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**Assessing the Effect of Experience on Bimanual Force Recreation**

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**Abstract**—Experts in various industries rely daily on finely tuned motor skills for their occupations. A surgeon must know how tightly to pull each end of a suture, and a drummer must know how firmly to hit their drums. This study seeks to determine whether subjects with a high level of force perception and fine motor skill experience could outperform subjects with an average level of motor skill in a novel bimanual force recreation task. The results of this work are inconclusive as to whether or not experience plays a role in bimanual force recreation accuracy, but interestingly, the high skilled group had a more consistent error as a group than the average skilled group did.

### I. INTRODUCTION

Force perception is an integral part of our everyday lives. It is required for tasks from typing on a keyboard to playing a guitar to flying a commercial jet. The general population has a natural tendency to attenuate self-generated forces causing humans to over estimate recreated forces. This has been exhibited in a number of ways where in each case the recreated force was consistently larger than the actual force applied to the participants [1], [2]. Valles and Reed [3] showed that subjects could be trained to overcome this attenuation to be more accurate in force recreation: suggesting that experience could affect force perception and recreation.

Other studies have shown that experience plays a role in specific force perception tasks. This subject has been of particular interest to the field of laparoscopic surgery where force feedback and perception are paramount. Experienced surgeons were seen to have a higher force perception threshold, but faster reaction times than novices [4], [5].

### II. METHODS

In this study, a bimanual force recreation task is used that is similar to the tasks used by the authors testing the general population [1], [2], [3]. Two levers were presented with a 1D force sensor at the end of each lever. The participant was asked to press down on the lever with weights (weights unseen by the participant) and then to recreate the force with their other hand on an unmoving lever for five seconds. There were a total of 40 trials for each subject.

Five engineers participated as the average skilled group while three physical therapists and two surgeons made up the high skilled group. All the participants were male; half were right hand dominant and half were left. This study was approved by the University of South Florida's Institutional Review Board and all participants signed an approved consent form.

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### III. RESULTS & DISCUSSION

A one-way ANOVA was performed with relative error between the hands as the dependent variable and the independent variable as experience level (average or high). The difference between skill groups was not statistically significant ( $F(1, 4.34) = 1.56, p = .21$ ).

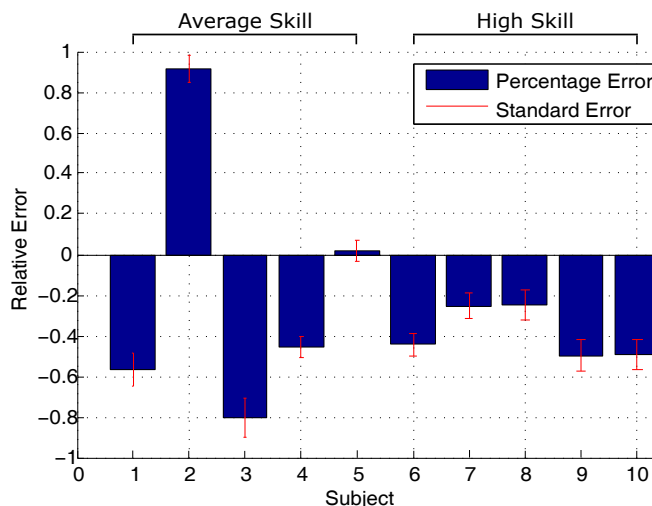


Fig. 1. The average and standard errors are shown here for accuracy vs subject. Subjects are shown grouped according to experience.

Although our initial hypothesis and the existing research pointed to experience playing a role in force recreation, our results did not confirm this. However, the high skilled subjects were much more consistent as a group compared to the average skilled group with standard deviations in percent error between subjects within their groups of 13% and 68%, respectively. Both the most and least accurate subjects belong to the average skilled group. Additionally, our results echo previous research findings that recreated forces are naturally over estimated (seen in Figure 1 as negative error).

### REFERENCES

- [1] S. S. Shergill, P. M. Bays, C. D. Frith, and D. M. Wolpert, "Two eyes for an eye: the neuroscience of force escalation," *Science*, vol. 301, no. 5630, pp. 187–187, 2003.
- [2] L. D. Walsh, J. L. Taylor, and S. C. Gandevia, "Overestimation of force during matching of externally generated forces," *The Journal of physiology*, vol. 589, no. 3, pp. 547–557, 2011.
- [3] N. L. Valles and K. B. Reed, "To know your own strength: overriding natural force attenuation," *Haptics, IEEE Transactions on*, vol. 7, no. 2, pp. 264–269, 2014.
- [4] M. Zhou, J. Perreault, S. Schwaizberg, and C. Cao, "Effects of experience on force perception threshold in minimally invasive surgery," *Surgical endoscopy*, vol. 22, no. 2, pp. 510–515, 2008.
- [5] M. Zhou, J. Perreault, S. D. Schwaizberg, and C. G. Cao, "Force perception threshold varies with experience in minimally invasive surgery," in *Systems, Man and Cybernetics, 2007. ISIC. IEEE International Conference on*. IEEE, 2007, pp. 2228–2232.