Effects of Force Level and Hand Dominance on Bilateral Transfer of a Fine Motor Skill.

K. Muller, A. Rai, L. Abraham

Motor Coordination Laboratory, Kinesiology and Health Education, The University of Texas at Austin

Introduction

Objective:
To investigate previously reported differences in bilateral transfer of a motor skill depending on force level of the task and direction of transfer

Aims:
Determine whether dominant limb practice has a higher impact on non-dominant limb performance than vice versa. Determine whether a task with a higher force level will lead to more transfer of skill

Methods

Participants:
- 40 right-handed, healthy volunteers ages 18-30 years randomly assigned to 1 of 4 groups: right hand practice, high force (**DH**), right hand practice, low force (**DL**), left hand practice, high force (**NH**), left hand practice, low force (**NL**).

Task:
Manipulate a computer screen cursor with isometric forces produced by the left and right index fingers in order to trace an X-shape. Participants will perform one test trial with one hand, followed by 20 practice trials with the other, followed by another test with the original hand. What hand they begin with, as well as the force level they will be performing the task at depends on what group they are in. Independent analog force data controlling the cursor location were collected @ 1kHz from both index fingers and compared to the moving target location using our MFQS apparatus (Figure 3)

Each participant performed:
- Pre isometric digit flexion maximal voluntary contractions (MVC) to normalize testing force levels.
- 1 familiarity trial to become accustomed to the equipment, including target movement and cursor control
- 1 baseline test trial of the task with their test hand
- 2 blocks of 10 practice trials with the opposite hand
- 1 test trial of the task with their test hand, to compare to the baseline trial

