with the dominant arm. The constant feedback consistent with the rotary pursuit most likely allowed an individual to improve his or her on target time throughout the testing procedure.

Initially, it was expected that the constant practice group would perform better than the variable group in the post-test (short-term retention) with dominant arm since they practiced intensively only at a constant speed of 30 rpm, therefore, they have a better idea of what 30 rpm is like (Schmidt and Lee, 1999). However, there was no prominent difference between groups in the post-test. There are a number of feasible explanations for this result. First, the speeds of the tracking task of the variable practice group during the practice session (26 and 34 rpm) were close enough to the speed of post-test session, which was at 30 rpm. Because all the subjects were tested at the same speed on pre- and post-tests, a learning effect might have occurred in this experiment.

Additionally, the motor skill involved in this experiment was practiced in a well controlled closed environment. This means the variability of the training effect could not be so obvious in this kind of experimental setting when the environmental con-

ditions are always quite similar. Because the criterion task to be learned is always similar, the various speed of practice itself could not affect the learning effect by constant training (Schmidt and Lee, 1999).

Finally, this study demonstrated the bilateral transfer of skills between dominant and non-dominant hands by showing the improvement of on target times without practice on the non-dominant side (Freeman, 1938). The improvement seen in the non-dominant arm on the post-test (above the highest score achieved on the pre-test) was obvious and this improvement could be induced by a result of transfer effect from practice done by the dominant arm.

Future studies could be developed based on this experiment, for example, clinical experiment to determine the bilateral transfer effect for rehabilitating patients with stroke, experiments to examine the effect of variability of practice on open skill, and studies to determine the variability of practice on long-term retention tests.

### Conclusion

It can not be derived from this study that variability of training influence motor learning with the photoelectric rotary pursuit task. However, bilateral transfer of motor skills without practice to the non-dominant side was evident in this study.

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