2015

A model for measuring the contribution of form to perception of biological sex in point-light actors

Michael Mintz
University of Northern Iowa

A MODEL FOR MEASURING THE CONTRIBUTION OF FORM TO PERCEPTION OF BIOLOGICAL SEX IN POINT-LIGHT ACTORS

An Abstract of a Thesis

Submitted

in Partial Fulfillment

of the Requirements for the Degree

Master of Arts

Michael Mintz

University of Northern Iowa

July 2015

ABSTRACT

People are able to judge the sex of actors represented in point-light displays. Much of the previous literature has focused on the contribution of motion information to this judgment, or has focused specifically on information gathered from the shoulders and hips. The purpose of the current study is to model how form information, based upon the distance between the dots representing a point-light actor's key joints, the shoulder, hip, elbow, knee, wrist, and ankle points, contributes to the perception of biological sex. In a pilot study, 6 naïve observers responded to 63 computer generated stimuli that ranged from extremely female to extremely male (i.e., from -3 to +3 standard deviations for biological sex) and also varied on a set of form and motion-affecting conditions (i.e., the actors were represented as being happy, sad, calm, nervous, heavy, light, or neutral). The results of the pilot study suggested that observers were less accurate at judging the sex of point-light walkers that were expressing emotions. In order to control for this, emotion conditions and motion variation between stimuli were not included for the thesis study. The model in the thesis study was developed based upon how 8 naïve observers judged the sex (i.e., male or female) of 72 computer-generated clips displaying a walking point-light actor. Nine (9) of these clips displayed an actor whose sex ranged from extremely female to extremely male and the remaining 63 actors based upon a sex neutral actor with different combinations of characteristics from the extremely female actor (i.e., elbow distance, hip distance, and ankle distance) and the extremely male actor (i.e., shoulder distance, wrist distance, and ankle distance). The final model developed in the thesis study suggests that judgments of sex from form cues in point-light displays rely most

heavily on the distance between the target actor's ankles, the distance between target actor's elbows, and the target actor's shoulder-to-hip ratio. However, observers also utilized other form cues, suggesting that the entire process of perceiving biological sex depends on information that is distributed throughout the actor.

A MODEL FOR MEASURING THE CONTRIBUTION OF FORM TO PERCEPTION OF BIOLOGICAL SEX IN POINT-LIGHT ACTORS

A Thesis

Submitted

in Partial Fulfillment

of the Requirements for the Degree

Master of Arts

Michael Mintz

University of Northern Iowa

July 2015

This Study by: Michael Mintz

Entitled: A model for measuring the contribution of form to perception of biological sex in point-light actors

has been approved as meeting the thesis requirement for the

Degree of Master of Arts

Date	Dr. Eric Hiris, Chair, Thesis Committee
Date	Dr. Nicholas Schwab, Thesis Committee Member
Date	Dr. Kimberly MacLin, Thesis Committee Member
Date	Dr. April Chatham-Carpenter, Interim Dean, Graduate College

TABLE OF CONTENTS

PAGE

LIST OF TABLES ... vi

LIST OF FIGURES ... viii

CHAPTER 1. INTRODUCTION ... 1

Biological Motion ... 1

Point-Light Displays ... 1

General Features of Biological Motion ... 2

Neurological Basis for Biological Motion Perception ... 4

Perception of Social Features in Biological Motion ... 6

Perception of Sex ... 6

Perception of Emotion ... 10

Model Development and Testing ... 13

Pilot Study ... 14

CHAPTER 2. PILOT STUDY METHOD ... 15

Model Development ... 15

Observers ... 15

Stimuli ... 15

Presentation Setup ... 16

Procedure ... 17

CHAPTER 3. PILOT STUDY RESULTS ... 18

Model Factor Calculations ... 18

PAGE

Model Development and Fit 18
Unweighted Model...19
Weighted Model...19
Individual Models Per Group of Conditions...20
CHAPTER 4. PILOT STUDY DISCUSSION 21
CHAPTER 5. THESIS STUDY METHOD 23
Model Development...24
Observers 24
Stimuli..25
Presentation Setup...26
Procedure 26
CHAPTER 6. THESIS STUDY RESULTS 27
Model Factor Calculations..27
Model Development and Fit 28
Additive Model 28
Unweighted and Weighted First-Order Model 29
Weighted Model with First and Second Order Factors 30
CHAPTER 7. THESIS STUDY DISCUSSION..31
CHAPTER 8. GENERAL DISCUSSION 34
Implications...34
Model Limitations and Future Directions...36