Dependent Measures:
- **Tracking error** - root mean squared error (**RMSE**)
- **Error Variability** - coefficient of variability of the error (**CVE**)
- **Time** – time taken to complete the tracing task
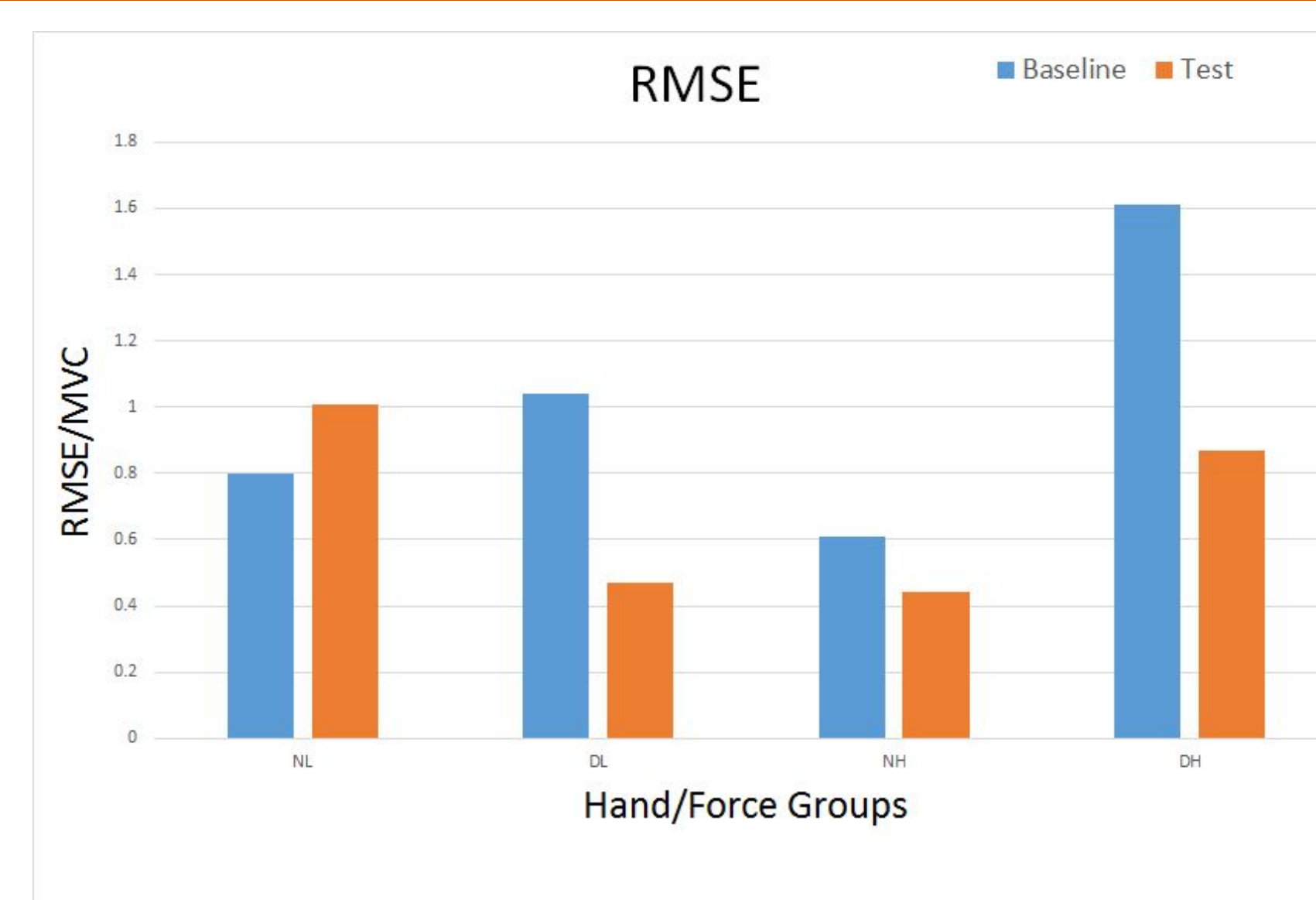
Results (Pilot Data)
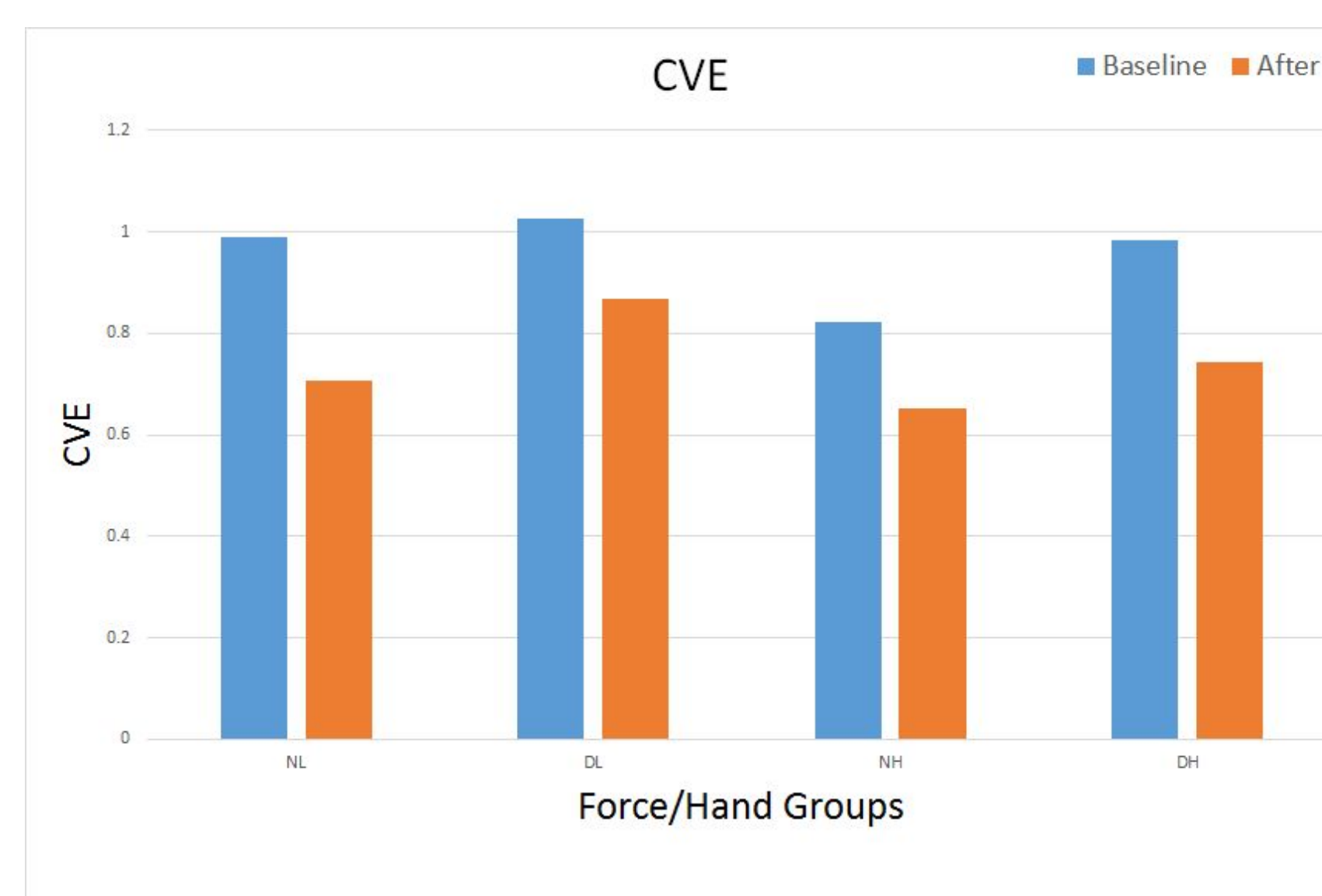

