The effect of visual feedback on a bimanual movement

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Introduction

A bimanual movement to two different targets requires monitoring the position of both hands during the one movement. Due to limitations of the human visual system, each hand must be monitored individually, which Riek et al. (2003) suggest results in a temporal asynchrony at the end of a movement.

Riek et al. described this temporal asynchrony as 'hover phase' and argued that by one hand 'hovering', the other is able to find its correct spatial positioning, then the visual focus is switched to the other hand to make positional correction before both limbs terminate the movement together. This suggests that whilst a movement may begin and terminate synchronously, the hands are not coupled throughout the whole movement.

On the other hand, Kelso et al (1979) argued that hands were tightly coupled throughout a bimanual movement (when analysing signed data).

Aim of the study

The aim of this study was to determine how both hands use the visual feedback available, and more specifically whether this affects the asynchrony between the hands at the end of a bimanual movement.

Acknowledgements

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Materials and methods

Twelve right handed adults from the University of Lincoln were asked to perform bimanual aiming movements to near (23cm) and far (27cm) targets.

Both congruent (both hands to the same distance) and incongruent (each hand to different distance) movements were made (figure 1) under the following four visual conditions: full vision (see both hands), no vision (see neither hand), right vision (see only right hand) and left vision (see only left hand).

The MIRAGE VR system was used to show real-time video images of hands (figure 2) and movements were recorded using the MiniBIRD magnetic tracking system.

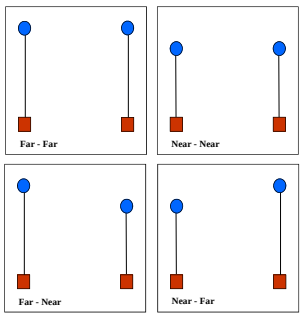

Figure 1. Bimanual movements used in this study

Figure 2. The MIRAGE VR system

Results

Signed Data

• No significant effect of vision on terminal asynchrony between the two hands – suggesting an equal lag across all of the conditions.

Absolute Data

• Main effect of vision [$F(2.623)=3.096, p<0.05$]

• Effect of visual condition: Greatest asynchrony found in left vision condition (see figure 3)

• Effect of movement condition: Greatest asynchrony found in incongruent movements, although not significant (see figure 4)

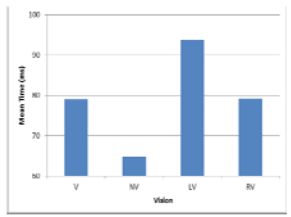

Figure 3. Mean lag for each of the vision conditions (absolute data)

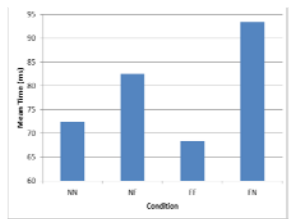

Figure 4. Mean lag for each of the distance conditions (absolute data)

Conclusions

The results differ greatly when analysing the two different types of data (signed and absolute). The signed data showed no significant main or interaction effects, which infers tight coupling (supporting findings of Kelso et al.) – conversely if analysing the absolute data, very different results are found:

The absolute data shows that the left and right hand use visual feedback in different ways, and this has an effect on the asynchrony at the end of a bimanual movement.

This research supports the findings of Riek et al. (2003). Figure 3 shows that the hands are most coupled when there is no visual feedback available (no vision condition). This demonstrates that visual feedback is used to make corrections about the positioning of the limbs – resulting in asynchronies, and when vision is removed, the hands display greater levels of coupling. Proprioceptive feedback is used to match the positioning of the limbs with the targets in the absence of vision of the hands.

Figure 3 also shows that a similar asynchrony was found in the full and right vision conditions – supporting the argument of Riek et al., that one's attentional focus is on the preferred (right) hand. This result supports the notion that the left hand maps itself to the right, arguing that visual feedback of the preferred limb is more important when making a bimanual movement.

Figure 4 shows that incongruent movements (NF & FN) produce the greatest asynchrony, and the longest lag occurred when the non preferred hand has the more difficult task (FN). This demonstrates that no only does the greatest asynchrony occur when visual feedback is from the non-preferred limb, but also the difficulty of the task also affects the level of coupling.

Literature cited

Kelso, J. A. S., Southard, D. L. & Goodman, D. (1979). On the Coordination of Two-Handed Movements. *Journal of Experimental Psychology: Human Perception and Performance*. 5 (2). 229-238

Riek, S., Tresillian, J. R., & Mon-Williams, M. (2003). Bimanual Aiming and Overt Attention: One Law for Two Hands. *Experimental Brain Research.* 153. 59-75