Effects of Gender and Gaze Direction on the Visual Exploration of Male and Female Bodies

by

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A thesis
presented to the University of Waterloo
in fulfilment of the
thesis requirement for the degree of
Master of Arts
in
Psychology

Waterloo, Ontario, Canada, 2011

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

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Abstract

The present study used eye-tracking to investigate whether a model's gaze direction influences the way observers look at the entire body of the model and how this interacts with the observer and the model's gender. Participants viewed individual male and female computer agents during both a free-viewing task and a rating task to evaluate the attractiveness of each character. The results indicated that both male and female participants primarily gazed at the models' faces. Participants also spent more time scanning the face when rating the attractiveness of each model. Observers tended to scan faces with a direct gaze longer than faces with an averted gaze for both the free-viewing and attractiveness rating tasks. Lastly, participants evaluated models with a direct gaze as more attractive than models with an averted gaze. As these results occurred for pictures of computer agents, and not actual people, this suggests that direct gaze, and faces in general, are powerful for engaging attention. In summary, both task requirements and gaze direction modified face viewing preference.

Acknowledgements

I would like to specially thank my supervisor, Roxane Itier, for her guidance and assistance with this project. I am very fortunate to receive her strong dedication and support in pursuing my research interests. I would also like to thank my reviewers, Britt Anderson and Dan Smilek, whose attention to detail in reviewing this project greatly improved the quality of this work.

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Introduction

In the field of social cognition, research on human gaze patterns has primarily focused on how observers scan and interpret facial cues, such as mutual gaze (e.g., Wieser et al., 2009), identity recognition (e.g., Henderson et al., 2005), and facial expression (e.g., Hall et al., 2010). However, real life social interactions generally involve the perception of an entire person. Successful social interaction requires interpreting a variety of nonverbal behavioural cues, including gaze direction (Castelhano et al., 2007; Driver et al., 1999; Friesen & Kingstone, 1998), head orientation (Itier et al., 2007, Langton, 2000; Langton & Bruce, 1999), and body position (Perrett & Emery, 1994; Zwickel & Võ, 2010) in order to infer the focus of attention and intentions of others. In contrast to faces, little research has examined how the human body is scanned and perceived in the context of other nonverbal facial cues. In particular, there is currently no research examining whether an actors' gaze direction influences the way observers look at the bodies of the actors and how this interacts with the observer and the actor's gender. The present study investigated facial cues in the context of the entire human body in order to bring this research one step closer to typical real life situations. The purpose was to examine the interaction between gaze direction and body visual exploration using an eye-tracking approach by presenting participants with full individual characters that were either looking straight ahead, as if looking at the participant (direct gaze), or away (averted gaze).

There is no doubt that human faces are an important source of social information during social interactions. Faces convey information about identity, gender, age, race, gaze, attractiveness, and emotions (e.g., Cunningham, 1986; Ekman & Oster, 1979; Fridlund 1991; Hall et al., 2005; Henderson et al., 2005; Janik et al., 1978; Schyns et al., 2002). The human brain is known to have a neural network for processing facial stimuli (Allison et al., 1999; Haxby et al., 2000, 2002; Hoffman & Haxby 2000; McCarthy et al., 1999; Puce et al., 1999). Very early in life, human infants start to fixate on faces and respond to different facial expressions (Johnson et al. 1991; Morton & Johnson, 1991). Newborns will also visually track a schematic face farther into the periphery than a scrambled face (Goren et al., 1975) and prefer to look at upright rather than inverted schematic faces (Mondloch et al., 1999). Thus, due to their biological and social significance, the brain may have evolved to be more responsive to faces which can preferentially capture and engage attention (Palermo & Rhodes, 2007). As a result of the wealth of information that faces convey in social interactions, we should expect that people would primarily gaze at each other's faces, even when presented with entire bodies, in order to perceive any potential nonverbal facial cues.

One major reason why we look at other people's faces is to detect and discriminate eye contact, also called direct or mutual gaze. Direct gaze can be used to convey information, express friendliness or intimacy, control social interaction, and communicate behavioural intent (Kleinke, 1986). Since gaze plays a major role during social interaction, the current study intended to address whether eye contact influences subsequent body visual exploration. One theory suggests the existence of an innate neurocognitive mechanism specialized in detecting eyes in the environment and their gaze direction (Eye Direction Detector—EDD; Baron-Cohen, 1995). This EDD is proposed to detect the presence of eyes and the direction of gaze based on the geometry created by the circular dark iris relative to the white sclera. The EDD mechanism also functions to determine whether one is the focus of the viewer's attention. Research has shown that direct gaze can elicit higher levels of autonomic arousal than averted gaze (Hietanen et al., 2008), and capture and engage attention better than averted gaze (e.g., Senju & Hasegawa, 2005; von Grünau & Anston, 1995). For example, using Posner-like attention paradigms in which a face cue is centrally presented prior to the onset of a lateral target, target detection (i.e., reaction time) is longer when the gaze of the face is direct rather than averted (Senju & Hasegawa, 2005; Vuilleumier, 2002). This suggests that direct gaze attracts and retains attention, and delays disengagement from the central face before orienting attention to the target location. Visual search paradigms have shown that direct gaze is also detected faster and more accurately than averted gaze in a crowd of opposite-gaze distractors (Conty et al., 2006; Doi, & Ueda, 2007; Doi et al., 2009; Senju et al., 2005; von Grünau & Anston, 1995). Recently, this "stare-in-the-crowd effect" has been replicated using eye-tracking, showing that direct gaze targets are visually located faster than averted gaze targets, although only in the left peripheral visual field (Palanica & Itier, 2011). Taken together, these studies support the notion that direct gaze is attention grabbing. An important topic of investigation in the current study was whether people would look faster and longer to faces with a direct gaze when the observer was presented with an entire human body. If direct gaze has a robust effect on the engagement of attention, then, compared to averted gaze faces, we should expect that participants would be faster to fixate on direct gaze faces, and delay their disengagement of attention before scanning other body regions.

Studies have investigated the effect of gaze on face recognition, gender discrimination, and attractiveness (e.g., Hood et al., 2003; Kampe et al., 2001; Macrae et al., 2002; Vuilleumier et al., 2005). Currently, there are no studies that have manipulated the gaze direction of full characters, while measuring the scanning of their bodies. One of the only studies examining how gaze direction influences social interactions with full characters was conducted by Bailenson and colleagues (2003). The researchers used interacting computer agents while participants navigated through an immersive 3D virtual environment. Their results showed that participants gave more personal space to virtual agents that engaged them in mutual gaze, replicating early research that was conducted with human confederates (e.g., Argyle & Dean, 1965). However, this study only measured the behavioural navigation of participants, while their gaze exploration of the agents was not monitored. The present study tracked participants' eye movements using an eye-tracking device, which is considered a reliable and sensitive measure of visual and cognitive processing (Henderson, 2006). Since it is widely acknowledged that faces are important for social interactions and may have an evolutionary advantage to capturing our attention, we expected participants to look at the characters' faces first (regardless of the gaze direction). The main purpose was then to test whether participants would spend more initial time scanning faces with a direct gaze than averted gaze, before moving their eyes to the various body regions.

The current study also examined gender differences in the visual exploration of bodies. Several eye-tracking studies have investigated participants' gender differences in how they view the faces and bodies of other male and female actors (Lykins et al., 2006, 2008; Rupp & Wallen, 2007, 2009; Tsujimura et al., 2009). However, these particular studies focused on the way participants view erotic stimuli, usually when presented with images of couples engaging in sexual behaviours. This type of research is not generalizable to the context of typical one-on-one social interactions in everyday life. These studies also only examined participants' eye movements to the face versus the body as a whole; that is, viewing patterns toward individual body regions (e.g., shoulders, breast, waist, hips, etc.) were not analyzed, and it is not possible to tell whether specific body regions were scanned more frequently than others. Since the human body is also much larger than the human face, it is possible that people could simply fixate on the body by chance because it is such a large area. One particular eye-tracking study by Hewig et al. (2008) did analyze the viewing patterns towards specific body regions of individually presented photographs of male and female models. Overall, the main finding from the study was that both male and female observers looked significantly earlier and longer at the models' faces compared to any other body region. However, the study also revealed significant gender differences across both models and participants in body visual exploration. It was found that men, compared with women, moved their eyes more rapidly towards females' breasts which they fixated for longer periods of time, while both genders behaved similarly in their viewing time for the waist and hip regions of the models. The authors suggested that this supports evolutionary hypotheses on mating strategies stating that female breast size in an important indicator of health and reproductive capacity (Jasienska et al., 2004), while the waist-to-hip ratio of the opposite sex has been found to be important for the assessment of sexual attractiveness for both male and female raters (Singh, 1993, 1995; Singh & Young, 1995). Thus, men and women seem to focus their attention on those body regions that most likely provide information about the suitability of another person as a mate. The current study predicted similar behaviours as found in the study by Hewig et al. (2008). That is, participants should primarily gaze at faces more than any other body region. Then, once participants did scan the rest of the body, gender differences were expected between participants, in which male participants would look earlier and longer at female breasts compared to female participants, while both sexes would spend more time scanning the waist and hip regions of the opposite sex compared to the same sex. An important investigation of the current study was whether gaze direction would affect these gender differences in body scanning.