Figure 1: RMSE values before and after practice
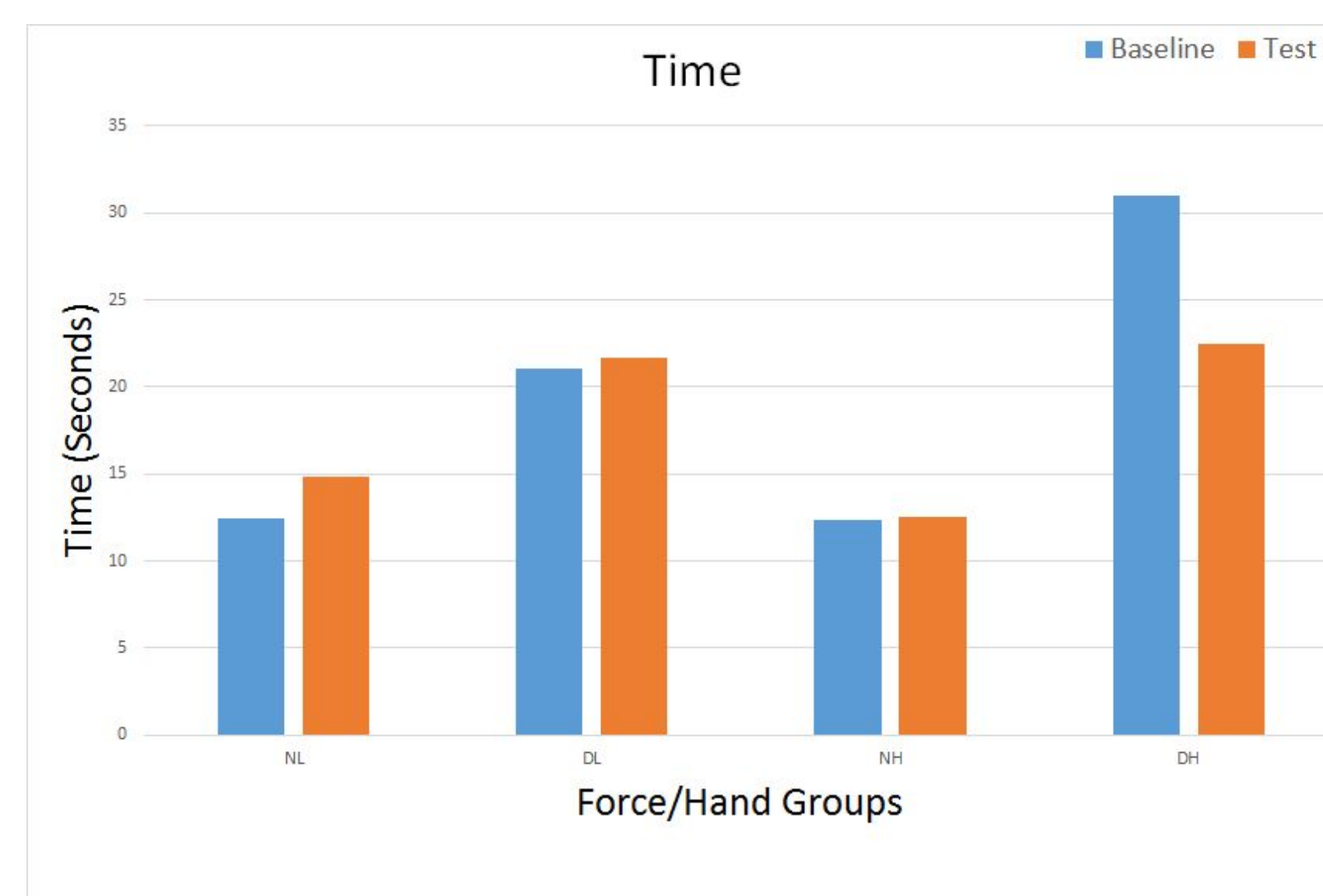