PAGE

Applications 37

REFERENCES 40

LIST OF TABLES

TABLE PAGE

1 Form and Motion Changes in Point-Light Walkers across Conditions 45

2 Constants, Slopes, and Weights for Factors Included in Unweighted Model 46

3 Predicted and Actual Mean Male Response Based on Sex and Condition in Unweighted Model...47

4 Constants, Slopes, and Weights for Factors Included in Weighted Model 48

5 Predicted and Actual Mean Male Response Based on Sex and Condition in Weighted Model 49

6 Constants, Slopes, and Weights for Factors Included in the Individual Model for the Light and Heavy Conditions 50

7 Constants, Slopes, and Weights for Factors Included in the Individual Model for the Nervous and Calm Conditions 51

8 Constants, Slopes, and Weights for Factors Included in the Individual Model for the Happy and Sad Conditions...52

9 Predicted and Actual Mean Male Response Based on Sex and Condition in the Individual Model for the Light and Heavy Conditions...53

10 Predicted and Actual Mean Male Response Based on Sex and Condition in the Individual Model for the Nervous and Calm Conditions..54

11 Predicted and Actual Mean Male Response Based on Sex and Condition in the Individual Model for the Happy and Sad Condition..55

12 Total Chi-Squared Values for Each Condition, per Model...56

TABLE PAGE

13 List of Stimuli Present within the Study 57

14 Mean Male Response Across Three Sessions For All Participants 58

15 Mean Male Response Per Session for Participant One 59

16 Mean Male Response Per Session for Participant Two 60

17 Mean Male Response Per Session for Participant Three 61

18 Mean Male Response Per Session for Participant Four 62

19 Mean Male Response Per Session for Participant Five 63

20 Mean Male Response Per Session for Participant Six 64

21 Mean Male Response Per Session for Participant Seven 65

22 Mean Male Response Per Session for Participant Eight 66

23 Predicted and Actual Mean Male Response in Additive Model 67

24 Constants, Slopes, and Weights for Factors Included in Unweighted Model 68

25 Predicted and Actual Mean Male Response in Unweighted Model 69

26 Constants, Slopes, and Weights for Factors Included in Weighted Model 70

27 Predicted and Actual Mean Male Response in Weighted Model 71

28 Constants, Slopes, and Weights for Factors Included in Weighted Model with Second-Order Factors 72

29 Predicted and Actual Mean Male Response in Weighted Model with Second-Order Factors 73

LIST OF FIGURES

FIGURE PAGE

1 Examples of Sex Variation in Point-Light Walkers 74

2 Examples of Form and Motion Varying Conditions Applied to Point-Light Walkers 75

3 Examples of Differences in Joint Distance on Point-Light Walkers 76

4 Chi-Squared Goodness of Fit Test Comparisons for Pilot Study Models 77

5 Examples of One-Joint and Six-Joint Changes..78

6 Visualization of Shoulder-to-Hip Ratio and Inner-Arm Angle 79

7 Observed and. Predicted Mean Male Response to the Computer Generated Stimuli in the thesis study 80

8 Chi-Squared Goodness of Fit Test Comparisons for Thesis Study Models 81

CHAPTER 1

INTRODUCTION

When we see another person, we are unconsciously processing a vast number of social cues. This ability to process visual input in our environment is an important element of social interaction. Upon seeing another person, individuals are able to immediately process visible socially relevant information (e.g., the sex and race of people around them) and categorize other people based on these features. Notably, people immediately categorize others based on their biological sex (Stangor, Lynch, Duan, & Glass, 1992). Although we know that we are able to make these judgments, little research has been conducted to determine how individuals use attributes of other persons in order to do so.

