Gaze patterns during perception of direction and gender from biological motion

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Humans can perceive many properties of a creature in motion from the movement of the major joints alone. However it is likely that some regions of the body are more informative than others, dependent on the task. We recorded eye movements while participants performed two tasks with point-light walkers: determining the direction of walking, or determining the walker's gender. To vary task difficulty, walkers were displayed from different view angles and with different degrees of expressed gender. The effects on eye movement were evaluated by generating fixation maps, and by analyzing the number of fixations in regions of interest representing the shoulders, pelvis, and feet. In both tasks participants frequently fixated the pelvis region, but there were relatively more fixations at the shoulders in the gender task, and more fixations at the feet in the direction task. Increasing direction task difficulty increased the focus on the foot region. An individual's task performance could not be predicted by their distribution of fixations. However by showing where observers seek information, the study supports previous findings that the feet play an important part in the perception of walking direction, and that the shoulders and hips are particularly important for the perception of gender.

Keywords: biological motion, active sign, attention

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Introduction

Human vision can extract much high-level information from the motion of living creatures, even when all visual cues are removed except for the movement of the major joints. Experiments using these point-light displays have shown that we are sensitive to the gender, heading direction, identity, and even the emotional state and personality of the producer of the motion (Blake & Shiffrar, 2007; Troje, 2008a). However more remains to be learned about which parts of the display are most informative for these different abilities. Determining the primary areas from which information is gathered will provide important clues to how each perceptual task is performed.

In this study, we observed the effect of differing task instructions on eye movement patterns when viewing the same set of biological motion point-light walker stimuli. We used two commonly studied biological motion tasks: determining the direction in which a walker is facing, and determining the gender of the walker. The facing direction can be derived from different sources. One of them is the articulated structure of the body revealed by the dynamic configuration of subsets of dots (Bertenthal & Pinto, 1994; Troje, 2002). Like the explicit structure of a static stick-figure, the motion-mediated structure of a point-light display clearly indicates whether a sagittal-view figure is facing left or right. A second source of information about facing direction is the local motion of individual dots, in particular the ones representing the extremities. Both Mather, Radford, and West (1992) and Thurman and Grossman (2008) found that removal of central dots in the displays did not harm walking direction judgment, whereas removal of dots representing the extremities did. Other experiments showed that the feet are sufficient for the perception of direction by making the overall form of the point-light walker inaccessible, whether by inverting all the dot trajectories of the walker except for the feet (Troje & Westhoff, 2006) or by showing the feet in isolation (Chang & Troje, 2009). Although Pinto and Shiffrar (1999) argued that the importance of the extremities may be limited to determining direction, the hypothesis they addressed involved the configuration of the extremities rather than the intrinsic local motion of the extremities, since the local motion was made uninformative by the study's use of simultaneous scrambled walker masks. Therefore the study did not contradict the premise that local motion of the extremities is relevant to more than judging walking direction.

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For the task of judging a point-light walker's gender, a number of structural and kinematic cues have been suggested, most involving the shoulders and hips. Murray, Kory, and Sepic (1970) described greater lateral movement of the hips during walking in women as compared to men, observations that were later quantified by motion capture studies (Cho, Park, & Kwon, 2004; Smith, Lelas, & Kerrigan, 2002). Several researchers manipulated structural and kinematic properties of synthetic point-light displays in order to investigate which inform gender judgments. Barclay, Cutting, and Kozlowski (1978) and Cutting, Proffitt, and Kozlowski (1978) showed that observers required movement in the dots of the walkers to correctly determine gender, but framed the movement differences as mediating underlying differences in the body structure, in particular in the relative width of shoulders and hips. However in another study using a synthetic walker, Mather and Murdoch (1994) showed that even with structure held constant, lateral shoulder and hip movement could produce specific gender impressions. In contrast to these studies evaluating individual candidate cues to gender, Kozlowski and Cutting (1977) removed subsets of dots from point-light walkers derived from videotaped motion, and found that participants were above chance at judging gender with every subset. This view of gender information being distributed across the body was supported by Troje's (2002) creation of caricatured male and female walks using a linear "walker space." However, the differences between the extreme male and extreme female walk were most visible in the frontoparallel movements of hips and shoulders.

The importance of different regions of a visual display to a perceptual judgment can be studied using eye movements. The location of central fixation is a good proxy for the focus of attention (Findlay & Gilchrist, 2003), and it is known that eye movement strategies change depending on the task, with relatively more fixations occurring in regions that are more informative for the task (Buswell, 1935; Castelhano, Mack, & Henderson, 2009; Yarbus, 1967). This technique was used by Buchan, Pare, and Munhall (2007) to explore where people look on a speaking human face when either comprehending the words or judging the emotion being expressed, and how the fixation locations change as the task became more difficult. Johnson and Tassinary (2005) observed gaze patterns for biological motion perception of gender, using solid animated walking figures created with the animation software Poser. Their participants spent the most time fixating on the waist and hips, followed by the chest, followed by the legs and head. However, only the specific candidate cues of shoulder swagger and hip sway were varied, and the walkers were shown only in a frontal view.

