









**Figure 2. Mean Times and Standard Deviation for each Device in Performing Selection Trials.**

Dynamometer data was taken from participants but results were not consistent enough to be reportable. Participants would both increase and decrease from their baseline after trials, by varying amounts. As a result, we found the dynamometer was not a useful measure of fatigue or effectiveness after using these devices. The change in readings from baseline dynamometer results after every trial are listed in Table 3.

Users did however report fatigue for each device on a scale in the questionnaires. The mean fatigue participants experienced with each device is listed in Table 4.

**Table 4. Reported fatigue from each interface on a scale from 1 to 7**

Device	Mean Fatigue
Air Mouse	2.66
Finger Mouse	4.00
Glove	5.92

## 5. DISCUSSION

In observing the performance of each device it is clear the gyroscopic mice greatly outperformed the camera-based interface. While some of this may be due to imprecision in the bend sensors on the glove, it is more greatly attributed to the far higher level of precision the mouse was able to produce over the Kinect. Issues with skeletal tracking with the Kinect camera would often lead to the pointing location changing erratically during trials, as the elbow and shoulder are frequently eclipsed from view when participants operate the interface. Measures such as changing posture and position came some way to fixing this but the interface was never as smooth and precise as the gyroscopes.

It was surprising to see a substantially higher performance with the air mouse over the finger mouse, given both operate with effectively the same internal technology. Part of this success may be attributed to the device being larger and thus easier for

participants to handle, or the analogue between it and using a standard desktop mouse (which many commented as being one of its strengths in the questionnaires). Differences in simple selection are relatively small, but in performing the more delicate task of moving objects around the screen, the mouse was found more precise by participants.

The differences between the results between the Air and Finger mice is interesting, since we expected better results with the Finger mouse, as the weight of the device is reduced, and so user pointing would be more similar to natural pointing with our hands. This contrary result is consistent with results in a paper on wands and other holdable devices [6]. It seems likely that holding a device is beneficial. In our future work we can investigate device size and weight and time trade-offs, as surely there are a maximum sizes/weights that meaningfully affect the way users point, and length of experiment, which could objectively demonstrate fatigue effects of different devices.

The results of the questionnaire were similarly revealing to the priority of the user when considering the design principles of the experiment. The majority of criticisms levelled at the system were to do with difficulty in performing small or precise movements with the system; where these interfaces acknowledge and work with the fact they suffer from poorer precision in these environments but provide a greater level of immersion and connection to the interface as a tradeoff. With only 3 comments regarding this (and no positive comments), this suggests that users prioritize performance, particularly precision over the user experience.

## 6. ACKNOWLEDGEMENTS

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## 7. REFERENCES

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