Figure 2: CVE values before and after practice

Figure 3: Time taken (seconds) before and after practice

Apparatus

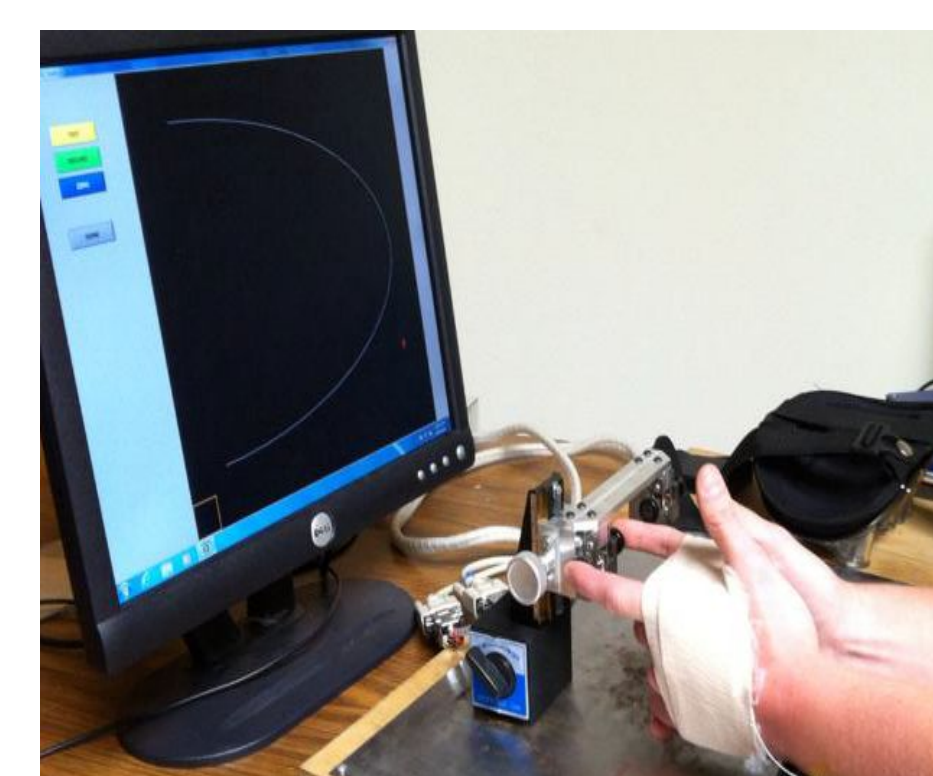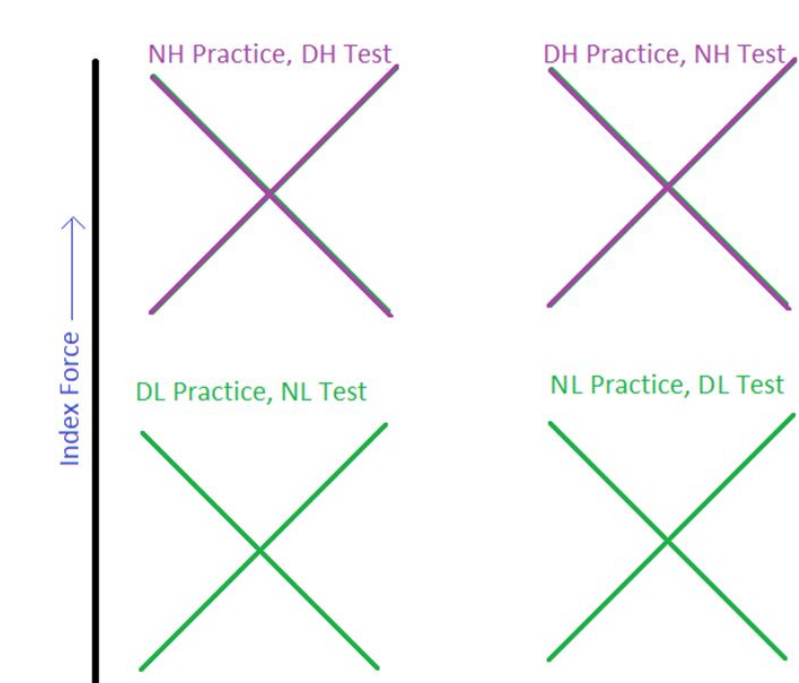**Figure 3:** MFQS apparatus