Because participants were presented with entire bodies of individuals of the opposite sex, it may also be argued that scanning someone's body when the actor is engaged in mutual gaze with the observer is a social faux pas. That is, according to typical social norms in everyday society, it is generally considered impolite to scan or stare at someone's body regions when they are looking directly at you, especially when those body regions are considered signals of sexual attractiveness (e.g., breasts, waist, hips). Haley and Fessler (2005) showed that in an experimental economic game in which participants could choose whether to share money with their fellow participants, more money was shared by participants whose irrelevant computer desktop background contained a pair of schematic eyes compared with a desktop background that contained no eyes. This study suggested that increased economic fairness and collaboration resulted from the feeling of “being watched.” It should also be noted that the feeling of “being watched” does not necessarily entail mutual gaze with the other individual; that is, you may be able to “know” that a person is scanning your body even if you are not looking directly at their eyes. Of course, mutual gaze would surely signal the observer that they are the focus of the actor’s attention. Thus, it was expected that participants in the present study would delay disengagement from the direct gaze of characters before scanning the rest of the body by fear of committing a social faux pas while feeling that they were being watched. In contrast, it was expected that participants would scan the bodies of characters earlier when those characters were averting gaze, because the participants would no longer feel that they were being watched.

Another topic of investigation in this study was the issue of task demands. Participants completed two different tasks when viewing the stimuli. First, they completed a free-viewing session, in which no specific task was required. Then, they completed a rating session in which they rated each character on physical attractiveness. Eye movement patterns can change dramatically from free-viewing to those based on high-level task demands (Yarbus, 1967). Typical one-on-one social interactions generally involve visual scanning with no particular goal in mind (i.e., freely viewing others). Free-viewing allows for the investigation of naturalistic gaze patterns. If direct gaze has a robust effect on the engagement of attention, then we should expect that participants would respond by delaying their disengagement of attention from direct gaze faces before scanning the body regions, whether or not they are aware of their own behaviours. By contrast, having an explicit task in mind, such as evaluating the attractiveness of another person, may influence how they scan other individuals. In particular, although both the face and body make significant contributions to overall ratings of attractiveness by male and female raters, facial attractiveness is known to be a significantly stronger predictor of attractiveness ratings than the body (Alicke et al., 1986; Currie & Little, 2009; Furnham & Reeves, 2006; Meuser et al., 1984; Peters et al., 2007), and the face is fixated significantly earlier and more often than other body regions when rating physical attractiveness (Hassebrauck, 1998). Thus, compared to the free-viewing session, it was expected that in the rating session, participants would spend more time scanning the face. Gaze direction also plays a role in attractiveness evaluations, with direct gaze faces being judged more favourably than averted gaze faces (Conway et al., 2008; Ewing et al., 2010; Kampe et al., 2001). Thus, it was expected that characters with a direct gaze would be rated as more attractive than those with averted gaze. Currently, it is unknown whether gaze direction affects eye movements when explicitly asked to rate the attractiveness of others. However, since direct gaze should engage attention longer than averted gaze, it was predicted that participants would spend more initial time fixating direct gaze than averted gaze faces in both the free-viewing and attractiveness rating sessions.

The last topic of investigation in the current study was the effect of context. That is, the effect that the background setting of the characters might have on the eye movements and ratings of the participants. For example, viewing a set of characters against a blank background setting may not be entirely realistic compared to usual social interactions (within a real environment). Instead, if participants viewed the characters within a social setting context, then they might be more inclined to scan the individuals in a naturalistic manner. The gaze of the characters may also convey a stronger signal in the social setting context, for example, because an averted gaze may actually signal that the individual is attending to another person or focus of interest (Baron-Cohen, 1995; Emery, 2000). Thus, this study contained a between-subjects design in which half of the participants viewed the models against a plain white background (No Context Condition), while the other half viewed the models against a bar setting background (Context Condition; see Figure 1). It was hypothesized that gaze would have a greater impact in the Context Condition, and participants' eye movements would be more influenced in the predicted manner as described above. That is, direct gaze should delay disengagement longer in the Context Condition than in the No Context Condition, while averted gaze should influence participants to scan the body regions faster.

To summarize, it was predicted that:

(1) All participants would scan the face earlier than the rest of the body, and spend the majority of the time exploring it compared to any other individual body region; this would be reflected in earlier onset times of first fixations to the face than to other body regions, and more fixations and longer viewing times overall for the face compared to any other body regions.

(2) When the models were looking at the participant (i.e., direct gaze), participants would initially look at their faces faster than if the models were looking away, and spend more initial time fixating the face before scanning the rest of the body; this would be reflected in earlier onset times of first fixations and longer durations of first fixations to direct gaze faces compared to averted gaze faces.

(3) Participants would be faster to move their eyes away from the face to scan the rest of the body for averted looking faces compared to direct looking faces; this would be reflected in

shorter durations of first fixations to averted gaze faces and earlier onset times of first fixations to the body regions after looking at an averted gaze face.

(4) Male participants, compared to female participants, would be faster to scan the breast region of female models and spend more time scanning the female breast region, reflected in earlier onset times of first fixations and longer overall viewing times to the female breast region; also, both genders would spend more time scanning the waist and hip regions of the opposite sex models (compared to same sex models), reflected in longer overall viewing times to the waist and hip regions of the opposite sex.

(5) Participants would spend more time scanning the face when asked to rate the physical attractiveness of the models, reflected by more fixations and longer overall viewing times to the face in the attractiveness rating session compared to the free-viewing session.

(6) Models with direct gaze would have higher ratings of physical attractiveness than models with averted gaze.

(7) Predictions (1) to (6) would be valid for both the Context and No Context Conditions, but the gaze of the models would have a stronger effect in the Context Condition in the predicted patterns described above.

Methods

Participants. Data were collected from a total of 56 undergraduate students (28 (gender matched) in each context condition) from the University of Waterloo (UW), who participated in the study for course credit. Ages ranged from 18 to 25 years (*M* = 19.9). All participants had normal or corrected-to-normal vision, and all participants were of heterosexual orientation. Ethnic backgrounds included Caucasian (50%), Chinese (14.3%), Black/African (7.1%), East Indian (7.1%), other Asian groups (9%), and other cultures (12.5%). Participants were either born in Canada (79%) or had lived in Canada for over 11 years. There were no differences in demographics between context conditions. All participants signed informed written consent letters and the study received full ethics clearance from the UW Research Ethics Board.

Stimuli. A set of 30 virtual humans (half male), or computer agents, were obtained from Vizard 3.15 software. Agents were viewed individually against either a white background (No Context Condition) or a bar scene (Context Condition; see Figure 1). Other than the background settings, all other details were identical in both context conditions. The scenes were displayed at a resolution of 1152 X 864 pixels and subtended 29.2° x 22.2° of visual angle at the viewing distance of 0.70 m. Each of the agent's full body (including the head) subtended visual angles of 6.5° horizontally by 19.5° vertically (male and female bodies were of the same dimensions). Each of the agent's faces subtended 2.0° horizontally by 2.7° vertically, which was situated at 8.6° visual angle from the center of the monitor (i.e., the fixation cross). Male and female faces were of the same size. It is important to note that the agent's faces were not in the foveal visual region of the starting point for each trial.

The 30 characters were selected from a series of 103 different agents (58 males, 45 females) from the Vizard software; the program contains models of males and females with all types of casual and business-formal style clothing. As in Hewig et al. (2008), care was taken so that each male model was matched with one female model, and that each such pair of models wore clothes of similar color, similar style, posed with similar body posture, and showed body regions of similar size.

In a pilot study, 20 independent undergraduates (11 female) of the same age as participants of the present study rated these 30 models on physical attractiveness. Using a 9-point Likert scale, the results showed an average rating of 5.8 (SD = 0.8) for female models and 5.2 (SD = 1.4) for male models, indicating that the models were of "moderate" attractiveness. This was important to avoid any biased responses that may be associated with either extremely attractive or extremely unattractive individuals. The pilot study also indicated that the female models were rated as more attractive than the male models ($t(19) = 2.29$, $p < .05$). This effect of model gender was also found in the results of the Hewig et al. (2008) study, and is generally found for computer agents, with more feminine characters rated as more attractive than masculine characters, by both male and female raters (Nowak & Rauh, 2006).

In order to control for eye gaze and body position, all of the individual models were viewed four times in either context condition in a counterbalanced fashion, i.e. each model was viewed with a direct eye gaze (as if looking at the participant) and an averted eye gaze (as if looking away from the participant) facing ¾ left, and then with a direct and an averted eye gaze facing ¾ right. All faces were of neutral expression. The gaze and body position of each agent was manipulated using Adobe Photoshop 11.0 and then mirror-reversed to avoid any bias between the right and left sides. This gave a total of 120 stimuli that were presented to participants in a semi-randomized order. Male and female models were counterbalanced such that the same gender was never viewed more than once in a row (i.e., presentation was male, female, male, female, etc.).

Figure 1. Example of the stimuli used; all images were shown in full colour. Left panels: examples of agents in the No Context Condition. Middle panels: examples of agents in the Context Condition. Note that these agents only represent stimuli with direct gaze; averted gaze agents comprised the same identities and body positions, but with differing eye directions. Right panels: upper image is a close-up of an agent with direct gaze; lower image is a close-up of an agent with averted gaze. Left and middle displays represent the entire monitor size.

