How Breaking Symmetry by Vision Influences the Stability of Coordination

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INTRODUCTION

Symmetry plays a crucial role in science and nature. In Coordination Dynamics[1], symmetry operations are used to categorize behavioral patterns and neural circuitry. For instance, in-phase and anti-phase rhythmic patterns between body parts are symmetric (Fig.1), but symmetry breaking occurs when the less stable anti-phase pattern spontaneously switches to in phase as movements speed up[2].

What happens to your coordinative abilities when there is a mismatch between what you see and feel?

Anti-Phase **In-Phase**

Fig. 1. At a slow pace, people can easily coordinate their fingers in-phase or in anti-phase. Yet, at some critical frequency people spontaneously switch from an anti-phase to the more stable in-phase pattern. How will a mirror affect switching?

METHODS

We collected 3D finger position at 100 Hz from two participants using a Vicon motion capture system (Fig. 2).

- Amplitude was calculated by taking the peak differences between the two signals (using 'findpeaks.m' MATLAB)
- Relative phase was calculated by Hilbert transform to establish the relationship between the left and right hands.

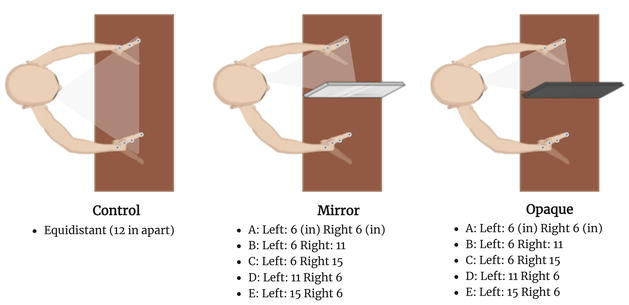
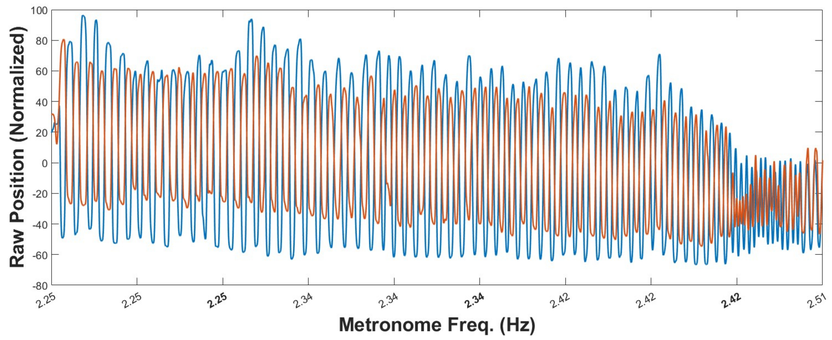
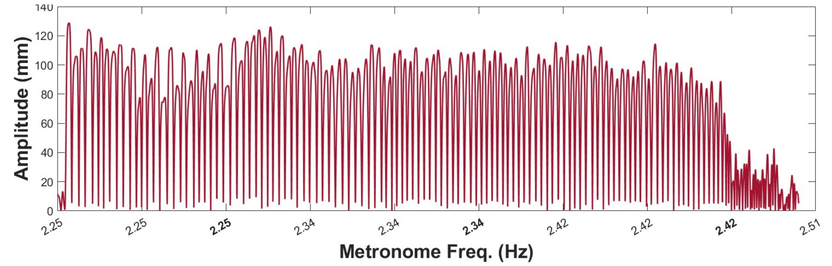


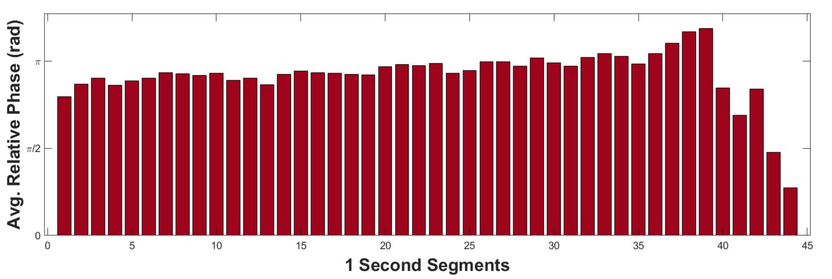
Fig 2. Participants were tasked to coordinate their fingers in antiphase during three barrier conditions (Control, Mirror, and Opaque). During the mirror and opaque trials the participant moved their hands to five different distances to assess the effects of asymmetry (see A-E above). During the mirror and opaque trials only the left hand was visibile. For each barrier type there were 13 frequency settings ranging from 125-190 BPM with the tone repeating 10 times at each frequency.

