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Display-control stereotype strength of left- and right-handers

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ABSTRACT

Many aspects of the performance of left and right handed persons have been reported. It is generally found that (a) Performance of left-handers, when the workplace is set up according to their handedness, is as good as that of right-handers when using their preferred hand. (b) When using the non-preferred hand, left-handers performance is generally superior to that of right-handers, possibly due to their having had to adapt to a right-handed world. There has been little reported research on the difference of stereotype strength or expectancies of device operation for right- and left handers. This paper reports such research using a set of rotational and translational controls with displays in four different locations relative to the operator. It is found that there was no significant effect of handedness of the participant for horizontally-moving displays and left- and right-handers were equivalent in performance. For vertically-moving displays there were effects of handedness through interaction with controls and display location. Some conditions showed non-equivalence of left and right-handedness in stereotype strength.

Relevance to industry: About 10% of people are left-handed, yet live in a world that is largely designed for right-handers. Experiments are reported to show that, for many combinations of control and displays, there is no significant effect of handedness on stereotype strength.

1. Introduction

There is research that shows that the left-hander is not disadvantaged relative to the right-hander when operating devices and when making movements. For example, in movement times the left-hander is as good as the right-hander (Hoffmann, 1997a); in computer mouse operation there is no disadvantage when using their preferred hand but the left-hander is superior when using the non-preferred hand (Hoffmann et al., 1997) and in assembly task learning and time performance, left-handers are not different to right-handers (Hoffmann and Halliday, 1997).

When studying stereotype strength of left and right handers for the relationship between controls and corresponding display movements, there are reasons for there to be differences between performance of the two groups, largely related to postural effects of the operator relative to the control and display (Hoffmann, 2009). Several references do show such an effect (Holding, 1957; Chapanis and Gropper, 1968), however, most research on stereotype strength has been with right-handed persons (DeLucia and Griswold, 2011; Hollands, 2012; Kee, 2014; Chan and Hoffmann, 2016). There are also effects of right-handers using their left hand for control and right handers using the right hand where a left hand would have been more suitable (Chan and Hoffmann, 2010). The reported research with left and right-handers has been for a rotary control with a frontally-located linear display moving either in the horizontal or vertical direction, in which participants used either their preferred or non-preferred hand in actuating the control (Chapanis and Gropper, 1968). Some differences in performance were found which showed that (i) left-handed people performed better with their non-preferred hand than did right-handers and (ii) right-handed participants had stronger stereotypes with established stereotypes, that is, when scales increased to the right or upward on the display. However, there was an effect of the left/right hander - × hand used such that the posture of the hand relative to the control added to the effects of handedness on stereotype strength (Hoffmann, 2009).

Other than these few experiments, there appears to be only general stereotypes studied, such as for increasing brightness of a light and volume of a sound system (Bradley, 1959). In these cases there was higher stereotype strength for right handers compared to left-handers. Boles and Dewar (1986), using paper and pencil tests, also reported a brief section where rotary knobs were used for

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increasing temperature, water level and other functions in a washing machine. Again, right-handers had higher rates of clockwise control rotations than left handers for these functions.

Much of the recent research in control/display compatibility is reported in work of the authors (Chan and Hoffmann, 2010, 2012; Hoffmann and Chan, 2013). This research has shown the importance of the various component principles that determine stereotype strength, such as Warrick's principle (Warrick, 1947), scale side principle (Brebner and Sandow, 1976), clockwise to increase principle (Wiebe and Vu, 2009), hand/control location effect (Hoffmann, 2009) and the Worringham and Beringer (1998) 'visual field' principle. Research has shown that these few principles can account for the major part of the stereotype strength with many different arrangements of controls and displays (Hoffmann, 1997b; Chan and Chan, 2008; Chan and Hoffmann, 2010, 2012).

As about 10% of the general population are left-handed (Coren, 1993a), it seems appropriate to determine if there are any differences in performance compared to right-handed persons in a much larger range of settings of the participant relative to the control and the display and with different forms of control. Thus, the aim of this research was to select a group of left-handers and a matched group of right-handers (matched by age and gender) and have these groups take part in an experiment in which stereotype strengths are measured for various display/control arrangements and with different forms of control.