Apparatus. The stimuli were presented on a Viewsonic PS790 CRT 19-inch colour monitor driven by an Intel Corel 2 Quad CPU Q6700 with a refresh rate of 60 Hz. Eye movements were recorded using a remote EyeLink 1000 eye-tracker from SR Research with a sampling rate of 1000 Hz. The eye-tracker was calibrated to each participant's dominant eye, but viewing was binocular. Calibration was done using a nine-point calibration accuracy test. Calibration was repeated if the error at any point was more than 1°, or if the average error for all points was greater than 0.5°. A chin and forehead rest maintained participants' viewing position and distance.

Materials and Procedure. Each participant was randomly assigned to either the No Context or Context condition. Participants were informed that the study involved answering a few short questionnaires and viewing a series of male and female models on a computer monitor. In each context condition, participants performed two sessions: first, a free-viewing session, and then an attractiveness rating session. Before participants viewed the stimuli, it was important to conceal the real purpose of the study of examining natural eye-gaze behaviour. Thus, participants were lead to believe that the purpose of the eye-tracking equipment was to investigate their pupillary reactions in response to the different luminosity of the pictures and to assess the dilations of the pupil in response to the stimuli (as in Hewig et al., 2008). Before the first free-viewing session, participants were given a practice session in which one male model and one female model were individually presented on the screen with a fixation slide between stimuli. Participants were instructed to “look at the pictures as you normally would.” In the first experimental session, pictures of models were individually presented in the center of the monitor for 4 s. A white screen was presented between each stimulus with a black centered fixation cross. After 1.5 seconds, the fixation cross was replaced by a fixation trigger that participants must have focused on for 300 ms to activate the next trial. Thus, the starting point of eye movements for each trial was always in the center of the screen close to the hip region of the models, replicating Hewig et al. (2008).

Once all 120 stimuli were viewed, participants were then instructed to rate the physical attractiveness for each of the models. In the attractiveness rating session, participants were still connected to the eye-tracker and viewed each model again in a new semi-randomized order. However, after each stimulus, participants were presented with a Likert scale (1-9 steps) asking “How physically attractive is this character?” Participants used the computer mouse to rate the

Likert scale, and were not able to view the next model until they answered the question. In order to decrease the influence of participants' eye movements on "naturally" scanning the models, the two experimental sessions were not counterbalanced; that is, all participants performed the free-viewing session before the attractiveness rating session. For both experimental sessions, participants were allowed to take a self-paced break after each block of 60 trials. At the beginning of each block, participants' eye movements were recalibrated.

Participants then completed a series of questionnaires, including the State–Trait Inventory for Cognitive and Somatic Anxiety (STICSA; Ree, MacLeod, French, & Locke, 2000), and the Revised Sociosexual Orientation Inventory (SOI-R; Penke & Asendorpf, 2008). The STICSA is a Likert scale questionnaire assessing cognitive and somatic symptoms of anxiety as they pertain to one's mood in the moment (state; 21 items) and in general (trait; 21 items). This was used to monitor the anxiety level of participants as it is known to interact with the processing of gaze (e.g., Fox et al., 2007; Wieser et al., 2009). The SOI-R is a 9-item Likert scale questionnaire assessing participants' behaviours, attitudes, and desires for sexual permissiveness (e.g., "With how many different partners have you had sex within the past 12 months?", "Sex without love is OK.", "In everyday life, how often do you have spontaneous fantasies about having sex with someone you have just met?"). Higher scores indicate more sexual permissiveness. This was used to examine if attitudes toward sexuality would affect scanning behaviour. Lastly, participants completed a demographic questionnaire assessing age, gender, ethnicity, and sexual orientation. Additionally, participants were asked how immersed they felt in the experience (i.e., how real they thought the computer agents were), and how often they played video games. Since we used images of computer agents, and not real people, this was to examine whether familiarity with virtual humans influenced scanning behaviour. After the experiment, all participants were thoroughly debriefed about the real purpose of the experiment and asked whether they became suspicious about any details of the eye-tracking recordings. All participants denied having any suspicion. The entire experiment lasted approximately 60 minutes.

Data Analysis

Any fixation with a duration of less than 80 ms was removed from the analyses. Each agent contained seven body areas of interest (AOI), including the face, shoulders, breast, arms (both together), waist, hips, and legs (both together; see Figure 2). The background of the models comprised less than 10% of the total viewing time across tasks and context conditions and will thus not be reported or discussed; there were also no differences in viewing patterns for the background between context conditions. The dependent variables for each participant and each picture consisted of: i) average viewing time within each AOI, ii) average number of fixations within each AOI, iii) average onset time of first fixation landing in each AOI for the first time, and iv) average duration of the first fixation landing in each AOI for the first time. The average viewing time and the average number of fixations indicated the average amount of attention spent to each body region across the whole picture-presentation time of 4 s in each trial. The average onset time of first fixation landing in each AOI was the average time taken to move the eyes from the fixation cross to the various AOI *for the very first time* in each trial. During this time, there could thus be one or several fixations made before first landing in the various body regions. Body region size was also controlled between male and female models. There were no differences in size for the face regions between model genders, but *t*-test comparisons showed that all male body regions were significantly larger in surface area than female body regions (all $p < .005$). To account for this difference in size, all data for the average viewing time and number of fixations for each AOI were normalized to the average size of each body region between male and female models. This was computed by dividing each AOI by the average pixel area across models. The following results contain only normalized data.

Eye recordings were also compared across context conditions, and within each condition between the first and second experimental sessions to investigate any differences in eye movements between the free-viewing and attractiveness rating tasks. To compare the dependent measures across context conditions, mixed ANOVAs were conducted using a 2 (gender of model) x 2 (direct vs. averted gaze) x 7 (AOI) (within) x 2 (gender of participant) x 2 (context condition) (between) design. For the comparisons of both the first and second experimental sessions, no main effect or interactions with context condition were found for any of the dependent variables described above, thus, not supporting the predictions for Hypothesis (7). Consequently, all 56 participants from both context conditions were collapsed together and analyzed and discussed from henceforth. For each experimental session, data was analyzed using a 2 (gender of model) x 2 (gaze direction) x 7 (AOI) repeated measures ANOVA with participant gender as a between subject factor. Pair-wise comparisons were tested using the Bonferroni correction for multiple comparisons. The Greenhouse-Geisser degrees of freedom correction was used whenever necessary. Lastly, Pearson correlations were used to explore relations between personality demographics, rating measures, and eye-tracking data.

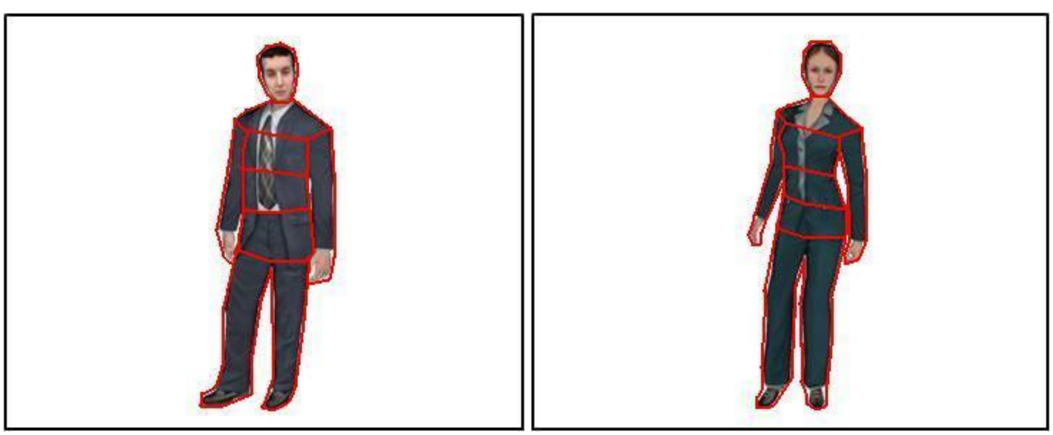

Figure 2. Areas used for the AOI. Regions outlined in red include the face, shoulders, breast, waist, hips, legs (both together), and arms (both together).

Results

Free-Viewing Session

Average Viewing Time per AOI

The ANOVA revealed a main effect of AOI ($F(6, 324) = 192.80$, $p < .001$, $\eta^2 = .78$; see Figure 3A) indicating significantly longer viewing times for the face as compared to all other regions, supporting Hypothesis (1). It was only predicted that gaze would affect the initial fixations toward the face (Hypothesis (2)), but there were no specific predictions for gaze affecting overall viewing time. However, a significant gaze x AOI interaction was found ($F(6, 324) = 3.41$, $p < .05$, $\eta^2 = .06$), indicating that faces with a direct gaze were viewed significantly longer overall than faces with an averted gaze ($t(55) = 2.45$, $p < .05$; see Figure 4). No other AOI showed an interaction with gaze. There was also a significant main effect of model gender ($F(1, 54) = 178.23$, $p < .001$, $\eta^2 = .77$), indicating longer average viewing times overall to female models compared to male models[1]. Additionally, there was a significant interaction between model gender and participant gender ($F(1, 54) = 7.12$, $p < .05$, $\eta^2 = .12$), indicating that male participants had longer average viewing times scanning female models ($M = 506.5$ ms) compared to female participants ($M = 459.6$ ms); no differences were found for viewing male models. Lastly, a significant interaction between model gender and AOI was found ($F(6, 324) = 67.97$, $p < .001$, $\eta^2 = .56$). As shown in Figure 3A, *t*-tests revealed that both male and female participants spent a longer time viewing male faces compared to female faces, and spent more time viewing male arms compared to female arms (all $p < .001$); in contrast, participants spent a longer time viewing the shoulders, breast, waist, hips, and legs of female models (all $p < .001$). These results did not support Hypothesis (4), predicting a model gender x participant gender x AOI interaction,

[1] As noted above, the analysis did not include fixations to the background, which might have accounted for unanalyzed fixations. Thus, it was possible to have a main effect of model gender with a fixed viewing time because other fixations could have gone to the background instead of the models.

where male participants would have longer viewing times for female breasts, and both genders would have longer viewing times for the waist and hip regions of the opposite sex.

