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

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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 1997); in computer mouse operation there is no disadvantage when using their preferred hand but superior when using the non-preferred hand (Hoffman et al. 1997) and in assembly task learning and time performance, left-handers are not different to right-handers (Hoffmann and Halliday 1997).

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). It has shown that some major principles such as Warrick’s principle (Warrick 1947), scale-side principle (Brebner and Sandow 1976), clockwise to increase principle, and hand/control location effect principle (Hoffmann 2009) can account for the major part of the stereotype strength with many different arrangements of controls and displays.

As about 10% of the general population are left-handed (Coren 1993), 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 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.

Method  
The basis of this experiment was to study the conditions of the FORT model of Wickens, Keller and Smith (2010). This model uses six different controls as shown in Figure 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 relative to the operator. The four displays are located in directions immediately to the front and rear of the operator and to the left and right-hand side (labelled as L, CF, R, B). Two display arrangements were used: horizontally-moving or vertically-moving (Figure 2).

20 right-handers and 20 left-handers took part. These were selected according to the Coren inventory for determining handedness. The experiment was carried out with each participant using both the right and left hands. 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 or up/down. Each participant performed the experimental conditions in a different random order to balance any effects of learning during the experiment. There were a total of 6 controls x 4 display locations x 2 hand-used (preferred or non-preferred) x 2 displays (vertical or horizontal) x 2 requested movement instructions (up/down or left/right).

Results  
Stereotype strengths for the six controls (CVR, CHR, FR, FT, RT and UT), the four display locations (left, right, ahead and behind) and the two requested display movement directions (left/right for horizontal displays and up/down for vertically-moving displays) are evaluated.

Horizontally-moving displays:  
Analysis of variance of the stereotype strength data showed a significant main effect of Control [F(5,53) = 110.3, p < .001] and a significant interaction of hand-used x control [F(5,53) = 4.88, p=.001]. There was no effect of display location. There was no significant effect of the handedness of the participant. Data are grouped by a Tukey post-hoc multiple-comparison test. There are three groups: UT and FT are significantly different to each other (p < .001) and each of these is significantly different to all other controls (p < .001), which are not significantly different to each other. The same pattern is seen when the requested movement direction on the display is to the left.

Vertically-moving displays:  
Analysis of variance indicated only a significant main effect of control type [F(5,53) = 82.5, p < .001]. Post-hoc tests revealed a similar pattern to that for the horizontally-moving displays, except in this case the best performing is UT followed by FT and then by all other controls which are not significantly different to each other.
Discussions
The major result of this experiment was that there was no effect of handedness of the participant on stereotype strength. The only effect involving the hand was that of the hand used and this arose as an interaction with the form of control, and then only for the horizontally-moving displays. As this is the most extensive study of the effects of handedness reported for control/display stereotypes and as the participants were chosen on the basis of them being strongly left or right-handed, it can be said with some confidence that such handedness effects are unlikely to affect the design of display/control interfaces – at least with this particular set of controls and control/display arrangements.

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References
Warrick, M.J., 1947. Direction of movement in the use of control knobs to position visual indicators. USAF AMC, Report No. 694-4C.
Figure 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).

Figure 2. Examples of the task for display movement for horizontally and vertically-moving displays.