Human and clock hands: how joint-constraints shape motion perception

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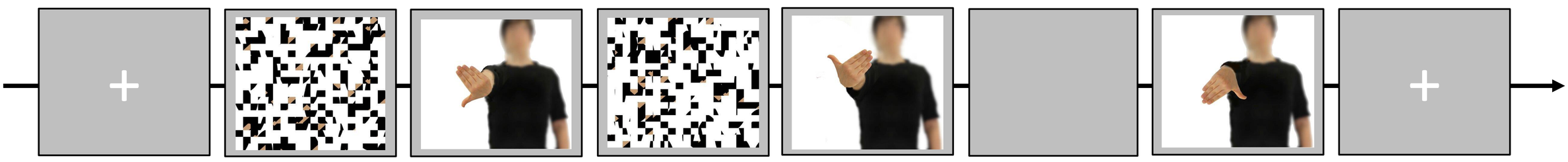
INTRODUCTION

Action and perception have been shown to be tightly linked. In a previous study, we explored this link by using bi-stable perceptual task wherein participants were asked to judge a stimulus, i.e. a sequence of two hand postures that induce an apparent motion effect , perceived as a clockwise or a counterclockwise rotation of human hands (BIO) vs. clock hands (NBIO). We found that the 45°-225° sequence was perceived as clockwise rotation more for BIO than NBIO stimuli, while the 135°-315° sequence was the most ambiguous for both BIO and NBIO stimuli. We conjectured that this was primarily due to the joint-constraints affecting hand-rotation when motorically executed. Indeed, according to these joint-constraints, the 45°-225° sequence should imply a clockwise movement, whereas the 135°-315° rotation is biomechanically possible with both a clockwise and a counterclockwise movement. The main aim of the present study was to **test whether an implicit processing of joints-constraints may *differentially* bias the perceived rotation of BIO and NBIO stimuli**, employing a visual priming paradigm.

Materials and methods



Bi-stable perceptual task

*Participants (N=21) underwent a bi-stable perceptual task, wherein they were asked to judge whether they perceived a **clockwise** or a **counterclockwise rotation** of visual stimuli pairs. The apparent motion was created by presenting two static images depicting either the hand of a clock (**NBIO stimuli**) or a human right-hand (**BIO stimuli**) in different positions. We included two rotation conditions:*

- ***45°-225°** (unambiguous pair);*
- ***135°-315°** (ambiguous pair).*

Before each pair of stimuli, a forward- and backward-masked prime was presented for 43 ms, i.e. a static image oriented at 45°, 135°, 225° or 315°, suggesting either a clockwise or a counterclockwise apparent motion depending on the following pair. The task comprised 28 trials for each condition (total duration: about 15 minutes).

Data analysis

*Clockwise responses were coded as 2, counterclockwise responses were coded as 1. Average responses for each condition were entered in a 2*2*2 repeated measures ANOVA, with stimulus (biological/non-biological), sequence (45°-225°/135°-315°) and prime (counterclockwise/clockwise) as within-subject factors.*

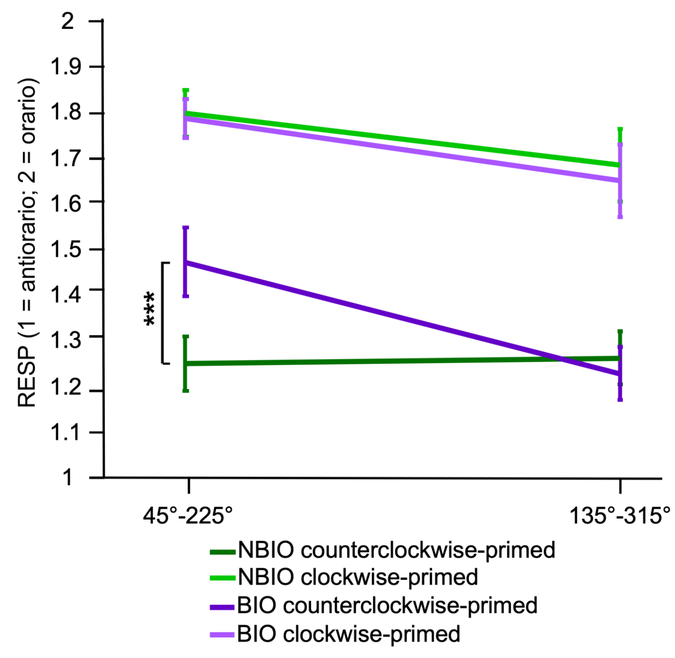
Results

*Results showed a **significant interaction between stimulus, sequence and prime** ($F_{1,20}$=22.47; p=0.0001). Bonferroni post-hoc tests revealed no difference between BIO and NBIO stimuli in the **135°-315°** counterclockwise- and clockwise-primed conditions, suggesting that visual priming exerted the same modulation on the ambiguous stimuli pair.*

*Crucially, in the **45°-225°** sequence differential results emerged between priming conditions:*

- *no difference between BIO and NBIO stimuli emerged in the clockwise-primed condition (p=1);*
- *in the counterclockwise-primed condition, BIO stimuli lead to significantly more clockwise responses compared to NBIO stimuli (p<0.000).*

Stimulus*rotation*prime



CONCLUSIONS

This finding suggests that joint-constraints may actually shape motion perception, by differentially channelling the visual priming effect. Indeed, visual priming equally affected motion perception of both BIO and NBIO stimuli when the primed rotations were motorically consistent. On the contrary, the visual priming effect on motion perception was different between BIO and NBIO stimuli when the primed rotation (counterclockwise) violated the joint-constraints. Future studies should exploit the present paradigm to investigate whether joint-constraints affect motion perception in patients with motor impairment (i.e., hemiplegic patients), to disentangle if a spared motor representation is necessary for the joint-constraints to modulate motion perception.

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