It may be argued that participants may not necessarily spend more time viewing the face compared to when all of the body regions are summed together. Thus, a separate 2 (gender of model) x 2 (gaze direction) x 2 (face vs. body) repeated measures ANOVA was conducted (with participant gender as a between subject factor) comparing the face to all of the body regions combined. Even when the face was compared to the entire body, there was still a significant main effect of AOI ($F(1, 54) = 7.98$, $p < .01$, $\eta^2 = .13$), indicating that participants spent more time viewing the face ($M = 1785.8$ ms) than all of the body regions combined ($M = 1318.0$ ms), giving stronger support for Hypothesis (1).

Average Number of Fixations per AOI

The omnibus ANOVA revealed a significant main effect of AOI ($F(6, 324) = 203.70$, $p < .001$, $\eta^2 = .79$; see Figure 3B), indicating significantly more fixations to the face as compared to all other regions, supporting Hypothesis (1). When the face was compared to the entire body, a main effect of AOI was found ($F(1, 54) = 13.89$, $p < .001$, $\eta^2 = .21$), indicating that participants made more fixations to all of the body regions combined ($M = 4.57$) than to the face ($M = 3.3$).

The omnibus ANOVA also found a main effect of model gender ($F(1, 54) = 206.96$, $p < .001$, $\eta^2 = .79$), indicating more fixations overall to female models compared to male models. Lastly, a significant interaction between model gender and AOI was found ($F(6, 324) = 103.33$, $p < .001$, $\eta^2 = .66$). *t*-tests showed that participants made more fixations to male faces compared to female faces, and more fixations to male arms compared to female arms (all $p < .001$); in contrast, participants made more fixations to the shoulders, breast, waist, hips, and legs (all $p < .001$) of female models. No other effects were found.

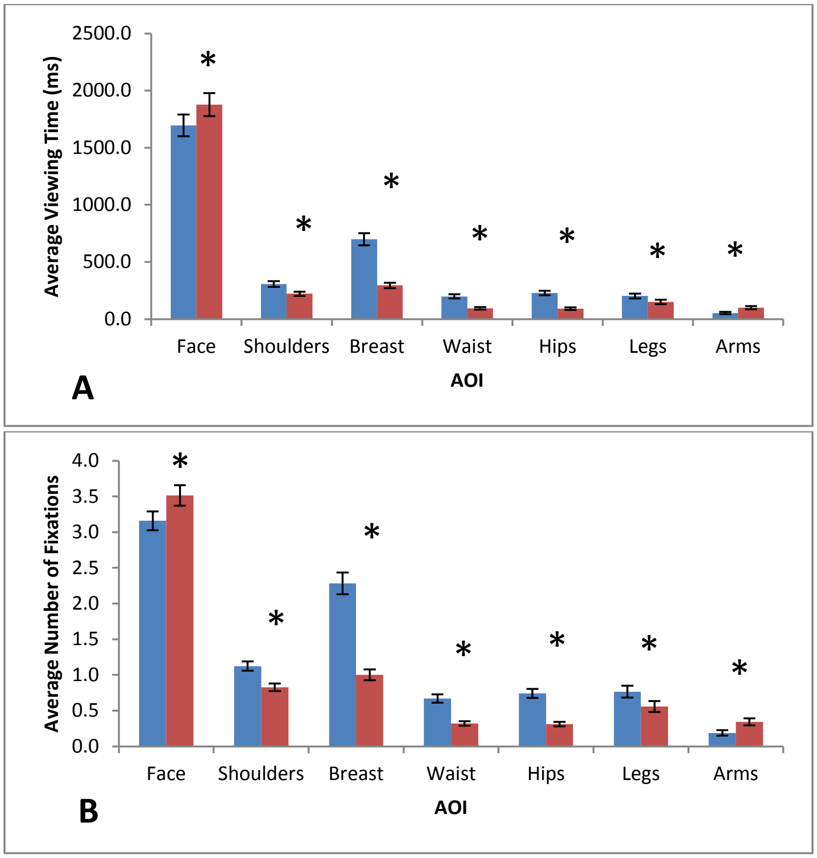

Figure 3. Results for (A) average viewing time, and (B) average number of fixations, as a function of model gender and (normalized) AOI in the free-viewing session (*N* = 56). Blue bars represent female models; red bars represent male models. Female vs. Male paired comparison: $^*p < .001$.

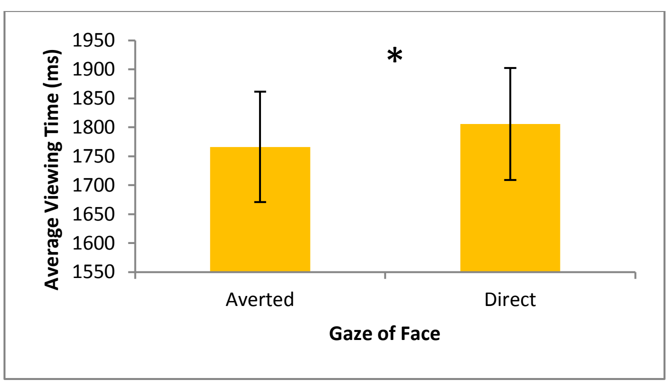

Figure 4. Results for the average viewing time to direct and averted gaze faces in the free-viewing session (*N* = 56). Direct Gaze vs. Averted Gaze paired comparison: $^*p < .05$.

Average Onset Time of First Fixation Landing in each AOI

The ANOVA revealed a main effect of AOI ($F(6, 84) = 75.20$, $p < .001$, $\eta^2 = .84$; see Figure 5A), indicating significantly earlier fixations to the face as compared to all other regions, supporting Hypothesis (1). Lastly, a main effect of model gender was found ($F(1, 14) = 5.90$, $p < .05$, $\eta^2 = .30$), indicating earlier average fixation onsets to regions of female models compared to male models. No other effects were found. These results did not support Hypothesis (4), predicting that male participants would have earlier onset times of first fixation for the breast region of female models.

Of particular interest in the current study was whether gaze direction made a difference in the initial onset time of first fixation to the face of the models. As outlined in Hypotheses (2) and (3), it was predicted that direct gaze would elicit faster onset times of first fixation to the face, and averted gaze would elicit faster onset times to the body, after first scanning the face. Separate ANOVAs were used to analyze the first fixations to the face in a 2 (gender of model) x 2 (gaze direction) design with participant gender as a between subject factor. About 51% of all first fixations went directly to the face[2] (see Figure 6); and, about 76% of *these first fixations on the face* remained on the face for a second fixation (i.e., only 24% of the second fixations after the face were made to the body regions). However, gaze did not affect the initial onset time of either the first or second fixation to the face. The data was also analyzed for those trials when participants first looked at the face, and then to the rest of the body in order to see if gaze information from the face affected their next fixation to the body. Again however, gaze did not have an effect on the initial onset time of first fixation to the body after participants first looked

[2] It should be noted that although not all of the very first fixations went directly to the face, the average onset time of first fixation to the face was earlier than any other body region (see Figure 5A). Thus, if participants did not fixate the face on their first eye movement, they were likely to do so on their second or third fixation (see also Figure 6).

at the face. Gaze also did not affect the location of the next fixation on the body after participants first scanned the face. Thus, these results did not support Hypotheses (2) or (3).

Average Duration of First Fixation Landing in each AOI

The ANOVA revealed a main effect of AOI ($F(6, 84) = 10.30$, $p < .05$, $\eta^2 = .42$; see Figure 5B), indicating that first fixations to the face were significantly longer than any other region. Lastly, a significant interaction was found between model gender and participant gender $F(1, 14) = 5.66$, $p < .05$, $\eta^2 = .29$), indicating that female participants had relatively longer durations of first fixations for male models ($M = 305.1$ ms) compared to female models ($M = 284.3$ ms; $p < .05$); no differences were found for male participants. No other effects were found.

Again, separate ANOVAs were used to analyze the first fixations to the face to see whether gaze direction influenced the duration of first fixation to the face of the models. As outlined in Hypotheses (2) and (3), it was predicted that direct gaze faces would delay disengagement and have longer durations of first fixations than averted gaze faces, before participants began to scan the body. The results showed that gaze did not affect the duration of either the first or second fixation to the face. Additionally, no effects of gaze were found for the duration of first fixation to the body regions after participants first looked at the face. Thus, these results did not support Hypotheses (2) or (3).

