Quantitative Assignment- WebFitt Study

Danya Balakumaran Meenakumari(yka2dk), Kazi Noshin(epw9kz)

Study Design:

This study is based on within-subject design as a sample of 4 participants were taken during this experiment. Initially, we were introduced with webfitt platform in our classroom, and we got familiar with how this platform works and got better insights of this experiment works. Once we started to analyze the data for our qualitative study, we understood various aspects and inferences from the files. We decided our independent, dependent variables, repetition of our trails, control variables and necessary conditions to carry forward our study.

We took the following strategies for our study:

Independent Variables:

- *Hand Dominance* [Dominant, Non-Dominant]
- *Number of targets* [15,7].

Dependent Variables:

- *Task completion Time*
- *Error Rate*
- *Throughput*

Control Variables:

- *Pointing Device: Touchpad*

To begin with, we set four different conditions between the hand dominance and number of targets (2(HD)*2(targets)). For each participant we have conditions

Condition 1: dominant hand, target size: 15

Condition 2: non-dominant hand, target size: 15

Condition 3: dominant hand, target size: 7

Condition 4: non-dominant hand, target size: 7

We repeated 3 trials for each condition resulting in 12 trials of all the conditions from each participant.

We approached our fellow classmates and other students from same and different departments as well. In the end, we got 4 participants in which three were female students and one male student. We did not get any consent forms from the participants as we had mutual verbal consents. All 4 participants were unaware of how this demographic survey works. So, we had one trial session to make them familiarize with this survey. 2 female participants were Ph.D. students and rest of them were Master's Students. All the participants were good enough at working with touchpad, we selected intermediate level for them. Finally, we started with our survey where each participant hardly took 7-8 minutes excluding the initial trial session.

Study Results:

Descriptive statistics:

The mean and standard deviation of mean completion time and mean click error for hand dominance is presented below:

Mean Completion Time		
Hand Dominance	Mean	Standard Deviation
Dominant	1198.8661	229.0981
Non-Dominant	1485.9517	201.1439

Table 1: *Effect of hand dominance on mean completion time*

Mean Click Error		
Hand Dominance	Mean	Standard Deviation
Dominant	6.9841	9.6254
Non-Dominant	2.7778	7.8431

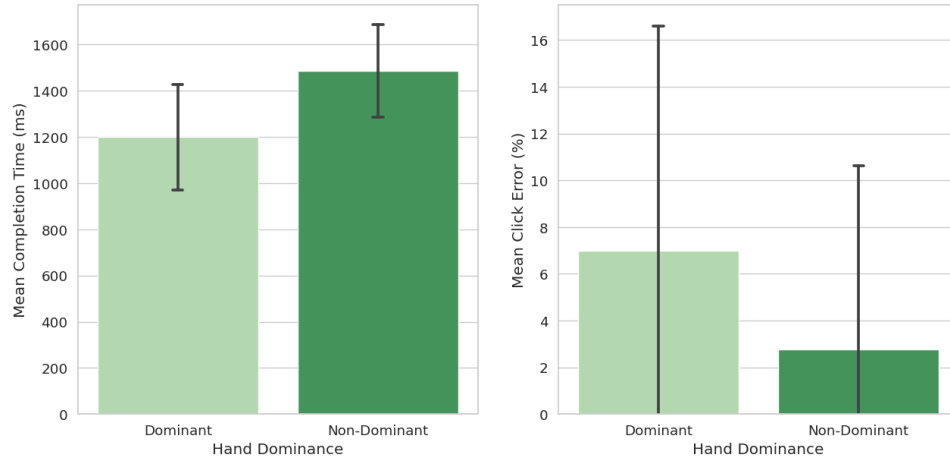**Table 2**: *Effect of hand dominance on mean click error*

Figure 1*: Effect of hand dominance on mean completion time and mean click error*

From Table 1, 2 and Figure 1, we see that people took less time while using dominant hand than using non-dominant hand, and surprisingly the error rate was less while people used dominant hand than used non-dominant hand. In our study, dominant hand was always before non-dominant hand. Our hypothesis is that order effect might influence the results.

The mean and standard deviation of mean completion time and mean click error for number of targets is presented below:

Mean Completion Time		
Number of Targets	Mean	Standard Deviation
15	1353.4922	253.09240
7	1331.3256	267.64433

Table 3*: Effect of number of targets on mean completion time*

Mean Click Error		
Number of Targets	Mean	Standard Deviation
15	5.0	7.9248
7	4.7619	10.0281

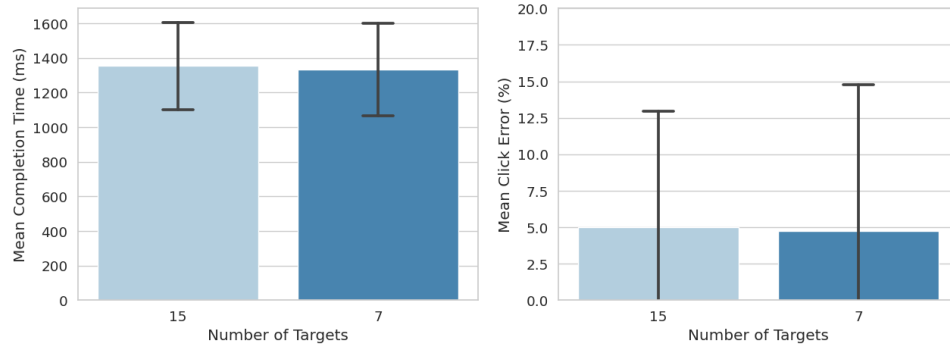***Table 4****: Effect of number of targets on mean click error*