Figure 4: The task shape

Summary of Results

The person that experienced the largest drop in RMSE was the high force, right hand practicing left hand testing group (**DH**). Next was the **DL** group, followed by the **NH** group, with the **NL** group having an increase in error.(Figure 1).

Cursor movement smoothness improved for each of the groups, with the **NL** group expriencing the most reduction in CVE, with the **DH** group closely behind. (Figure 2).

Time taken to finish the task remained almost the same for the **DL** and **NH** groups, and increased for the **NL** group. Time decreased for the **DH** group.

Conclusions

These preliminary results support our hypothesis. The **DH** was the only group to express improvement in all three metrics of performance, with a lower RMSE, CVE, and Time. We hypothesized that more bilateral transfer would occur in higher force conditions, and from the right hand to the left, and this supports that idea. The **NL** group was hypothesized to show the least improvement, and this is what our results show. **NL** had only a derease in CVE, but an increase in Time and RMSE.**DH** had the second most improvement as both **DH** and **NL** experience little change in time but **DH** had a larger decrease in RMSE. This leads us to believe that directionality is more important than force level when it comes to degree of transfer, however further testing is required.

References

Dettmers , C. , Fink , G. R. , Lemon , R. N. , Stephan , K. M. , Passingham , R. E. , Silbersweig , D. , Holmes , A. , Ridding , M. C. , & Frackowiak , R. S. (1995) Relation between cerebral activity and force in the motor areas of the human brain . Journal of Neurophysiology , 74 , 802 - 815 .

Parlow , S. E. , & Kinsbourne , M. (1989) Asymmetrical transfer of training between hands: implications for interhemispheric communication in normal brain . Brain and Cognition , 11 , 98 - 113 .

Spirduso WW, Eakin T, Francis K, and C. Stanford (2005). Quantification of manual force control and tremor. Journal of Motor Behavior. Vol. 37 No. 3, p. 197-210.

Teixeira , L. A. (1993) Bilateral transfer of learning: the effector side in focus . Journal of Human Movement Studies , 25 , 243 - 253 .

Teixeira , L. A. (2000) Timing and force components in bilateral transfer of learning . Brain and Cognition , 44 , 455 - 469 .

Yao, Wan X., Alberto Cordova, Yufei Huang, Yan Wang, and Xing Lu. (2014): "Bilateral Transfer For Learning To Control Timing But Not For Learning To Control Fine Force 1." *Perceptual and Motor Skills* 118.2 400-10. Web.