2. Method

2.1. Displays and controls

The basis of this experiment was to study the conditions of the FORT model of Wickens et al. (2010). This model uses six different controls as shown in Fig. 1. Three of these were rotary controls (CVR, CHR, FR) and three were translational (FT, RT, UT), with one translational and one rotational control in each of three planes (top, front, right sagittal) relative to the operator. The four displays were located in directions immediately to the front and rear of the operator and to the left and right-hand side (labelled as CF, B, L, R, respectively). Two display arrangements were used: horizontally-moving or vertically-moving (Fig. 2). The controls always remained in the locations shown in Fig. 1. When using the left hand, the control box was moved left so that a comfortable hand/arm posture was available to the participant. The control locations, type of control, control plane, display plane and display movements included in this model are of importance in manual control of high complexity devices such as space ships, nuclear reactors, aircraft, etc.

2.2. Participants

20 right-handers and 20 left-handers were selected according to the Coren inventory for determining handedness (Coren, 1993b). Participants were chosen to be of strongly right- or left-handedness. The experiment was carried out with each participant using both the right and left hands, enabling the effect of handedness and hand-used (preferred or non-preferred) to be established. Participants were fully informed as to the purpose of the experiment and took part under the ethical guidelines of City University of Hong Kong.

2.3. Instructions to participants

When presented on a computer screen, the display indicated, via a red mark on the display, a direction in which the indicator was to be moved, either left/right for horizontally-moving displays or up/down for vertically-moving displays. The indicator always moved in the requested direction, independent of the control movement.

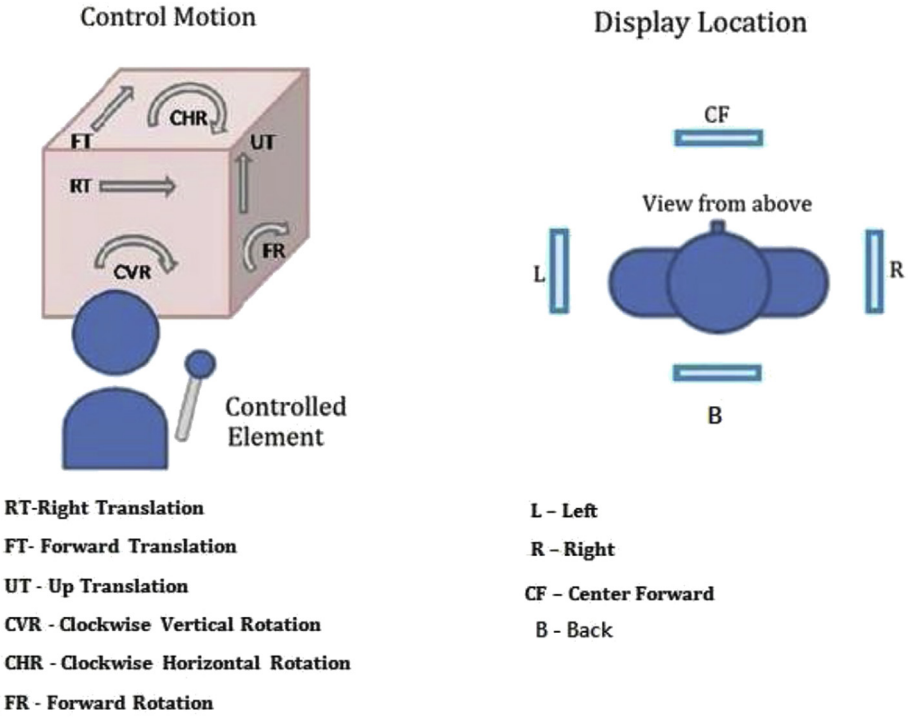

Fig. 1. Controls and display locations used in the experiment. For left-hand operation, the translational and rotational controls were moved to the left of the control box. Adapted from Wickens et al. (2010).