We used eyetracking and a point-light walker derived systematically from recorded human movement (Saunders, Suchan, & Troje, 2009; Troje, 2008b), presented with different view angles and different degrees of maleness or femaleness, to investigate where viewers were gathering information during a direction and a gender biological motion task. The fact that the displays were synthesized from real walking patterns allowed us to avoid preconceived ideas of where directional or gender information was located, while still precisely modulating the availability of relevant cues.

We hypothesized that there would be a difference between the tasks in the number of fixations that fell in different regions, with more fixations at the feet in the direction task as compared to the gender task, and more fixations at the pelvis and shoulders in the gender task as compared to the direction task. We also hypothesized that task difficulty would have an effect on fixations in both tasks, with relatively more fixations being directed to informative locations as the task becomes more difficult. We evaluated these hypotheses using fixation maps and a region-of-interest analysis on the number of fixations. We also looked at individual differences, assuming that individuals would demonstrate different gaze strategies and that some strategies would be more effective than others for each task.

Methods

Participants

Twenty participants (7 men and 13 women) completed this study, primarily recruited from an introductory psychology course (several other recruited participants withdrew or did not complete due to technical problems). Their ages ranged between 17 and 38 ($M = 20$) and they were not experienced with biological motion stimuli. Participants were compensated with money or course credit.

Materials

Eye positions during the trials were recorded using a head-mounted EyeLink II system at a 250 Hz sampling rate. It has a gaze position accuracy of <0.5°. The stimuli were presented on a CRT monitor and controlled by a computer running MATLAB and the Psychophysics Toolbox (Brainard, 1997) which also received eyetracking data.

Stimuli

The stimuli consisted of point-light displays of human walking. They were created from the walks of 100 individuals, including 50 men and 50 women. Walking sequences were obtained using a motion capture system (Vicon 512, Oxford Metrics) and data were converted into Fourier-based representations, before averaging across several walking trials recorded for each individual (Troje, 2008b). We applied principal component analysis (PCA) to the collection of averaged individual walks to reduce

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the dimensionality of the space, and then used discriminant function analysis to create an axis that best captured gender-specific differences (Troje, 2002). A unique walker was generated for each trial by first choosing the point on the gender axis corresponding to the desired level of maleness or femaleness, and then adding a small random vector in the walker space, orthogonal to the gender axis. This had the effect of producing a novel animation that was a valid-looking walker with the desired gender level. The point-light displays consisted of 15 white dots on a black background, 10 cm tall, subtending 9.5° of visual angle at the viewing distance of 60 cm.

The synthetic walkers were either male or female, with one of three gender levels in units of standard deviations of the original 100 individuals' gender scores: 0.5, 1.5, and 2.5, where larger values indicate more exaggerated gender cues. The gender level affected all the dots of the walker, changing both static and dynamic properties. For example, the most extreme male walker had a shoulder-to-hip ratio of 2.4, whereas the most extreme female walker had a shoulder-to-hip ratio of 1.6. The shoulder sway also decreased from extreme male to extreme female, with the lateral distance traveled over a gait cycle by the dot representing the clavicle decreasing from 0.35 to 0.11 degrees of visual angle. The orientation of the walkers in the horizontal plane was also varied, with leftward or rightward walkers at one of three view angles: 3°, 30°, and 90°, with 90° corresponding to a sagittal (side) view and 3° corresponding to a near-frontal view.

To combat ceiling effects by increasing the difficulty, we introduced a mask of linearly moving dots traveling at 1.7° per second in random directions. The dots had a lifetime of 1 second after which they reappeared at a different location. There were 150 dots on the screen at any time in a 13° by 13° square centered on the point-light walker.

The walker and surrounding noise could be centered at one of four locations all offset from the initial fixation mark at the center of the screen by 4.8° of visual angle, shifted either up and left, up and right, down and left, or down and right. The purpose of this was to force viewers to make at least one saccade to reach the walker, reducing a possible bias towards fixating the center of the figure.

Procedure

The study was run in two blocks. The same set of point-light displays was used in both blocks; only the instructions were different. Following calibration of the eyetracker, participants were instructed to either identify the gender of the walker (male or female), or the direction the walker was walking (left or right) in the following trials. After those trials and a short break, they were given the other set of instructions and continued. The order of the blocks was counterbalanced across participants.