Figure 2*: Effect of number of targets on mean completion time and mean click error*

From Table 3, 4 and Figure 2, it can be observed that people take a little more time to finish the task for 15 targets than 7 . The error rate also doesn't vary significantly with varying the number of targets.

To be sure about the effect of hand-dominance and target width on completion time and error rate, we proceed with hypothesis test.

Hypothesis Testing Results:

Two Way Anova Test:

	sum_sq	df	F	PR(>F)
C(hand_dominance)	9.890182e+05	1.0	20.414246	0.000046
C(number_of_targets)	5.896312e+03	1.0	0.121705	0.728856
C(hand_dominance):C(number_of_targets)	1.468967e+02	1.0	0.003032	0.956336
Residual	2.131688e+06	44.0	NaN	NaN

Figure 3: *Two way anova test result for Hand, Target and Hand*Target with respect to mean completion time*

In figure 3, Degree of Freedom for Hand, target and Hand*Width are 1. From this anova test result we can say that the effect of Hand dominance is statistically significant for task completion time as (F > 1, P < 0.05). On the other hand, for Target and Hand* Target, the effect on task completion time is statistically non significant(F < 1, ns).

	sum_sq	df	F	PR(>F)
C(hand_dominance)	212.320484	1.0	2.914175	0.094853
C(number_of_targets)	0.680272	1.0	0.009337	0.923461
C(hand_dominance):C(number_of_targets)	339.304611	1.0	4.657078	0.036424
Residual	3205.744520	44.0	NaN	NaN

Figure 4: *two way anova test result for Hand, Target and Hand*Target with respect to mean*

Figure 4 tells that the effect of hand, targets, and hand*target on error rate is statistically insignificant.

Tukey's Honest Significant Difference (Tukey HSD) Test:

```
        Multiple Comparison of Means – Tukey HSD, FWER=0.05
       ============================================================
        group1      group2     meandiff p–adj  lower    upper    reject
       ------------------------------------------------------------
       Dominant Non–Dominant 287.0857    0.0 161.8211 412.3502   True
       ------------------------------------------------------------
```

Figure 5: *TukeyHSD for Hand Dominance with respect to mean completion time*

```
        Multiple Comparison of Means – Tukey HSD, FWER=0.05
       ===================================================
       group1 group2 meandiff p–adj    lower    upper    reject
       ---------------------------------------------------
          7.0   15.0  22.1666 0.7695 –129.1854 173.5187  False
       ---------------------------------------------------
```

Figure 6: *TukeyHSD for Number of Targets with respect to mean completion time*

From Figure 5, it can be observed from Tukey's Honest Significant Difference (Tukey HSD) that there is a significant difference in mean completion time between the Dominant and Non-Dominant groups, where figure 6 shows that number of target doesn't make significant effect on mean completion time.

```
       Multiple Comparison of Means — Tukey HSD, FWER=0.05
====================================================================
  group1       group2      meandiff  p—adj    lower   upper   reject
--------------------------------------------------------------------
Dominant Non—Dominant   —4.2063  0.1038 —9.3079  0.8952  False
--------------------------------------------------------------------
```

***Figure 7**: TukeyHSD for Hand Dominance with respect to mean click error rate*

```
     Multiple Comparison of Means — Tukey HSD, FWER=0.05
=================================================
group1 group2 meandiff p—adj   lower   upper   reject
-------------------------------------------------
   7.0   15.0   0.2381 0.9277 —5.0135  5.4897  False
-------------------------------------------------
```

***Figure 8**: TukeyHSD for Number of Targets with respect to mean click error rate*

Figure 7 and 8 show there is no significant difference in mean click error rate for both the hand dominance groups and different number of targets.

Discussion and Reflection:

- It was interesting to learn about the statistical and hypothetical analysis from the test results. As we used the code with Python, we got familiar with how this entire anova test works and we learned how to understand the results/outputs.
- We used a fixed set of combinations for all the trials and for the entire participants group, which might introduce order effect in our study.
- We got familiar with the difficulties of collecting data. We observed that people are not willing to spend time giving data as they assumed to be time consuming.
- One of the participants tried to click with dominant hand while navigating with non-dominant hand for non-dominant condition. This could result in some discrepancy in our overall analyses.
- The results can be uncertain as the participants are four.
- This study requires repetitive trials for the same combination of tasks, which seemed to be boring and exhausting for the participants.
- We took the data from 2 participants through zoom, which can affect the result because we were not in-person to invigilate them. But, The participants were trustworthy for the non-dominant tasks.