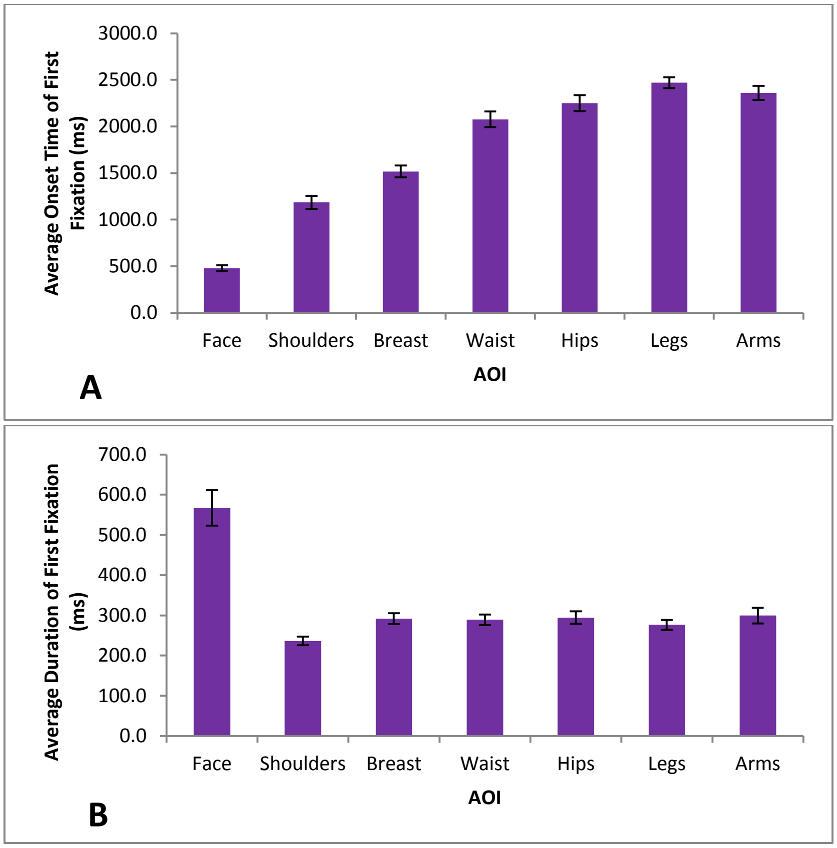

Figure 5. Results for (A) average onset time of first fixation, and (B) average duration of first fixation, as a function of AOI in the free-viewing session (*N* = 56).

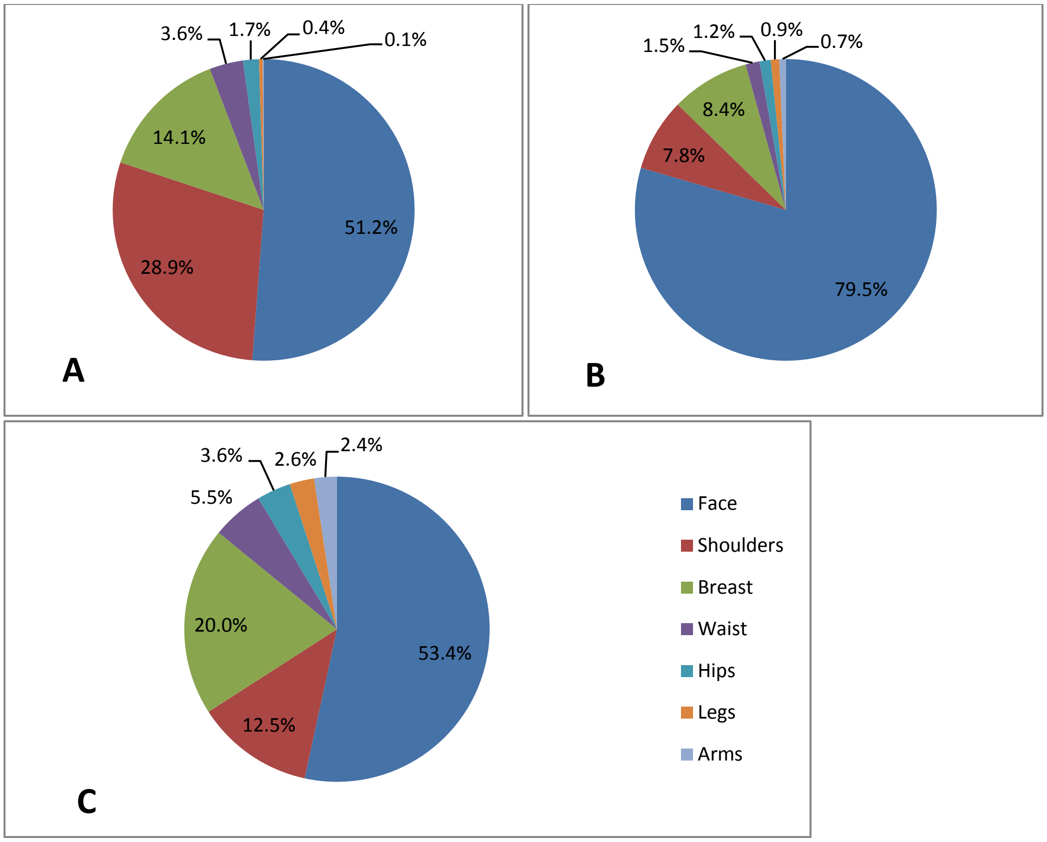

Figure 6. Proportions of fixations to each AOI for the (A) first fixation, (B) second fixation, and (C) third fixation in the free-viewing session (N = 56).

Proportions of Fixation Sequences

The data indicated that there were no three-way interactions between model gender, participant gender, and AOI for any of the dependent variables. According to Hypothesis (4), it was predicted that participants would scan the opposite sex differently than the same sex. The average number of fixations did not reveal any interactions between model gender and participant gender, but it is possible that the fixation sequence proportions were different between participant genders. As a possible example, both males and females may have made the same amount of fixations to the various AOI overall, but males could have consistently scanned the bodies in a fixation sequence such as "*face, breast, waist, hips*", whereas females could have consistently scanned the bodies in a fixation sequence such as "*face, shoulders, waist, legs*". In order to examine any differences in fixation sequence patterns between participants, the proportion of fixations to each AOI were analyzed for each fixation sequence number (i.e., first, second, third, etc.). Data was analyzed using a 2 (gender of model) x 2 (gaze direction) x 7 (AOI) repeated measures ANOVA with participant gender as a between subject factor. Contrary to Hypothesis (4), the results showed no differences between participants for the proportions of any fixations.

Attractiveness Rating Session

Average Viewing Time per AOI

The omnibus ANOVA revealed a main effect of AOI ($F(6, 324) = 351.62$, $p < .001$, $\eta^2 = .87$; see Figure 7A), indicating significantly longer viewing times for the face as compared to all other regions, supporting Hypothesis (1). When the face was compared to the entire body, a main effect of AOI was also found ($F(1, 54) = 51.06$, $p < .001$, $\eta^2 = .49$), indicating that participants spent more time viewing the face ($M = 2123.8$ ms) than all of the body regions combined ($M = 1057.9$ ms).

As in the free-viewing session, it was only predicted that gaze would affect the initial fixations toward the face (i.e., Hypothesis (2)), so there were no predictions for gaze affecting overall viewing time. However, the omnibus ANOVA revealed a main effect of gaze ($F(1, 54) = 4.67$, $p < .05$, $\eta^2 = .08$), indicating longer viewing times to models with a direct gaze compared to averted gaze. A significant gaze x AOI interaction was also found ($F(6, 324) = 8.43$, $p < .005$, $\eta^2 = .14$), indicating that faces with a direct gaze were viewed significantly longer overall than faces with an averted gaze ($t(55) = 3.54$, $p < .005$; see Figure 8), while models with an averted gaze had longer viewing times to the hip region ($M = 141.7$ ms) than models with a direct gaze ($M = 130.5$ ms; $t(55) = 2.05$, $p < .05$). There was also a main effect of model gender ($F(1, 54) = 265.35$, $p < .001$, $\eta^2 = .83$), indicating longer average viewing times overall to female models compared to male models. Lastly, a significant interaction between model gender and AOI was found ($F(6, 324) = 71.39$, $p < .001$, $\eta^2 = .57$). *t*-tests showed that participants spent more time viewing male faces compared to female faces, and spent more time viewing males' arms compared to female arms (all $p < .001$); in contrast, participants spent a longer time viewing the shoulders, breast, waist, hips, and legs of female models (all $p < .001$). No other effects were found. As in the free-viewing session, these results did not support Hypothesis (4), predicting that male participants would have longer viewing times for female breasts, and both genders would have longer viewing times for the waist and hip regions of the opposite sex.

Average Number of Fixations per AOI

The omnibus ANOVA revealed a main effect of AOI ($F(6, 156) = 323.38$, $p < .001$, $\eta^2 = .86$; see Figure 7B), indicating more fixations to the face as compared to all other regions, supporting Hypothesis (1). When the face was compared to the entire body, no main effect of AOI was found.

The omnibus ANOVA also revealed a main effect of model gender ($F(1, 54) = 152.27$, $p < .001$, $\eta^2 = .74$), indicating more fixations overall to female models compared to male models. A main effect of gaze was found ($F(1, 54) = 6.28$, $p < .05$, $\eta^2 = .10$), indicating more fixations overall to models with an averted gaze compared to direct gaze. Lastly, a significant interaction between model gender and AOI was found ($F(6, 324) = 114.22$, $p < .001$, $\eta^2 = .68$). *t*-tests showed that participants made more fixations to male faces compared to female faces, and more fixations to males' arms compared to female arms (all $p < .001$); in contrast, participants made more fixations to the shoulders, breast, waist, hips, and legs (all $p < .001$) of female models. No other effects were found.

