

# **Mirror feedback modulates temporal and spatial aspects of bimanual coordination.**

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## **Abstract**

**Introduction:** Mirror therapy has become an effective and recommended intervention for a range of conditions affecting the upper limb (e.g. hemiparesis following stroke). However, little is known about how mirror feedback affects the control of bimanual movements (as performed during mirror therapy). In this study, in preparation future clinical investigations, we examined the kinematics of bimanual circle drawing in unimpaired participants both with (Experiment 1) and without (Experiment 2) a visual template to guide movement.

**Method:** In both experiments, 15 right-handed unimpaired participants performed self-paced continuous bimanual circle-drawing movements with a mirror/symmetrical coordination pattern. For the mirror condition, vision was directed towards the mirror in order to monitor the reflected limb. In the no mirror condition, the direction of vision was unchanged, but the mirror was replaced with an opaque screen. The movements of both hands were recorded using motion capture apparatus.

**Results:** In both experiments, the most striking feature of movements was that the hand behind the mirror drifted spatially during the course of individual trials. Participants appeared to be largely unaware of this marked positional change of their unseen hand that was most pronounced when a template to guide movement was visible (Experiment 1). Temporal asynchrony between the limbs was also affected by mirror feedback in both experiments; in the mirror condition, illusory vision of the unseen hand led to a relative phase lead for that limb.

**Discussion:** Our data highlight the remarkable impact that the introduction of a simple mirror can have on bimanual coordination. Modulation of spatial and temporal features is consistent the mirror inducing a rapid and powerful visual illusion; visual capture of movement in the unseen hand appears to override proprioceptive signals. The strength of this illusion can be augmented by including a visual template to guide movement and this may have utility in rehabilitation.

**Keywords:** *Bimanual coordination, Mirror visual feedback, Mirror paradigm, Motor control,*