RESULTS

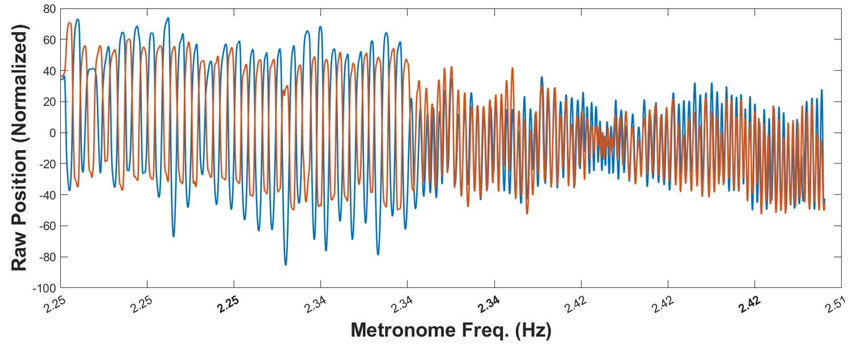
Control
Higher Switching Frequency

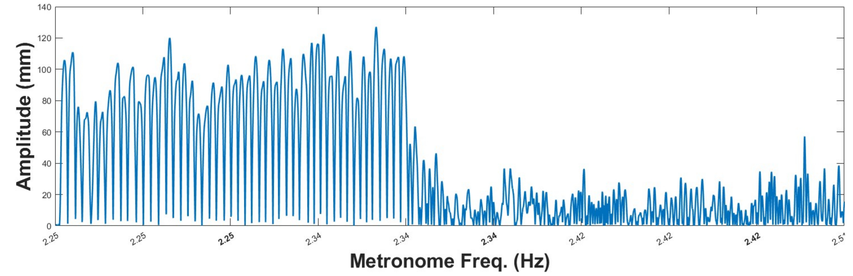


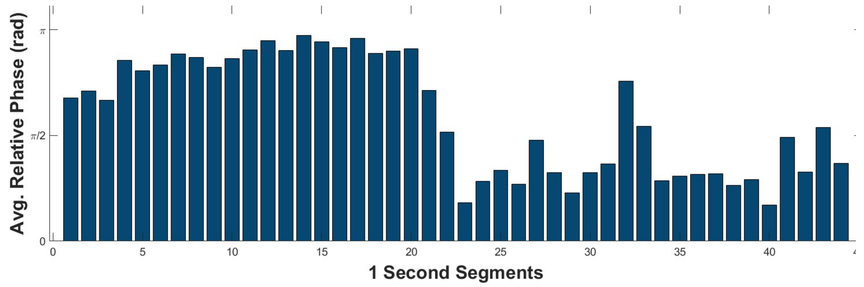




Mirror
Lower Switching Frequency







CONCLUSION

Preliminary findings reveal a remarkable discovery. Placing a **mirror** in-between the participants hands leads to earlier switching at a much lower movement rate. This is because the mirror image is seen as in-phase with the other, **conflicting** with what participant's feelings and intentions.

While stabilizing in-phase motion, vision destabilizes the naturally less stable anti-phase pattern, indicating that **visual perception exerts a powerful influence on the stability of coordinated movements.**

REFERENCES

1. Kelso, J.A.S. (2009). Coordination Dynamics. In R.A. Meyers (Ed.) *Encyclopedia of Complexity and System Science,* Springer: Heidelberg (pp. 1537-1564).
2. Kelso, J. A. (1984). Phase transitions and critical behavior in human bimanual coordination. *American Journal of Physiology-Regulatory, Integrative and Comparative Physiology*, *246*(6), R1000-R1004.

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