Biological motion fixation distributions depend on the task: Direction discrimination vs. gender classification

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INTRODUCTION

We can extract information from biological motion. From only the motion of dots representing the major joints of a person walking, humans can determine basic and complex properties of the action. For example, the heading direction of the walking, or the gender of the person producing the action.

Where is the information that we use located in the display? Answering this question will give important clues to how humans accomplish biological motion perceptual tasks. We focused on direction discrimination and gender classification.

The feet are important for determining walking direction. Local motion patterns are a source of information about biological motion (Troje & Westhoff, 2006). Direction can be determined even when the global structure of the walker is disrupted by randomizing the locations of points in a point-light display (Saunders, Suchan & Troje, 2009). This appears to be primarily due to the motion of the feet, which can cue direction when information from the rest of the body is weakened by inversion (Troje & Westhoff, 2006) or removed entirely (Chang & Troje, 2009).

The shoulders and hips are important for determining gender. Observational studies suggested that the primary gait differences between men and women are found in lateral movement of the shoulders and hips (e.g. Murray, Kory, and Sepic, 1970). Whether the human visual system makes use of these differences was tested by manipulating the hip and shoulder movement of point-light displays of walking (Cutting, 1978; Mather & Murdoch, 1994). This produced reliable gender judgments in observers.

We used eye tracking to identify the focus of overt attention during a direction and a gender biological motion task. We hypothesized that participants would rely on different regions between the two tasks, and that these differences would be accentuated when the tasks were more difficult.

METHODS

STIMULI

- Synthesized point-light walking animations at 6 levels of gender (male and female, 0.5, 1.5, and 2.5 standard deviations from mean), presented at 6 different directions (left and right, 3°, 30° and 90°).
- Gender specified by using an axis created via DFA from motion captured walks of 50 men and 50 women.
- Presented at one of 4 possible locations offset from the center of the screen (so that at least one saccade was needed to reach the walker).
- Noise mask consisting of 150 dots with random linear motion.

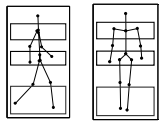
PROCEDURE

- 20 participants, 7 male and 13 female, age 18-38.
- Fitted with eye tracker (Eyelink II, < 1° RMS error) and calibrated
- Walker presented for 2 s, then participant presses a key to indicate either "Left" or "Right", or "Male" or "Female".
- Two blocks of trials, 288 trials in total, with i*dentical* stimuli in both. Only order of trials and instructions changed: one block had direction instructions and one had gender instructions. Order counterbalanced between participants.

ANALYSIS

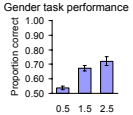
- After detecting fixations, we created fixation maps (Wooding, 2002) for the major conditions, using a 2D gaussian with a standard deviation of 1° of visual angle.
- Within-subjects ANOVAs on number of fixations that fell into 3 regions of interest representing feet, pelvis and shoulders. Three factors: Task (Direction, Gender) x Direction level (3°, 30°, 90°) x Gender level (0.5, 1.5, 2.5).
- Prop. correct showed successfully manipulated difficulty for both the direction and the gender task.

Region of interest definitions



Direction task performance

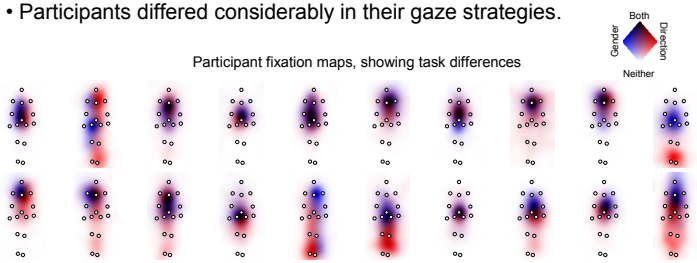
Gender task performance



RESULTS

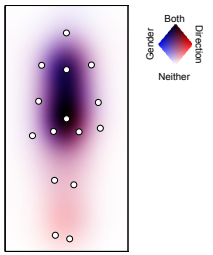
- Participants differed considerably in their gaze strategies.

Participant fixation maps, showing task differences

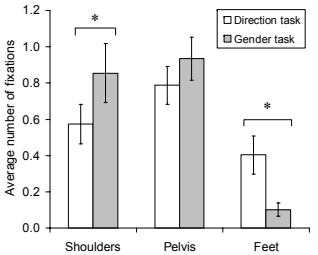


- On average, more fixations on the feet in the direction task than in the gender task, $F(1, 19) = 10.64$, $p = .004$.
- More fixations on the shoulders in the gender task, $F(1, 19) = 4.89$, $p = .04$.

Fixation map across all participants, genders and directions

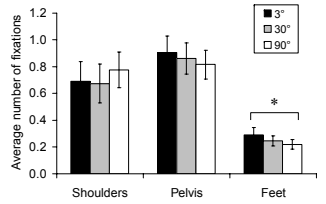


Number of fixations in ROIs by task



- A Task x Direction level interaction ($p = .04$), with increased angle reducing the number of foot fixations in the direction task only.
- No effect of gender level on region fixations.
- No correlations between regions fixated and correctness for the gender or direction tasks.

Number of fixations in ROIs by viewpoint, direction task



DISCUSSION

- People change their gaze patterns as a result of the biological motion task and more accessible attributes of the display (i.e. the walking direction), but not the less easily accessed style attributes (i.e. gender).
- Individual differences in gaze strategy, but unable to predict performance from strategy.
- The central region frequently fixated in both tasks, but the shoulders fixated more often in the gender task, and the feet more often in the direction task. More evidence that shoulders important in gender classification, and that humans make use of local motion information carried by the feet.

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