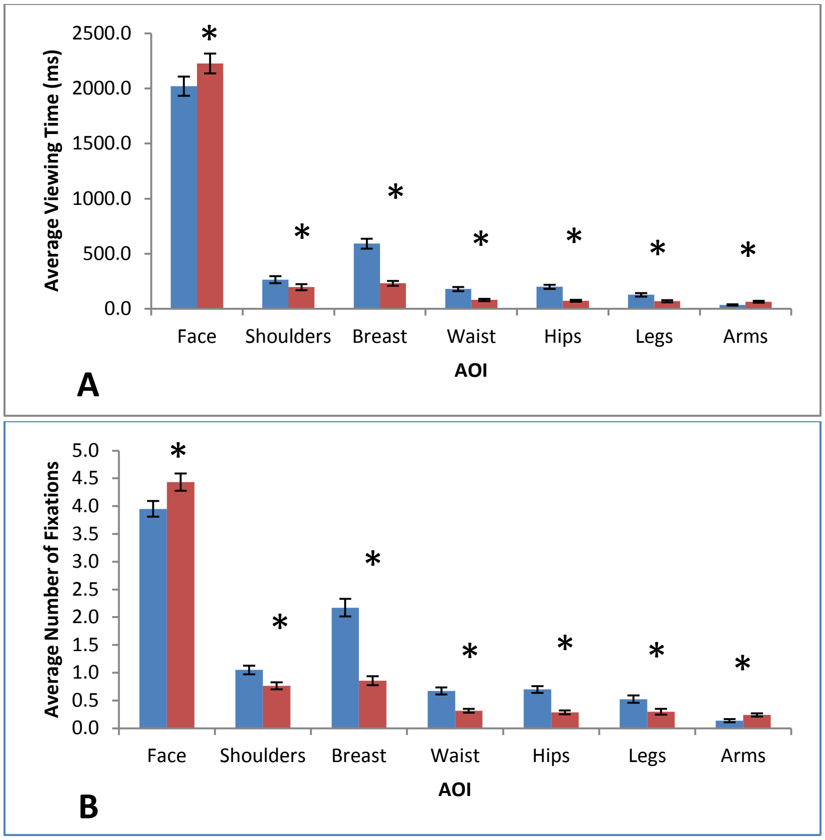

Figure 7. Results for (A) average viewing time, and (B) average number of fixations, as a function of model gender and (normalized) AOI in the attractiveness rating session ($N = 56$). Blue bars represent female models; red bars represent male models. Female vs. Male paired comparison: $*p < .001$.

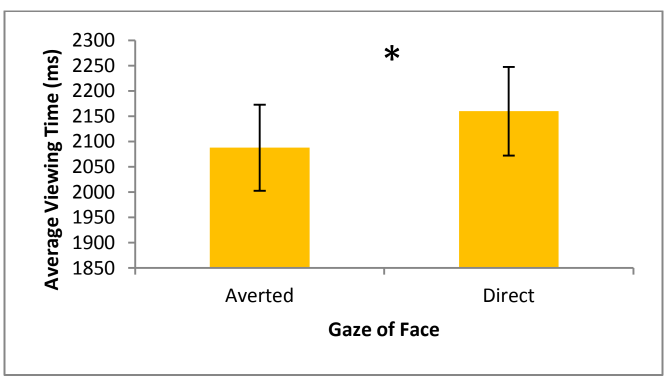

Figure 8. Results for the average viewing time to direct and averted gaze faces in the attractiveness rating session ($N = 56$). Direct Gaze vs. Averted Gaze paired comparison: $*p < .05$.

Average Onset Time of First Fixation Landing in each AOI

A main effect of AOI was found ($F(6, 60) = 50.02$, $p < .001$, $\eta^2 = .83$; see Figure 9A), indicating significantly earlier fixations to the face as compared to all other regions, supporting Hypothesis (1). There was also a main effect of model gender ($F(1, 10) = 5.32$, $p < .05$, $\eta^2 = .35$), indicating earlier average fixation onsets to regions of female models compared to male models. No other effects were found. As in the free-viewing session, these results did not support Hypothesis (4), predicting that male participants would have earlier onset times of first fixation for female breasts.

Again, separate ANOVAs were used to analyze the first fixations to the face region. About 58% of all first fixations went directly to the face (see Figure 10); and, about 84% of these first fixations on the face remained on the face for a second fixation. The results of the ANOVA found no effect of gaze for the onset time of either the first or second fixation to the face. Additionally, gaze did not affect the initial onset time to the body or the location of the next fixation to the body after participants first looked at the face. Thus, these results did not support Hypotheses (2) or (3).

Average Duration of First Fixation Landing in each AOI

The omnibus ANOVA revealed only a main effect of AOI ($F(6, 60) = 14.12$, $p < .001$, $\eta^2 = .59$; see Figure 9B), indicating that first fixations to the face were significantly longer than any other region.

The ANOVA analyzing the first fixations to the face region revealed a main effect of gaze ($F(1, 54) = 7.69$, $p < .01$, $\eta^2 = .13$), indicating that faces with a direct gaze ($M = 521.8$ ms) had longer first durations than faces with an averted gaze (M = 486.6 ms). This result helps support Hypotheses (2) and (3), which predicted that direct gaze faces would delay disengagement and have longer durations of first fixations than averted gaze faces. However, as indicated above, no effect of gaze was found for the onset time to the body after participants first looked at the face. Thus, direct gaze faces delayed disengagement longer than averted gaze faces, but this did not significantly affect subsequent scanning of the body after participants moved their eyes from the face. No other effects of gaze were found for the duration of the second fixation to the face. Additionally, no effects of gaze were found for the duration of first fixation to the body after participants first looked at the face.

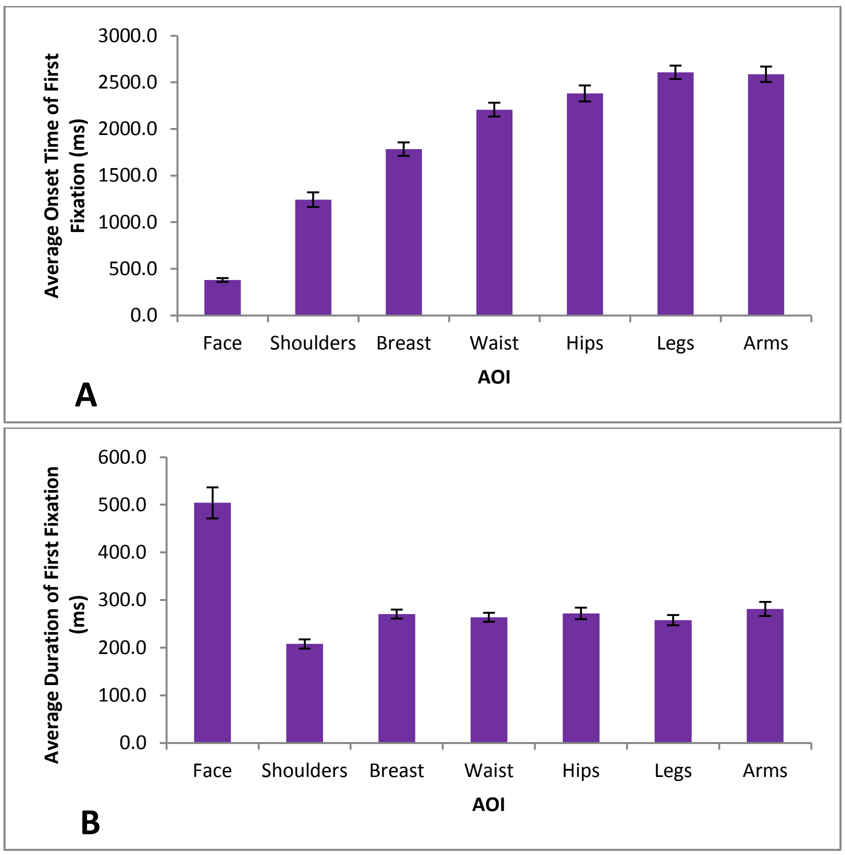

Figure 9. Results for (A) average onset time of first fixation, and (B) average duration of first fixation, as a function of AOI in the attractiveness rating session (*N* = 56).