The six gender conditions, six view angle conditions, and four possible offsets from the center combined to make a total of 144 possible stimuli. Each of them occurred twice, resulting in a total of 288 trials for each block, with the order randomized within the block.

Trials began with a central fixation point that also served the purpose of drift correction for the eyetracker. Once the participant had fixated this point, that is, their eyes were relatively stationary, they pressed the spacebar and the fixation point disappeared to be replaced by the walker. The walker was displayed for 2 seconds, with the eyetracker collecting eye position data, after which the participant was prompted to press one of the arrow keys on the computer's keyboard to indicate their judgment of either the gender or the direction of the walker, depending on which of the two blocks they were running.

Data analysis

We analyzed the eyetracking position data to determine fixation locations. To detect saccades, we first smoothed the instantaneous eye velocity information with a moving average window 40 ms in width. Then we determined a saccade velocity threshold for each trial separately by computing the median and standard deviation of eye movement velocity after removing data points over 50°/s, and labeling all samples with velocities of more than 3 standard deviations above the median as part of a saccade. All samples between the saccade periods were labeled "fixations," even though by examination of eye velocity plots there was some movement during fixation periods, indicating possible microsaccades, fixation drift, or pursuit eye movements. Therefore the eye gaze events that we distinguished might be more accurately called saccades and non-saccades. However we will refer to the latter as fixations for the rest of the paper. The location of a fixation was defined as the average eye position during the fixation period.

For visualization purposes, we constructed fixation maps (Wooding, 2002) for different sets of conditions. We began with a matrix of all zeros corresponding to individual pixels of the display, and then progressively added circular Gaussian blobs for each fixation, centered on the fixation location (independent of fixation duration). These Gaussians had a standard deviation of 27 pixels or 1° of visual angle, roughly the size of the foveola, and equal heights of 1 unit. After all fixations for the relevant conditions were added to the map, the values at each pixel were scaled relative to the highest peak in the map, meaning that the darkest part of the image was the most fixated and corresponded to a value of 1. To compare fixations between the two tasks, we combined maps, creating dual-color fixation maps, by using the saturation of red at a given point to indicate fixations in the direction task, and the saturation of blue to indicate fixations in the gender task. Locations that were fixated frequently in both tasks appeared dark purple or black.

To test our hypotheses about fixation regions quantitatively, we defined three regions of interest (ROI) relative

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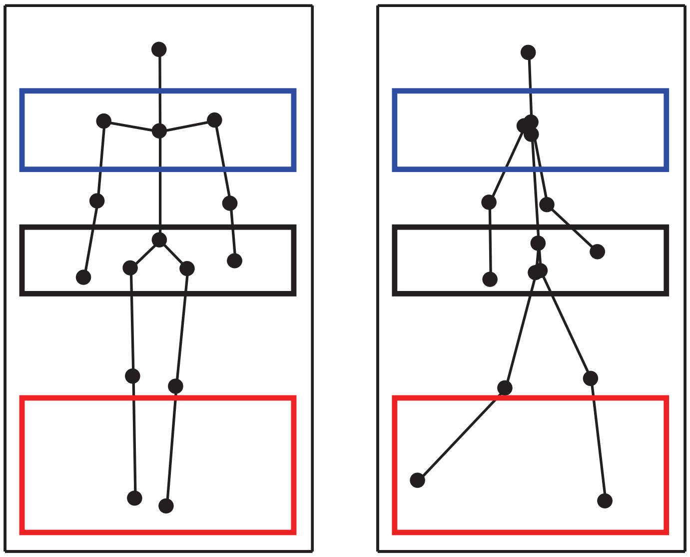

Figure 1. The predefined shoulder, pelvis and foot regions of interest, with the dots of an example point-light walker in frontal and side view respectively superimposed for reference. The rectangles indicating the regions and the lines connecting the dots are for illustration purposes and were not part of the stimuli.

to the center of the walker (Figure 1). The vertical coordinates of the ROIs were selected to fully contain the pairs of dots that represented either the shoulders, pelvis or feet across all view angles, gender levels, and frames of the animation, with an additional margin of approximately 0.5 degrees of visual angle above and below to capture fixations that were near the dots.

We conducted three-way repeated-measures ANOVAs to investigate the role of task and difficulty levels on gaze patterns, in the three predefined regions separately. The factors were Task (Direction or Gender), View Angle (walker rotated 3°, 30° or 90° from front-facing), and Gender Level (0.5, 1.5 and 2.5, with 2.5 being the most distinctively male or female). We used as a dependent measure the number of fixations that fell into each of the three ROIs, making a total of three 2 × 3 × 3 ANOVAs. All repeated-measures F values were computed using an assumption of sphericity.