Biological Motion

Point-Light Displays

Previous research has measured biological motion perception to assess how individuals use attributes of other people to make social judgments. Biological motion perception is the ability to process information available in living creatures, particularly when the motion is produced by humans. In experimental contexts, biological motion stimuli are created through point-light displays; or a series of light sources (i.e., "dots") fixed to points on a human walker. These points of light are generally used to represent major points of articulation (e.g., shoulders, hips, elbows, knees, wrists, and ankles) and other key, defining points (e.g., head, chest, and waist).

Observers are able to perceive these actors represented in these point-light displays as human (Johansson, 1973) and interpret social information, particularly sex (Barclay, Cutting, & Kozlowski, 1978), gender[1] (Johnson & Tassinary, 2005), and emotion (Atkinson, Dittrich, Gemmell, & Young, 2004). Additionally, other research has demonstrated that observers are able to differentiate between point-light actors, and are able to differentiate between different types of actions (see Richardson & Johnston, 2005).

Historically, studies have primarily relied on recording videos of human participants wearing sets of lights to create point-light stimuli (Johansson, 1973); however, more modern studies have used computer-generated representations of actors (Troje, 2002). Troje (2002) recorded movements of 40 individuals using 38 markers on each individual. Motion capture data was used to algorithmically represent biological sex linearly and allow for the creation of stimuli that represent individuals on the far extremes of that linear scale. The stimuli created in this fashion do not represent actual individual people, as the algorithm used to create the walkers combines gait cycles from forty people.

<u>General Features of Biological Motion</u>

The ability to recognize biological motion improves as more information is available (i.e., as more dots are visible on a point-light display; Neri, Morrone, & Burr, 1998). However, it might not be the case that the visual system is specifically geared

---

[1] Although a large portion of the literature uses “sex” and “gender” interchangeably, sex generally refers to a genetic quality that is chromosomally defined whereas gender generally refers to a personal identity or a behavioral quality. In the following research, observers were explicitly asked to judge the sex of actors.

toward detecting biological motion, so much as it is capable of detecting objects in motion that have well-defined form (Hiris, 2007). Given this, it might not be the case that humans have systems in place that detect biological motion per se, but rather, a complex series of mechanisms that are able to detect important information in ambiguous or complex stimuli and make evaluations about them. Even if that is the case, we are still able to process biological motion cues and make judgments about them, as well as extracting key information from form and motion cues.

Observers are able to recognize specific, familiar people from their unique gait style as portrayed in point-light stimuli. Specifically, observers report focusing on dynamic information within the cues, such as bounciness, speed, rhythm, arm movement, or stride length when making their evaluations (Cutting & Kozlowski, 1977). Viewing angle also contributes to the ability to identify specific actors, with predictions based on frontal views being the most accurate (Troje, Westhoff, & Lavrov, 2005). Gait is also useful for identifying a point-light actor, allowing observers to distinguish between individual point-light actors. Furthermore, observers are still able to identify the actor if they tried to hide their identity by changing their gait (Runeson & Frykholm, 1983). This suggests that how actors hold their weight and distribute it throughout their walking animation is a key kinematic feature to interpreting information from biological motion stimuli.

Structural information also factors into biological motion perception. The positions of the dots and where and how they move in relationship to each other are processed unconsciously, taking individual sets of static information and combining them into dynamic movement presentations (Lange, Georg, & Lappe, 2006). Additionally, individuals are able to integrate global and local level cues about motion and form information from stimuli to make complicated evaluations about the person depicted (Blake & Shiffrar, 2007).

Neurological Basis for Biological Motion Perception

Neurological research suggests that the posterior superior temporal sulcus (pSTS) and left inferior precentral sulcus in the ventral premotor cortex are associated with biological motion detection. Additionally, individual differences in grey matter density near those regions is associated with individual differences in ability to detect biological motion, but not other kinds of motion (Gilaie-Dotan, Kanai, Bahrami, Rees, & Saygin, 2013). In addition to the pSTS, biological motion perception is associated with noticeable increases in activity in the middle-temporal complex and in the cerebellum (i.e., areas associated with general motion processing and motor control, respectively; Grossman et al., 2000). Activity from biological motion stimuli seems to be partially contralateral and is associated with increased activity in the center and left parietal cortices compared to scrambled motion stimuli. By contrast, scrambled motion stimuli produce greater activity in the frontal and right occipital cortices (Fraiman, Saunier, Martins, & Vargas, 2014). Event-related potential research suggests that the major events in biological motion perception occur in three phases. Between 100 and 200 ms after viewing a biological motion stimulus, a positive shift occurs in the kinetic-occipital and medial temporal cortices, areas that are primarily associated with motion detection. Next, a negative modulation occurs between 200 and 350 ms near the pSTS. Finally, a positive shift occurs after 400 ms from stimulus onset near the medial central-parietal region, but only in cases when observers are asked to specifically attend to information in the stimuli (Krakowski et al., 2011).

