# Reference frames for biological motion and face perception

**Dorita H. F. Chang[1], Laurence R. Harris[3], & Nikolaus F. Troje[1,2]**

[1]Centre for Neuroscience Studies and [2]Department of Psychology, Queen's University, Canada
[3]Department of Psychology, York University, Canada

BIO MOTION LAB
www.biomotionlab.ca
5dc16@queensu.ca

Queen's UNIVERSITY

## INTRODUCTION

- The perception of both faces and biological motion is impaired if the stimulus is inverted[1,2,3].
- While the inversion effect observed for face perception has been attributed to disruptions in configural processing[4], global structure-from-motion processes and local motion processes contribute to distinct inversion effects in biological motion perception[3,5].
- Little is known about the reference systems in which inversion effects operate.
  - the orientation of a stimulus can be described according to a variety of egocentric and allocentric coordinates
  - previous reports have suggested either the retina[6,7] or gravity as the dominant frame of reference[8]

**Here, we investigated the reference frames according to which the perception of faces and biological motion operates by testing observers on face recognition and biological motion tasks inside the York University "tumbling room" with which the stimulus, observer, and room can be rotated independently.**

## METHOD

*Participants*

- 12 observers with normal/corrected vision.

*Stimuli and Procedures*

- Observer strapped in chair with display mounted on wall opposing the observer at the axis of rotation of both room and chair (Fig. 1).

**Biological motion direction discrimination task**

- Human, cat, pigeon in sagittal view.
- On each trial:
  - coherent walker in scrambled walker mask moving in opposing direction (global cues) or
  - scrambled walker in a random-dot mask (local cues).

  *Is the walker facing left or right / up or down?*

**Face recognition task**

- On each trial:
  - 2 intervals: 1 face at 5 deg left/right from frontal view and 1 face at 10 deg in the opposing direction from frontal view
  - faces can be same or different identity

  *Are the faces the same or different?*

- Three systems (retinal, visual-environmental (room), gravitational) compared via 12 x ~2 minute pseudo-counter-balanced blocks of trials (Figure 2).

**Figure 1**

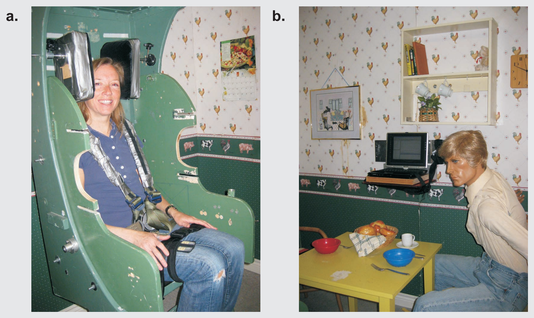
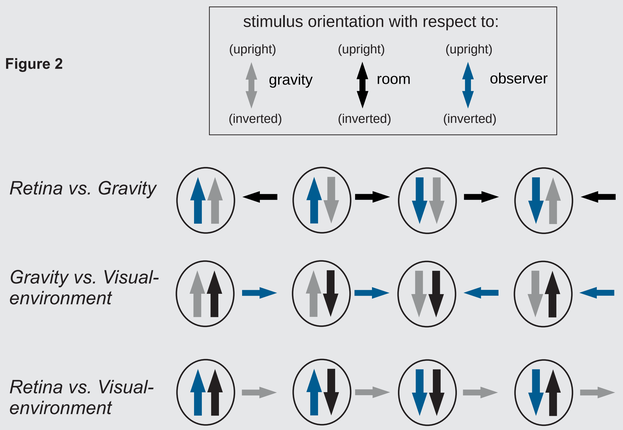



**Figure 2**

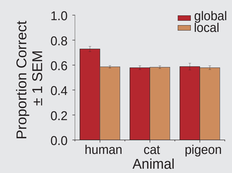



## RESULTS

**Biological motion direction discrimination task**

- Performances were better for displays requiring global rather than local discriminations ($p < 0.001$).
- Performances depended on walker type, but for trials requiring global discriminations only ($p = 0.005$) (Fig. 3).

**Figure 3**

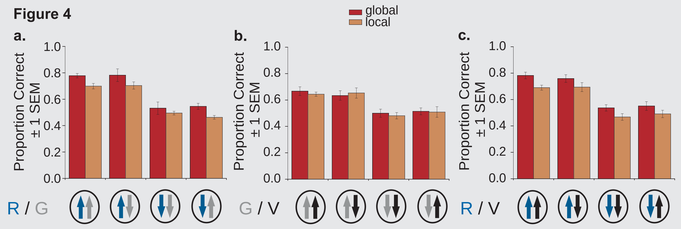



*Retina vs. Gravity (Fig. 4a):* Performances were best when the stimulus was aligned with the observer ($p < 0.001$).

*Gravity vs. Visual-environment (Fig. 4b)*: Performances were best when the stimulus was upright with respect to gravity ($p < 0.001$).

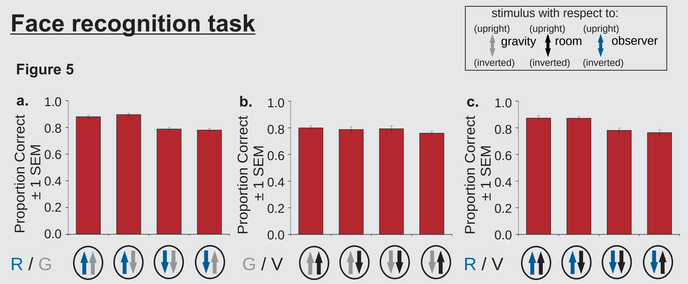
*Retina vs. Visual-environment (Fig. 4c):* Performances were best when the stimulus was upright with respect to the observer ($p < 0.001$).

**Figure 4**




**Face recognition task**

**Figure 5**




*Retina vs. Gravity (Fig. 5a):* Performances were best when the stimulus was aligned with the observer ($p < 0.001$).

*Gravity vs. Visual-environment (Fig. 5b):* Performances did not depend on stimulus orientation with respect to gravity or the room ($p > 0.200$ for both).

*Retina vs. Visual-environment (Fig. 5c):* Performances were best when the stimulus was upright with respect to the observer ($p < 0.001$).

## DISCUSSION

- The results suggest that the perception of both faces and biological motion operates largely according to an egocentric frame of reference.
- If the egocentric coordinate is rendered useless, the perception of biological motion, but not faces relies more on the gravitational frame of reference as compared to the visual-environmental frame of reference.
  - previous work suggest that humans and other vertebrates employ gravitational heuristics when interpreting inanimate and animate events[3,9]
  - the current data suggest that such heuristics may be implemented by the visual system by incorporating input from the vestibular organs when interpreting biological motion

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