Results

Accuracy

A repeated-measures analysis of variance applied to the proportion correct showed that we successfully manipulated the difficulty of the direction and gender tasks (Figure 2) by varying the viewing angle and the degree of maleness or femaleness, respectively. The factors were Task (direction or gender), View Angle (3°, 30° or 90° offset from a frontal view) and Gender Level (0.5, 1.5, or 2.5, where larger values are less ambiguous). There was a significant main effect of Task, $F(1, 19) = 170.42$, $p < .001$, with the gender task ($M = 0.64$) being more difficult than the direction task ($M = 0.86$). There were significant interactions between Task and View Angle, $F(2, 38) = 174.84$, $p < .001$, and between Task and Gender Level, $F(2, 38) = 44.76$, $p < .001$.

Within the direction task results, a follow-up 3 × 3 repeated-measures ANOVA showed an effect of View Angle on accuracy, $F(2, 38) = 381.36$, $p < .001$, but no effect of Gender Level, $F(2, 38) = 0.43$, $p = .65$. The effect of View Angle was due to accuracy differences between each pair of view angles, as shown by follow-up pairwise comparisons, $p < .003$, with the direction of walkers at near-frontal view angles being most difficult to judge.

Within the gender task results, a follow-up 3 × 3 repeated-measures ANOVA showed an effect of Gender Level on accuracy, $F(2, 18) = 21.01$, $p < .001$, and also View Angle, $F(2, 18) = 63.59$, $p < .001$, with no interaction between View Angle and Gender Level, $F(4, 16) = 2.16$, $p = .12$. Follow-up pairwise tests showed significant differences between gender accuracy at gender levels 0.5

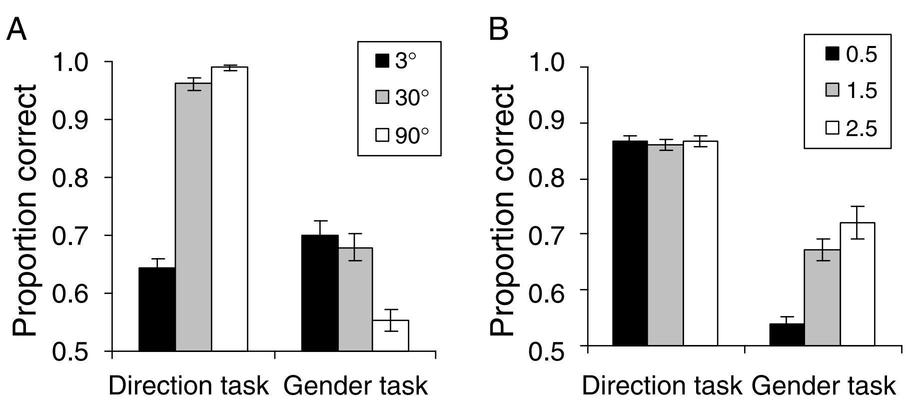

Figure 2. The average proportion correct for the direction and gender task at A) the different walker view angles, where 90° represents a side view and 3° represents a near-frontal view, and at B) the different gender levels, where 0.5 is most ambiguously male or female and 2.5 is most exaggerated. Error bars represent 1 *SEM*.

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and 1.5 and between levels 0.5 and 2.5, $p < .001$, as well as between 1.5 and 2.5, $p = .011$, with performance improving as the gender of the walkers became more distinct. Though performance at the 0.5 gender level, the most ambiguous, was close to chance level (which was 50%), it was still significantly above chance, $t(19) = 2.87$, $p = .01$. Follow-up tests showed that the effect of View Angle was due to significant differences between gender accuracy at the 3° and 90° view angles, and between 30° and 90°, $p < .001$, but not between 3° and 30°, $p = .21$. Performance at the 90° view angle was much worse than in the more frontal conditions, but significantly better than chance, $t(19) = 2.76$, $p = .01$. The gender task performance results fell within the range reported by studies included in a meta-analysis conducted by Pollick, Kay, Heim, and Stringer (2005): these studies found accuracies for point-light walker gender tasks between 58% and 76% (M = 71%) for walkers presented from frontal or oblique views, and between chance level and 72% (M = 66%) for walkers presented in a sagittal view.

Fixation maps

The dual-color fixation map averaged across conditions and participants (Figure 3A) showed that in both tasks, participants fixated most often in the area of the point-light walker stretching between and including the pelvis and shoulders. The corresponding plot of the vertical distribution of fixations (Figure 3B) confirms this. An overall tendency of participants to fixate more on the feet in the direction task can be seen in the light red areas of the fixation map. Only in the direction task were there any number of fixations that fell below the pelvis.

