The Effects of Computer User Handedness on a Mouse-Clicking Task

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The present study examined computer user handedness on a motor task using Fitts's Law. Results indicated that right-handed participants were significantly faster than the left-handed participants when performing the motor task as measured by the Index of Performance. This finding could be partially attributed to the mouse design that is inconsistent with differential user handedness. Conversely, this finding could also be partially attributed to the degree of training left-handed participants received relative to their right-handed counterparts. The right-handed users outperformed their counterpart left-handed users perhaps because of physical design biases or relative degree of training. The present findings have practical implications for computer input device such as game controllers, joysticks, or mice that are physically designed for right-handed users.

INTRODUCTION

The proliferation of computer technologies such as smartphones has had remarkable influence across a wide spectrum of applications (e.g., aerospace, medicine, learning, driving, entertainment, home computing, etc.) during the last twenty years (Campbell-Kelly, 2009; Parasuraman & Mouloua, 1996; Allan, 2001). While these developments have provided many opportunities for such advanced computer systems, as well as wearable and portable devices, and a variety of interactional techniques, these penetrations have also led to various human factors issues of usage due to advanced automation technology (Mouloua & Parasuraman, 1994; Parasuraman & Mouloua, 1996). Human-Computer Interaction (HCI), as a field, continues to rely on a variety of models, heuristics, principles, and theories to drive the innovation and development of such interactive computer devices. One goal of HCI is to enhance the effectiveness and safety of human-interaction with technology across various human-machine systems (Mouloua & Koonce, 1997; Scerbo & Mouloua, 1999; Vincenzi, Wise, Mouloua, and Hancock, 2004). One such popular and common relationship known as "Fitts's Law" describes the relationship between movement time, distance, and performance accuracy for rapid movement tasks such as pointing and dragging an object in space using a variety of interactional devices (e.g., computer mouse, game controller, iPad stylus, joystick, etc.).

The utility of Fitts's Law has been well documented, especially with regard to the design and evaluation of various computer input devices (MacKenzie, 1992). It allows HCI researchers and practitioners to design effective and efficient touch screen applications. However, such research efforts have not been extensively examined with regard to users' individual differences such as age, sex, and handedness. The importance of people's hand movements in space and time is vital for the vast majority of the human population. Such movements can control various behaviors that are part of our daily activities. Understanding the impact of handedness on motor behavior is relevant to user performance and safety. The goal of this study therefore was to empirically examine Fitts's Law via participants' handedness and sex on a graphically presented motor skills task. We hypothesized that handedness and sex would affect users' performance on this ubiquitous mouse-clicking task.

METHOD

Participants

Twenty-five college age participants consisting of

10 left-handed and 15 right-handed were randomly selected from a Southeastern University. They ranged between 18 and 30 years with a mean age of 21.96. All participants received extra course credit as part of their psychology course requirements and were treated according to the American Psychological Association (APA) ethical guidelines.

Task and Materials

Participants were given a handedness (Oldfield, 1971) task to index their hand use dominance and preference in a variety of settings. All participants were then required to complete a motor skills task consisting of mouse-tracking using their dominant hand (left versus right hand). This task was developed based on Fitts's Law (Fitts, 1954), a mathematical model predictor for human movement. The task consisted of clicking on two alternating green bars appearing on a computer screen (left and right side of screen), presented by E-Prime 2.0. Throughout 16 trials across the duration of the task, the width of the bars and distance between them variated to present participants with differing indices of difficulty (ID, measured in bits) on each given trial. The ID is calculated using Fitts's formula

$$ID = \log_2 (2D/W) \quad (1)$$

Where ID is calculated by evaluating the base 2 logarithm of 2 times the distance (D) between the bars, divided by the width (W) of the bars (for a given trial, and averaged across all trials for one participant). ID represents the average information generated per movement (Fitts, 1954). By introducing time into this equation, we can determine the average rate of information generated by a series of movements - the index of performance (IP), for each participant. This is defined in the time-inclusive equation

$$IP = (ID/MT) \quad (2)$$

Where IP is calculated by averaging 16 trials' ID's divided by participants' mean times to move the mouse cursor between the bars, whilst clicking the bars. IP, also known as bandwidth, represents participants' movement performance in terms of data transfer speed. Participants' averaged IP's were calculated and then analyzed by grand averaging across all participants.

Design

The study examined the effect of computer user handedness (right versus left) on a motor task. The dependent variables were the Edinburgh handedness scores and the computer (mouse-clicking) motor task.