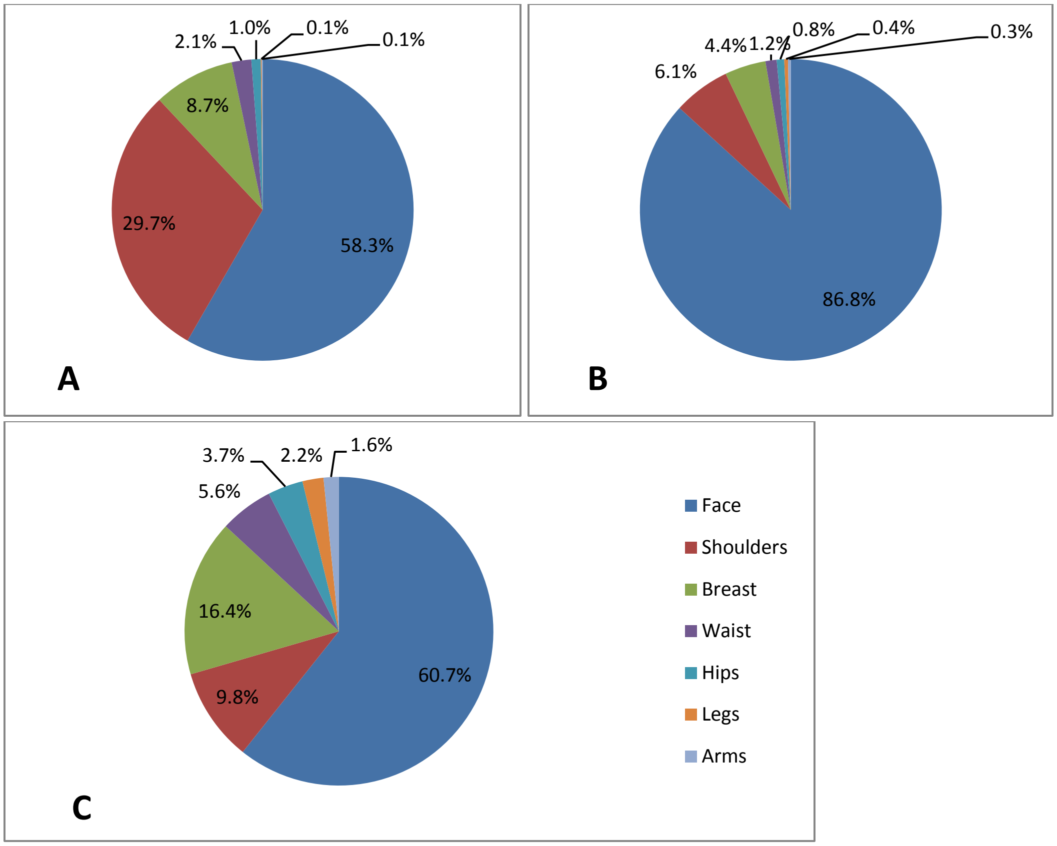

Figure 10. Proportions of fixations to each AOI for the (A) first fixation, (B) second fixation, and (C) third fixation in the attractiveness rating session ($N = 56$).

Proportion of Fixation Sequences

Again, the data were analyzed to examine any differences in fixation sequence proportions between participants. For the proportion of the *first fixation* (i.e., the very first fixation in each trial, regardless of AOI), a model gender x participant gender x AOI interaction was found ($F(6, 324) = 3.02$, $p < .05$, $\eta^2 = .05$); individual t-tests revealed that male participants had a larger proportion of first fixations to the female breast region ($M = .13$) than female participants ($M = .06$; $t(54) = 2.51$, $p < .05$). This result helps support Hypothesis (4), which predicted that male participants would be faster than female participants to scan the breast region of female models. No other interactions were found, and there were no other differences for the proportions of any other fixations.

Comparing the Free-Viewing and Attractiveness Rating Sessions

Across experimental sessions, a trend appeared where participants spent more time scanning the face when asked to rate the attractiveness of the models compared to free-viewing (i.e., with no task). Thus, eye movements were compared between the first and second experimental sessions across AOI using a 2 (gender of model) x 2 (direct vs. averted gaze) x 7 (AOI) (within) x 2 (gender of participant) x 2 (task) (between) mixed ANOVA design to examine any differences in eye recordings.

For the *average viewing time per AOI*, a significant interaction between task and AOI was found ($F(6, 324) = 13.52$, $p < .001$, $\eta^2 = .20$). *t*-tests showed that participants spent a longer time viewing faces in the attractiveness rating session (*M*s = 2123.8 ms vs. 1785.8 ms; $p < .001$), but spent a longer time viewing the arms (*M*s = 76.3 ms vs. 50.0 ms), breast (*M*s = 496.4 ms vs. 412.1 ms), and legs (*M*s = 175.5 ms vs. 98.3 ms; all $p < .01$) in the free-viewing session. This result supports Hypothesis (5), indicating longer viewing times to the face in the attractiveness rating session compared to the free-viewing session. No other interactions with task were found.

For the *average number of fixations per AOI*, a significant interaction between task and AOI was found ($F(6, 324) = 24.94$, $p < .001$, $\eta^2 = .32$). *t*-tests showed that participants made more fixations to faces in the attractiveness rating session (*M*s = 4.2 vs. 3.3; $p < .001$), but made more fixations to the arms (*M*s = .27 vs. .19) and legs (*M*s = .66 vs. .41; all $p < .005$) in the free-viewing session. Again, this result supports Hypothesis (5). No other interactions with task were found.

No effects of task were found for either the *average onset time of first fixation landing in each AOI* or the *average duration of first fixation landing in each AOI*.

Rating Data and Correlations

Attractiveness ratings of male and female models revealed a significant main effect of model gender ($F(1, 54) = 64.66$, $p < .001$, $\eta^2 = .55$), indicating higher ratings for females models ($M = 6.1$) than for male models ($M = 4.8$). A main effect of gaze was also found ($F(1, 54) = 16.59$, $p < .001$, $\eta^2 = .24$), indicating higher ratings for models with direct gaze ($M = 5.5$) than averted gaze ($M = 5.4$), supporting Hypothesis (6). Lastly, there was a significant interaction between model gender and participant gender ($F(1, 54) = 6.24$, $p < .05$, $\eta^2 = .10$), indicating that male participants rated female models ($M = 6.6$) more attractive than female participants ($M = 5.6$; $t(54) = 3.82$, $p < .001$); there were no differences between participants for rating male models.

Pearson correlations were used to examine the relations between rating measures and personality demographics across participants (see Table 1). A positive correlation was found for the association between attractiveness ratings and SOI-R scores ($r = .41$, $p < .005$, $R^2 = .17$), indicating that attractiveness ratings were inflated overall for individuals with higher SOI-R scores. A positive correlation was also found for attractiveness ratings and video game usage ($r = .35$, $p < .01$, $R^2 = .12$), indicating that participants who played video games more often rated the models as more attractive. Lastly, a positive correlation was found for attractiveness ratings and how immersed participants felt in the study (i.e., how real they thought the characters were; $r = .33$, $p < .05$, $R^2 = .11$), indicating that the more “real” participants felt the characters were, the higher their ratings of them.

Table 1. *Correlations between rating measures and personality demographics*

	Attractiveness Ratings	SOI-R Scores	Video Game Usage	Feelings of being Immersed
Attractiveness Ratings	—	—	—	—
SOI-R Scores	.41**	—	—	—
Video Game Usage	.35**	.29*	—	—
Feelings of being Immersed	.33*	.26 (ns)	.27*	—

Note. *$p < .05$; **$p < .01$; ns = nonsignificant ($N = 56$).

Pearson correlations were also used to examine relations between rating measures and eye-tracking data across all participants and trials (6720 data points). However, these correlations contributed to less than 1% of the variance (as indicated by the R^2 values), and will thus not be reported or discussed.

Discussion

The present study used eye-tracking to investigate whether a model's gaze direction influenced the way observers looked at the body of models and how this interacted with the observer and the model's gender. Because of the biological and social significance of faces, it was predicted that faces would be the most attended feature of the entire body. It was also predicted that direct gaze would capture participants' initial attention faster and longer than averted gaze, before participants started scanning the rest of the body. The results supported the main prediction that faces were attended to more frequently than any other body region, but gaze did not seem to have a major effect on participants' *initial* eye movements. However, gaze direction did seem to influence overall viewing times, with direct gaze faces being viewed significantly longer than averted gaze faces. These effects and their implications are discussed in more detail below.

As predicted by Hypothesis (1), faces were fixated earlier, longer, and more frequently than any other body region across experimental tasks. Faces also had longer total viewing times compared to all body regions combined, which supports other eye-tracking research indicating that faces are a salient region of body visual exploration (Hewig et al., 2008). As these results occurred with pictures of computer agents, and not real people, this supports the notion that facial stimuli may have evolved to preferentially capture and engage attention (Palermo & Rhodes, 2007). However, one methodological limitation should be noted in the current study. In order to make a stronger claim that faces are fixated significantly earlier and more frequently than other body regions, it would be ideal to randomize the location of the fixation cross between trials. In other words, if participants always fixated the face earlier than other body regions in every trial, even though the location of the fixation cross between stimuli was not predictive of the location of the face, then this would support the claim that faces attract initial attention. In the current study, the fixation cross was always in the center of the monitor, so participants knew where to look to reach the location of the face. The rationale for this design was to replicate the eye-tracking study by Hewig et al. (2008) on body perception.