Qualifying these overall results, individual dual-color fixation maps (Figure 4) showed a large amount of variation among the 20 participants in where they fixated, and in how different their fixation patterns were between the two tasks. Most participants' fixations fell horizontally at the midline of the body on average. Vertically they landed frequently at the pelvis, shoulders, or both. Some participants did not show much difference in fixation patterns between the two tasks, which can be seen from their primarily black and dark purple maps, while others changed their fixations greatly, which can be seen in clearly separated red and blue regions. Of those who did change their fixation strategy to an appreciable degree, the majority placed a greater emphasis on the feet in the direction task than in the gender task (and so have red areas near the feet). Some participants (e.g. #2, #11, #15) also showed a horizontal shift of their typical fixation locations between the two tasks, but these shifts did not show a consistent pattern across participants.

In the next section these observations are quantified using the average number of fixations that fell within three pre-defined regions of interest.

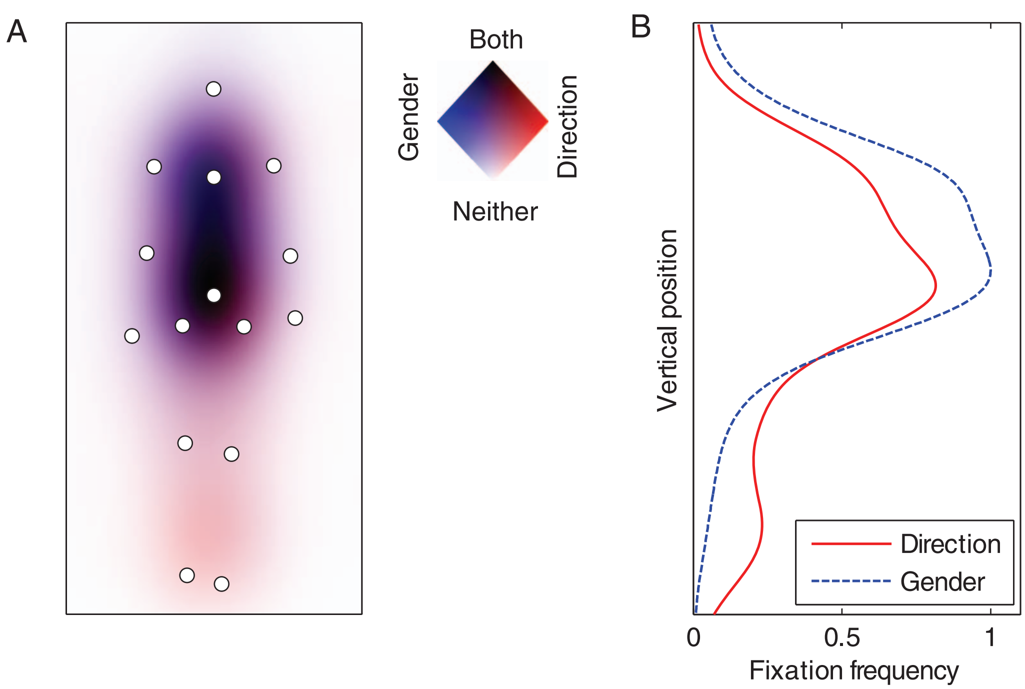

Figure 3. A) Fixation map across all participants and all conditions. The red areas indicate where there were the most fixations in the direction task and the blue where there were the most fixations in the gender task, while dark purple or black areas were frequently fixated in both tasks. B) Corresponding vertical distribution of fixations, showing the average height of the fixation map at each vertical position for the two tasks. Normalized so that the highest peak across both tasks is 1.