The brains of humans and non-human primates have specialized mechanisms for interpreting biological motion. However, the superior temporal sulcus has localized areas for interpreting different kinds of motion (Puce & Perrett, 2003). Different cells of the STS respond to different types of hand motion. For instance, perceiving a grasping motion causes specific cells within the STS to activate, regardless of the object being grabbed. Additionally, STS activation has not been shown to discriminate between different attributes on motion. Motion speed and stimulus position in the visual field also have not been shown to affect activation. Goal-oriented behaviors (e.g., an actor grabbing an object and moving it to his or her mouth) cause greater activation in the STS than non-goal driven behaviors. Furthermore, research with macaque monkeys suggests that the STS is more responsive toward biological (i.e., a hand moving) versus non-biological motion (i.e., a bar of the same size and shape moving). Hand motion, body motion, and facial motion all activate in the STS, which might suggest that the STS fulfills a role of recognizing cues involved in social communication (Allison, Puce, & McCarthy, 2000).

How observers attend to the information presented in biological motion stimuli affects how the information is processed. The neural processing streams used for processing biological motion may be divided, with a stream dedicated to motor processing of visual stimuli (i.e., the dorsal stream) and a stream dedicated to processing the content of visual stimuli (i.e., parietal stream). If observers see motion events with the intent to replicate them, the brain carries the information from the visual cortex, through the dorsal stream, to the parietal cortex. By contrast, if the observer is not primed to replicate the action, the information is carried along the ventral stream toward the temporal cortex (Decety & Grèzes, 1999). The information sent along the dorsal stream seems to prepare the motor cortex for action versus simply perceiving and understanding the content of the motion. Although the STS has different cells for different kinds of motion (Allison et al., 2000; Puce & Perrett, 2003), the same kinds of motion can be processed differently depending on the intentions of those actions (Allison et al., 2000; Krakowski et al., 2011).

Perception of Social Features in Biological Motion

Perception of Sex

Observers have been shown to be able to perceive social cues from biological motion stimuli. Particularly, people are able to perceive the sex of the actor from dynamic cues without any prior experience with point-light displays (Kozlowski & Cutting, 1977). Additionally, individuals viewing point-light displays can recognize sex-specific gait information (Cutting, Proffitt, & Kozlowski, 1978). Removal of lights from the upper or lower body do not affect the ability to identify the sex of the actor, suggesting that the judgment of biological sex is part of a holistic integration of multiple aspects of the stimuli (Kozlowski & Cutting, 1977). Although removing specific joints does not cause a decline in accuracy, changes to the stimuli that affect the relationship between the joints cause observers to have difficulties in identifying the sex of the actor. Changes in walking speed (i.e., increasing or decreasing the rate at which the stimuli are presented) also affect the perception of biological sex (Barclay et al., 1978). Observers however, may be unable to recognize the sex of actors presented in static walker stimuli (Kozlowski & Cutting, 1977). Not only can observers discern the identity and sex of an actor but also, they are able to identify the intentions of the actor. Observers are able to judge the sex of the actor even when the actor is actively altering their natural gait to deceive others about their sex. The actual sex of the actor and the sex that the actor is pretending to be are perceived and processed simultaneously, but observers process these cases independently of each other. For example, a person can recognize that a male actor was pretending to be female, and would be aware of both the actor's actual sex and the intention to act as if he were female simultaneously (Runeson & Frykholm, 1983). The ability to distinguish between the actual sex and the presented sex could be attributed to the ability of an individual to change their gait to mimic someone of the opposite sex, but the inability for them to alter their actual physical structure. Alternatively, it may only suggest that individuals used within Runeson and Frykholm's study were not mimicking the gait.