RESULTS AND DISCUSSION

A series of independent t-tests were performed to examine the mean difference between left-handers and right-handers on each of the dependent variables. Results showed a significant effect of handedness $t(23) = 3.479$, $p < 0.005$, Eta squared was 0.35 on participants' bandwidth in a motor skills task. This indicated that right-handed participants were significantly faster (9.2 bits/sec, 1.14) than left-handers (7.5 bits/sec, 1.32). This effect of handedness is depicted in Figure 1.

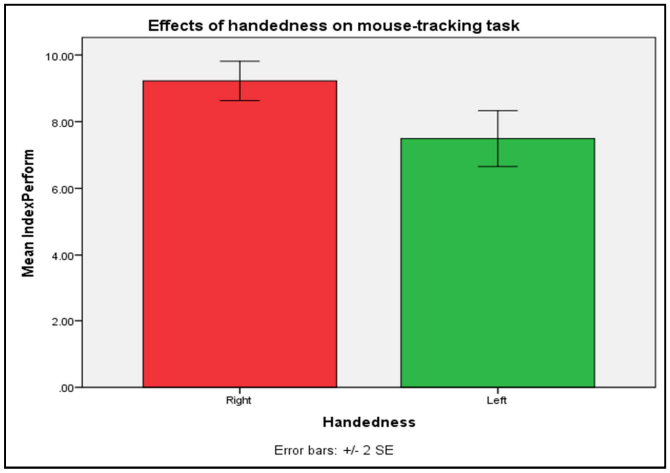

Figure 1. Effects of Handedness on Motor Task

There was also a significant effect of handedness $t(23) = 5.967$, $p < 0.001$, Eta squared was 0.60 on participants' Edinburgh Handedness Inventory questionnaires. This indicated that right-handed participants scored significantly higher (13.00) than left-handers (-4.00) on the subjective handedness score. The effect of handedness is depicted in Figure 2.

Finally, we also tried to examine the effect of sex on the motor task. Because we did not have a large sample and an equal number of male and female participants, we did not perform a two-way ANOVA to examine the main and interaction effects. However, an initial analysis revealed a marginally significant effect of sex $t(23) = 1.753$, $p < 0.1$. This indicated that a pattern of performance differences was shown in male participants (Mean = 9.40) outperforming the female participants (Mean = 8.30). This effect is not unexpected given the difficulty in finding extreme left-handers in the population (Hancock, 2011). We are currently collecting more data on both male and female participants in order to justify and examine the interactive effects of sex and handedness on the motor task.

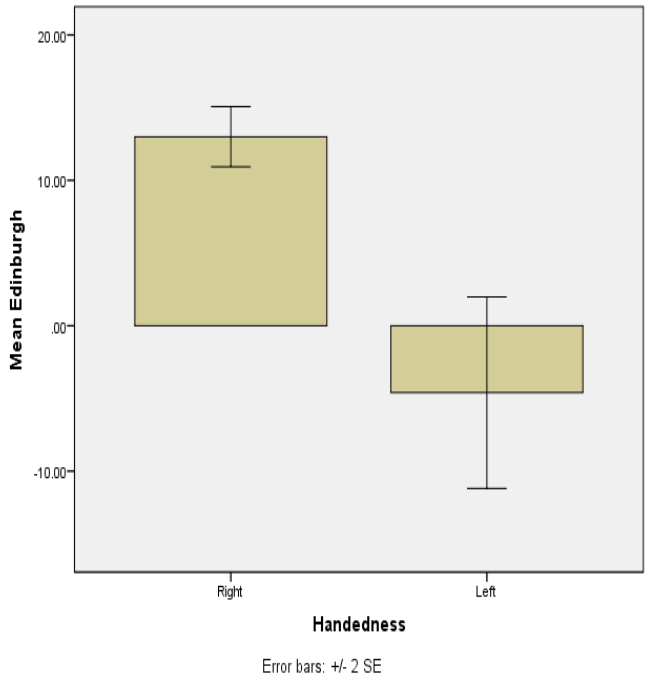

Figure 2. Effects of Handedness on Edinburgh Handedness Inventory.

DISCUSSION

The present study examined computer user handedness in a motor skills task using Fitts's paradigm. Results indicated that right-handed participants were significantly faster than left-handed participants when performing the motor task, as measured by the Index of Performance. This finding could be partially attributed to the mouse design that is inconsistent with differential user handedness. The right-handed users outperformed their counterpart left-handed users perhaps because of inherent physical design biases. It may be that the advantage recorded was, in reality, an effect of the relative handedness of each sample. Thus, the right-handers being more evidently "handed" than the left-handers confers some advantage. Against this we know that many contextual designs disproportionately disadvantage left-handers, and perhaps the present differences actually grow as the latter group exhibit a greater handedness propensity. Regardless of the reason, the observations here have inherent importance for the design of individual effector systems and individualized workstations.

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