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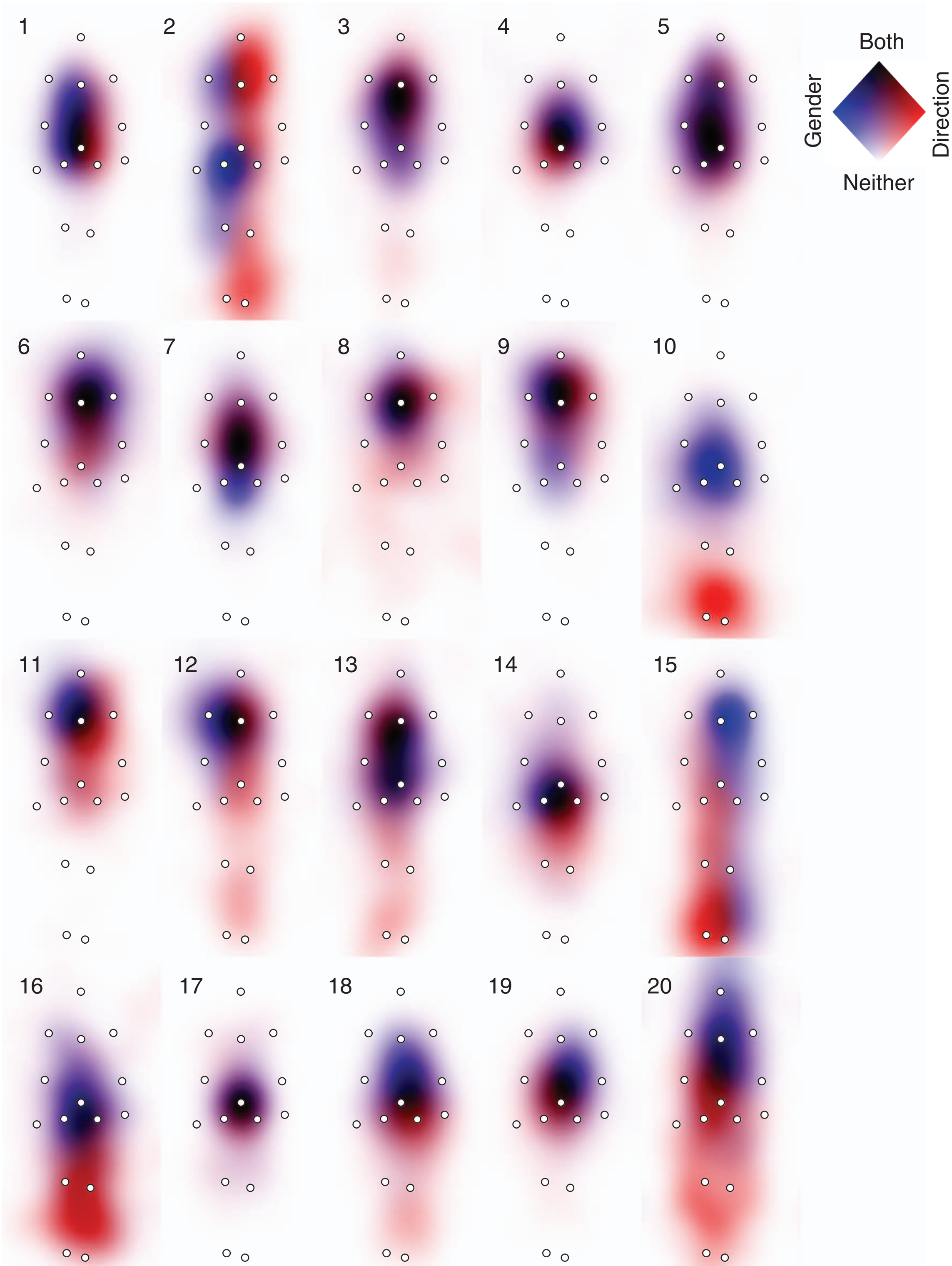

Figure 4. Fixation maps for each participant, showing the fixations for the two tasks across all view angles and all gender levels. The red areas indicate where there were the most fixations in the direction task, and the blue where there were the most fixations in the gender task. Dark purple or black areas were frequently fixated in both tasks.

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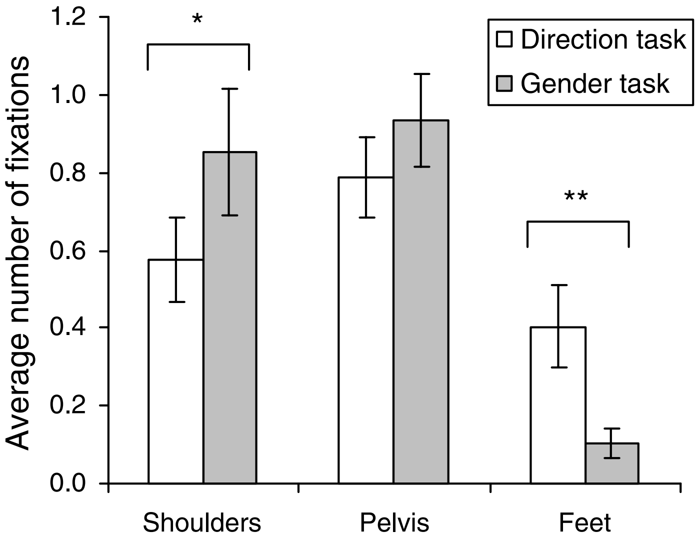

Figure 5. The average number of fixations within the three ROIs for the two tasks. Error bars represent 1 *SEM*. * indicates significance at the .05 level, ** significance at .01.