Physical morphological differences between men and women are factored into social judgments, including biological sex. The ratio between an actor's waist and hips can be used by observers to make judgments about the biological sex of the actor. However, observers only rely on shoulder-hip ratio if they are asked to determine the sex of the actor; if they are told the sex beforehand, they generally do not visually scan the body of the actor. Additionally, observers primarily use form information to judge sex (i.e., male and female physiological components), whereas observers primarily use motion information judge gender (i.e., masculine and feminine expressed behaviors and characteristics; Johnson & Tassinary, 2005). For the purposes of determining the sex of an actor in a point-light stimulus, observers focus on shoulder and hips more frequently than other regions of an actor. By contrast, for a task like determining facing direction, an observer might attend more to the dots representing the ankles of the actor (Saunders, Williamson, & Troje, 2010).

Several major theories have been proposed for how people use shoulder and hip information to judge the sex of others. Shoulder-to-hip ratio and visible body torque influence how observers perceive the sex of others; however, shoulder-to-hip ratio alone would not include motion information. However, Kozlowski and Cutting (1977) have shown that observers can make accurate judgments about the sex of an actor based off the movement of a single arm or leg, which contradicts the idea that torque is exclusively used to judge sex. Center of moment, or the position of the point the shoulders and hips visually appear to rotate around, has been suggested as a way to account for both shoulder-to-hip ratio and torque information (Cutting et al., 1978).

The primary competing theory suggests that the lateral sway in the hips or shoulders of the stimulus is more influential than the center of moment. Shoulder and hip sway emphasize how sex-specific distances between dots mediate the ability to judge the sex of the actor, rather than just the positional differences within the step cycle (Mather & Murdoch, 1994). Differences between male and female actors (e.g., torso shape, torque, and lateral sway) can be made more or less visible based upon how stimuli are presented. For example, a side view of an actor would make the torso shape less visible, causing actors to make less accurate judgments about sex (66% from a side view versus 71% from frontal views; Pollick, Kay, Heim & Stringer, 2005). Mather and Murdoch's (1994) tests of center of moment used side facing stimuli, meaning that observers were neither able to see information about the actor's torso shape, which is based off the shoulder-to-hip ratio, nor information about the torque of the actor's body. Together, this suggests that the observers in Mather and Murdoch's study were unable to see the center of moment, and thus used information that was available, such as the lateral sway of the actor's hips (Pollick et al., 2005). Based on this, viewing angle may determine what information an observer incorporates into the judgments they make about point-light actors.

Effects that alter the form and motion information available in stimuli affect how observers will perceive the sex of the stimuli. Point-light walkers who appear to be more female are more likely to be perceived as walking away from the observer. By contrast, actors who are represented as being either male or ambiguous are more likely to be perceived as advancing toward an observer (Brooks et al., 2008; Schouten, Troje, Brooks, van der Zwan, & Verfaillie, 2010). This facing bias has been shown to be related to structural properties of the stimuli, particularly cues in the lower portion of the body rather than explicitly to the sex of the actor. The structural information from the dots representing the ankles has the strongest influence on the direction perceived. This suggests that the perceived sex of the actor has no bearing on how observers view the facing direction of that actor (Schouten, Troje, & Verfaillie, 2011). It has been suggested that this effect could be related to how individuals process socially-relevant biological motion events in their environment (Brooks et al., 2008; see also Allison et al., 2000).

However, the fact that the facing bias effect is not directly associated with biological sex, but rather, with differences in the lower body structure of point-light stimuli that simply happen to be highly correlated with biological sex, refutes the notion that the effect is directly connected to social processing (Schouten et al., 2011). More current research by Weech, McAdams, Kenny, and Troje (2014) has suggested that the facing-bias can be reduced to a bias for perceiving that ambiguous shapes are convex relative to the observer's perspective. Rather than the bias deriving from the gender of the perceiver or from the perceived sex or gender of the observed actor, it may only be a side effect of how internal representations are processed.