The current results supported the prediction that participants would initially scan the face of the models before scanning the rest of the body (Hypothesis (1)). However, the prediction, as outlined in Hypotheses (2) and (3), that models' gaze direction would modulate the initial onset of scanning both the face and body was not supported. That is, it was predicted that direct gaze of the models would attract attention faster (e.g., von Grünau & Anston, 1995) and also delay participants' disengagement (e.g., Senju & Hasegawa, 2005) from the face before scanning the rest of the body. It was also predicted that averted gaze of the models would influence participants to scan the rest of the body quicker because they would no longer be committing a social faux pas while feeling "watched" by the models. In the attractiveness rating session, when separate analyses were conducted on the initial fixations to the face region alone, direct gaze faces had longer durations of first fixations than averted gaze faces. This indicates that faces with direct gaze, compared to averted gaze, delayed disengagement from the face which supports the notion that direct gaze delays initial disengagement of attention (Senju & Hasegawa, 2005; Vuilleumier, 2002). This result helped support Hypotheses (2) and (3), however, no effect of gaze was found for the onset time to scanning the body after participants first looked at the face. This was the main prediction of Hypotheses (2) and (3), which was not supported. Additionally, this effect of delayed disengagement from direct gaze faces did not appear in the omnibus ANOVA using all AOI. A few possibilities may account for this result. For example, it is possible that static pictures of faces with a direct gaze do not elicit the same level of arousal as real persons with a direct gaze (Hietanen et al., 2008), because a live person actually has the ability to engage in a real social interaction which may elicit differences in gaze patterns. Additionally, it is possible that viewing individual characters in the central visual field may not influence initial eye movements to faces with direct versus averted gaze. For example, Palanica and Itier (2011) had participants locate a character with either a direct or averted gaze amongst several opposite-gaze distractors. Stimuli were displays of four full characters (the same ones used in the current study) aligned across the monitor (one target and three distractors). The results showed that direct gaze targets elicited faster reaction times and onset times of first fixation compared to averted gaze targets, but only for those characters situated in the far peripheral visual fields. No gaze difference was found for centrally-situated characters. Thus, the reason why gaze direction did not influence the initial onset or duration of first fixation to the face in the current study may be due to the central location of the character.

The current study did find that faces with a direct gaze had longer viewing times overall than faces with an averted gaze across experimental tasks. Therefore, even though direct gaze may not have influenced the initial onset of fixations, participants tended to fixate on direct gaze faces significantly longer overall than averted gaze faces across the duration of the stimulus presentation. So, rather than delaying initial disengagement from direct gaze (Senju & Hasegawa, 2005; Vuilleumier, 2002), participants appeared to systematically scan direct gaze faces longer at later stages of their gaze patterns. That is, participants first scanned the face, and then the body, but when they scanned the face during later fixations, they spent longer times viewing faces with direct gaze versus averted gaze. This finding was not a matter of fixation number, as there were not more fixations to direct versus averted gaze faces. In fact, in the attractiveness rating session, there were actually more fixations to averted than direct gaze faces.

Thus, direct gaze may have delayed disengagement at later stages of scanning. It is also possible that the difference between the average viewing time for direct versus averted gaze faces (40 ms difference in the free-viewing session, 72 ms difference in the attractiveness rating session) was diluted across all fixations. In other words, since participants made between 3 and 4 fixations to the face on average per trial, the total difference in viewing time between direct and averted gaze conditions may have been distributed into such small proportions that there was no evidence of gaze difference at any one particular fixation in the sequence of scanning. Mojzisch et al. (2006) and Wieser et al. (2009) also found that participants spent longer times overall viewing virtual characters with a direct rather than averted gaze, which supports the notion that direct gaze is attention grabbing (e.g., Senju & Hasegawa, 2005; von Grünau & Anston, 1995). The current study presented individuals with entire bodies, rather than just faces, which suggests that direct gaze can be a powerful stimulus for attracting attention during visual scanning. Furthermore, the current study only used static pictures of computer agents, unlike Mojzisch et al. (2006) and Wieser et al. (2009) which used dynamic video stimuli of faces. This suggests that the mere sight of direct gaze can attract attention, aside from the effects of face or eye motion.

In the attractiveness rating session, models with an averted gaze also elicited longer viewing times to the hip region than models with a direct gaze. This means that during the rating task, participants not only viewed direct gaze faces longer than averted gaze faces, but subsequently viewed the hip region less when the models were looking straight. This supports the possibility that scanning someone's body regions when they feel like they are being watched may be interpreted as a social faux pas, especially when those body regions are considered signals of sexual attractiveness (e.g., the hips; Singh, 1993, 1995; Singh & Young, 1995).

As predicted in Hypothesis (6), direct gaze also appeared to play a significant role in physical attractiveness ratings. Models with a direct gaze were rated as significantly more attractive than models with an averted gaze, supporting previous research (Conway et al., 2008; Ewing et al., 2010; Kampe et al., 2001). Participants also fixated longer and more frequently the face in the attractiveness rating session than in the free-viewing session (by an average difference of 338 ms), supporting Hypothesis (5). This also supports other research suggesting that judging the face is a stronger predictor of attractiveness ratings than judging the body (Alicke et al., 1986; Currie & Little, 2009; Furnham & Reeves, 2006; Meuser et al., 1984; Peters et al., 2007). However, it should be noted that the order of the free-viewing and attractiveness rating tasks were not counterbalanced to decrease the influence of naturalistic scanning behaviour during free-viewing. Consequently, the stronger preference for face viewing in the attractiveness rating session could possibly stem from something other than task effects. This is a methodological limitation of the current study which should be addressed with future research.

Another topic of investigation in this study was the effect of participant and model gender on eye movements to the various body regions. The results indicated several differences on eye movements and ratings between model genders. Across experimental tasks, both male and female participants had longer average viewing times and made more fixations to male faces, but had longer average viewing times and made more fixations to female body regions, specifically the shoulders, breast, waist, hips, and legs. All of the models of the same sex had identical body types (see Figure 1), and it is possible that the images of female bodies were more attention grabbing. That is, while the male bodies were relative uniform in visual appearance, the female bodies had natural "curves," especially around the breast, waist, hips, and legs, which perhaps were more stimulating to scan. This would have translated into relatively more fixations to the bodies of females, but more fixations to male faces (instead of male bodies). However, there were no differences in overall eye movements between participant genders. As outlined in Hypothesis (4), it was predicted that male participants would look earlier and longer at the breast region of female models (compared to female participants), while both genders would spend more time scanning the waist and hip regions of opposite sex models (compared to same sex models). This result would be in line with evolutionary hypotheses on mating strategies for assessing the suitability of another person as a mate (Jasienska et al., 2004; Singh, 1993, 1995; Singh & Young, 1995), and also support previous eye-tracking research (Hewig et al., 2008). Only when the proportions of fixations were analyzed did male participants have a larger proportion of first fixations to the female breast region than female participants (13% vs. 6% of all first fixations). But this was only the case for the attractiveness rating session, and the average onset time of first fixation to the breast region was not different between participants across experimental sessions, thus, not supporting Hypothesis (4). One possible reason for these results is that the current study used images of computer agents, while other research has used images of real people (e.g., Hewig et al., 2008). The current study used computer agents for stimuli because they could be controlled for many aspects of presentation, including size, clothing, body position, gaze, and background contexts. Most previous research examining gaze patterns to human bodies contained images that were not controlled for various aspects of presentation. It is also important to note that people generally behave similarly to computer agents as they do to humans (Nowak et al., 2009), and several studies examining human behaviours of processing gaze direction have used virtual characters as stimuli (e.g., Bailenson et al., 2003; Gamer & Hecht, 2007; Mojzisch et al., 2006; Nuku & Bekkering, 2008; Pelphrey et al., 2004; Schilbach et al., 2006; Wieser et al., 2009). Thus, it seemed logical to use computer agents in the current study. In the case of evaluating computer agents, more feminine characters are generally rated as more attractive than masculine characters, by both male and female raters (Nowak & Rauh, 2006). In the current study, both male and female participants gave higher attractiveness ratings to female than male characters. Therefore, it is possible that this gender-biased evaluation was also related to eye movements in the current study, such that both male and female participants scanned the bodies of female agents more so than male agents. It is also important to point out that attractiveness ratings were positively correlated with video game usage, the level of immersion that participants felt in the study, and scores on the Revised Sociosexual Orientation Inventory (SOI-R). Thus, participants who played more video games or felt that the agents were life-like tended to rate the characters as more attractive. Perhaps future research could examine the differences between frequent and non-frequent video gamers to see if familiarity with virtual humans affects eye movements. Additionally, those who had higher levels of sexual permissiveness (i.e., higher scores on the SOI-R) also tended to rate the characters as more attractive, which should be expected considering their positive attitudes and desires toward sexual encounters. Future research examining personality differences while using controlled images of real people, video clips, or even human confederates in the laboratory might reveal more complex patterns of results in the measurement of eye-movements during various social interactions.

The last main question of this study was the issue of context effects. Hypothesis (7) predicted that the background setting of the models would influence the gaze patterns of participants. Specifically, it was hypothesized that gaze would have a greater influence in the Context Condition compared to the No Context Condition because gaze signals may convey a stronger signal if the model actually appeared to be attending to another person or focus of interest (Baron-Cohen, 1995; Emery, 2000). Additionally, participants might have been more inclined to scan other individuals in a naturalistic manner if they viewed the characters within a social setting context (e.g., bar scene). However, the omnibus ANOVA comparing context conditions revealed no main effect or interaction with context for any of the dependent variables. This may have resulted because participants spent less than 10% of their total viewing time scanning the background of the models in either the Context or No Context Conditions, and there were no differences in viewing times for the background between context conditions. Thus, context did not influence participants' gaze patterns significantly in this study, perhaps because the background contained irrelevant information for the tasks at hand (i.e., either free-viewing or rating attractiveness).

Overall, the current study supports the importance of the face during body visual exploration. Even when presented with entire bodies of others, observers tended to scan the face earlier, longer, and more frequently than any other body region, and spend even more time scanning the face when assessing physical attractiveness. Furthermore, observers scanned faces with a direct gaze longer overall than faces with an averted gaze, and also evaluated models with a direct gaze as more attractive than models with an averted gaze. As these results occurred in the presence of static computer agents, and not real people, this suggests that direct gaze, and faces in general, are powerful stimuli that have the ability to engage overall attention.

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