Regions of interest

We analyzed the average number of fixations in each ROI. In the foot region, a three-way repeated measures ANOVA on the average number of fixations, with Task, View Angle, and Gender Level as factors, showed a significant main effect of Task, $F(1, 19) = 10.64$, $p = .004$, with participants fixating more often on the feet in the direction task (Figure 5). There was also a main effect of View Angle, $F(2, 38) = 3.91$, $p = .03$ and an interaction between Task and View Angle, $F(2, 38) = 3.49$, $p = .04$. Follow-up ANOVAs within the direction task and gender task revealed that the main effect of View Angle was carried exclusively by mean differences in the direction task, $F(2, 38) = 4.13$, $p = .02$, with no effect of View Angle in the gender task, $F(2, 38) = 0.32$, $p = .73$. Pairwise tests in the direction task showed that there were more fixations on the feet in the 3° than in the 90° (side view) view angle (Figure 6), $p = .04$, but no significant difference between the number of feet fixations in the 3° and 30° view angles or the 30° and 90° view angles, $p = .10$ and $p = .07$ respectively. A test for a linear trend was significant, $p = .04$. There was no significant main effect of Gender Level in the foot region, as well as no other interactions.

Participants fixated more often in the shoulder region during the gender task than during the direction task, $F(1, 19) = 4.89$, $p = .04$ (Figure 5). There were no effects of View Angle or Gender Level in the shoulder region, and no interactions.

In the pelvis region, there was a significant main effect of View Angle on number of fixations, $F(2, 38) = 4.51$, $p = .02$, and no other main effects or interactions. Pairwise tests indicated more fixations on the pelvis in the 3° (near frontal) view angle than in the 90° view angle, $p = .02$. Although differences between the other pairs of view angles in number of fixations did not reach significance, a test for a linear trend was significant, $p = .02$, indicating a pattern of fewer pelvis fixations at the less frontal view angles.

Individual gaze patterns and accuracy

To determine whether the regions typically favored by each individual in the direction and gender task could predict their performance, we conducted a multiple regression for each task. The predictors were an individual's average number of fixations in the three ROIs (shoulder, pelvis and foot) during the task, and the dependent variable was their proportion correct. In the direction task, the regression was

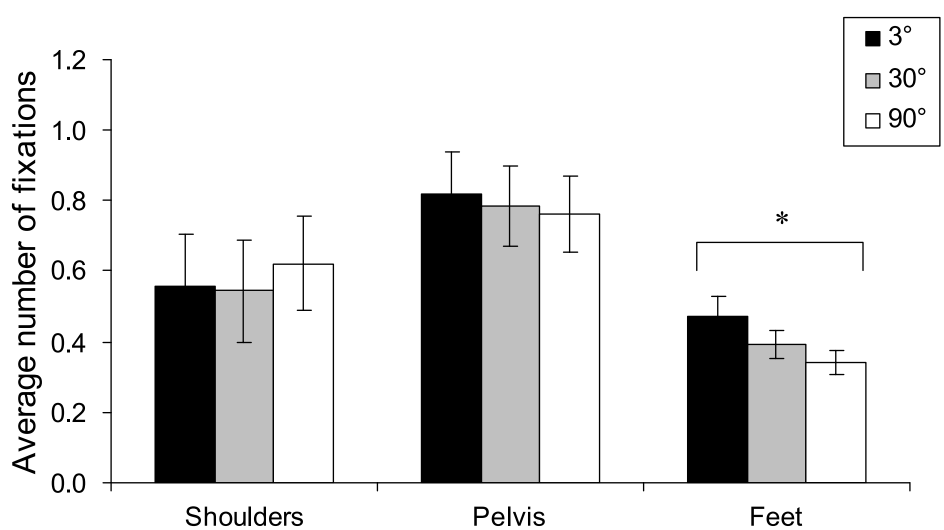

Figure 6. The average number of fixations during the direction task in the three ROIs for the different view angles, where 90° is a side view and 3° is a near frontal view. Error bars represent 1 *SEM*. * indicates significance at the .05 level.

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not significant, R^2 = .03, adjusted R^2 = −.15, $F(3, 16)$ = .18, p = .90. In the gender task, the regression was also not significant, R^2 = .21, adjusted R^2 = .06, $F(3, 16)$ = 1.40, p = .28. Average number of fixations in the three ROIs could not predict an individual's performance.

Discussion

Our results reveal that observers look at the feet of a point-light walker when performing a direction task, but rarely when performing a gender task. Furthermore, they look at the shoulders in a gender task relatively more often than in a direction task. These findings provide evidence for task-specific cues in those locations.

The premise that the primary cues to gender are found in the shoulder and pelvis of a walker is supported by our results. Participants looked often at the hips and shoulders in the gender task and rarely at the feet. The importance of the shoulders may be that they most clearly reveal the degree of lateral body sway (Mather & Murdoch, 1994). Kozlowski and Cutting's (1977) experiment on gender judgments when sets of dots were removed from a point-light walker found that upper body (head, arms and shoulders) information was more helpful than lower body (pelvis and legs). The fact that our participants on average did not look at the shoulders more often than the pelvis may have been because people are not aware that the shoulders carry gender cues: in Barclay et al.'s (1978) study, when asked which body movements they thought best differentiated men and women, all participants mentioned the hips while only 76% mentioned the shoulders. Other candidate cues involve the shoulders and pelvis equally, such as the shoulder–hip ratio. In contrast to our finding of approximately equal number of fixations on the shoulders and pelvis, Johnson and Tassinary (2005), also studying gaze patterns in a gender classification task, observed almost twice as many fixations on the pelvis and lower torso as on the chest and shoulders. This could be accounted for by the fact that they used solid models for their walking displays, which, unlike point-light walkers, depicted the size of the waist and other non-skeletal anatomical measures. Exaggerating this effect, half the trials in their eye movement analysis only varied the shape of the waist, with the kinematics remaining constant, so that the only gender information was in the waist–hips area. The present study extends Johnson and Tassinary (2005) by showing the role of different tasks, and by defining gender levels in terms of a linear space of motion-captured male and female walking patterns rather than by varying isolated motion cues such as hip and shoulder sway. We also observed fixations with the walkers displayed at different view angles.

On average, our participants fixated more often in the region containing the feet when they performed the direction task than when they performed the gender task. Along with the frequent fixations on the pelvis and upper body in this task, this points to a contribution of both local and configural cues in judging direction. Although the present study cannot directly address the relative importance of these two sources of information, the localized change in attentional emphasis is predicted by previous findings (Chang & Troje, 2009; Mather et al., 1992; Troje & Westhoff, 2006) that the local motion of the extremities, in particular the feet, are useful in perception of direction. A hypothesized aspect of the foot motion that triggers biological motion processing is the characteristic acceleration profile: Chang and Troje (2009) found that inversion reduced accuracy in direction judgments from two foot dots, but not when the acceleration profile of the foot movement was distorted. The bottom-most ROI always contained the foot dot, but for certain walkers the knee dots passed into it during part of the gait cycle. This means that our findings of increased fixations in this ROI are also consistent with an alternative model, that local subconfigurations of limbs (Pinto & Shiffrar, 1999) are what are critical for some biological motion tasks. In either case, the task-related shift in attention to the lower body indicates that participants likely made use of directional information located there.

Our prediction that increased task difficulty would enhance the difference in gaze patterns between the two tasks was partially verified. In the direction task the most difficult condition, in which the walker was displayed at a near-frontal view angle, resulted in the most foot fixations on average, whereas the sagittal view angle resulted in significantly fewer foot fixations. Changes to both the gender level and to the view angle affected performance in the gender task, replicating Mather and Murdoch's (1994) and Troje's (2002) finding that the gender of a point-light walker is easiest to determine in frontal views; however neither gender level nor view angle affected the number of fixations in the ROIs. This discrepancy between the effect of task difficulty in the two tasks may be the result of view angle being more immediately accessible (as reflected in the higher accuracies), allowing the participant to adjust their gaze strategy dynamically based on the difficulty, whereas in the gender task the 2 second display time may not have been sufficient to both determine the difficulty of the task and then carry out an appropriate strategy. Alternatively, 2 seconds may have been more than sufficient to determine the walking direction in the easier direction task conditions, after which the viewer could explore the display freely, including areas not necessary for performing the task. This interpretation is supported by the finding of ceiling and near-ceiling direction performance at the 90° and 30° view angles.

Contrary to our expectations, performance in the two tasks could not be predicted by how an individual distributed their fixations among the shoulders, pelvis and feet. This may have been due to lack of variability in individual behavior. In the direction task there was

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relatively low between-subjects variability in the proportion correct (*SD* = 0.04) and high variability in the distribution of fixations, whereas in the gender task there was somewhat higher variability in the proportion correct (*SD* = 0.08) and low variability in the regions fixated (almost exclusively the shoulders and pelvis). This could be improved in future studies by making the direction task more difficult, and by using a larger walker, so that observers would have to decisively fixate on the pelvis or shoulders to gather information from them. Nevertheless, the fact that participants fixated more on the feet in the direction task than in the gender task, and more on the upper body in the gender task than in the direction task, shows that they sought task-relevant information in these two areas.

Future eyetracking studies using human motion stimuli should examine the temporal patterning of fixations. The time dimension is critical for describing gaze behavior when viewing non-periodic actions; in particular, displays of social interaction. It is already known that there are predictable temporal and spatial patterns of fixations for normal observers on video of social scenes, but which are different for people with autism (Klin, Jones, Schultz, Volkmar, & Cohen, 2002). This phenomenon could be further investigated with point-light displays, which offer a large number of possibilities for controlling aspects of social interaction animations: information can be removed and altered, and even the degree of interactivity can be modulated.

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