Other research suggests that inversion of the stimulus severely impairs the accuracy of individual judgments of biological sex (Barclay et al., 1978) and might exclusively interfere with sex perception based on kinematic cues (Fitzgerald, Brooks, van der Zwan, & Blair, 2014). If the information is primarily coming from the actor's form, then inversion does not affect how observers perceive the actor. Additionally, actors represented with strong male kinematic cues are likely to be perceived as more female, versus actors represented with weaker male kinematic cues, who are generally perceived as being male. Actors with female kinematic cues are generally perceived as being female, even when inverted (Fitzgerald et al., 2014).

Perception of Emotion

In addition to sex, emotions can be interpreted from information present in biological motion stimuli. Individual observers are able to recognize emotion from bodily expressions, and specifically without any facial cues being present. This not only applies to short, dynamic scenes (e.g., point-light actors walking), but also to static images, although to a lesser degree (Atkinson et al., 2004). Although observers are unable to recognize exact emotions represented by movement of single limbs in most of the cases, they are often able to make close misidentifications (e.g., perceiving a sad affective state as being fearful). However, this suggests that observers may rely on kinematic information, specifically average velocity of the arm movement to make judgments about the emotion being displayed (Pollick, Paterson, Bruderlin, & Sanford, 2001). Furthermore, kinematic cues, and specifically velocity, seem to be heavily tied into human perception of emotion within biological motion stimuli. Although success in correctly identifying different emotional states varies between individual emotions, more exaggerated body movements increase likelihood that observers will correctly interpret the presented cues. Furthermore, static form information has been shown to be less important for making judgments about the emotional state of an actor (Atkinson et al., 2004). Movement speed is heavily involved in the perception of emotion. Emotions with similar levels of movement (and ostensibly, similar levels of arousal) are often confused with each other. This leads to actors expressing happiness to be perceived as angry, or actors expressing sadness being perceived as fearful (Roether, Omlor, Christensen, & Giese, 2009).

Happy walkers move at a faster pace, travel a greater distance, and have greater arm movement than neutral walkers. By contrast, sad walkers travel a shorter distance and have less arm movement than neutral walkers. Aside from changes to perceived velocity, however, there are very few changes to the form of the walker. Happy walkers, when compared to neutral, have slightly increased distances between the dots representing their shoulders, elbows, knees, and ankles. Sad walkers, again compared to neutral, have slightly increased distance between the dots representing their hips and hands, but decreased for the other four joints. The difference between the wrist dots may, however, be a result of the differences in movement. Nervous walkers move at a faster pace than neutral and also have reduced distance between each pair of the joints. Calm walkers, by contrast, move more slowly and have all of their joint pairs moved further apart. Weight seems to affect form information most similarly to sex, as light walkers have the same form trends as female walkers (i.e. increased hip distance, decreased distance between every other joint) and heavy walkers have the same form trends as male walker (i.e. decreased hip distance, increased distance between every other joint), although the changes are at different ratios. Heavy walkers also appear to move with a wider amount of lateral sway in the shoulders, whereas light walkers appear to have much of their motion sway in their hips. See Table 1 for more detailed explanation of the effects from each condition type.

When emotional states are combined with specific actions, observers are less able to accurately judge the sex of an actor (compared to just having a specific action visible), even when all of the visual information necessary for those judgments is available. Additionally, observers are more accurate at judging the expressed emotion than they are at judging the sex of the actor. When an observer is shown a point-light actor representing an angry female making a knocking motion, the expressed emotion would make it more difficult to judge the sex of the actor (Pollick, Lestou, Ryu, & Cho, 2002).

This suggests that emotional information in stimuli can confound how we perceive biological sex. Additionally, actor posture does factor into the perception of certain emotions. Particularly, emotions like anger or fear involve a large interaction from limb positioning, and happiness and sadness include changes in head posture (i.e. the inclination of the head; Roether et al., 2009). For example, observers may attend to particular angular arrangements when judging that an actor is angry and to how high or low the actor is facing when judging happiness or sadness respectively. Furthermore, it is possible that we integrate the movement information from the emotions into how we perceive and interpret biological sex. Assuming that the ability to identify biological sex derives largely from form information, emotional information that interferes with the ability to perceive or interpret structural cues seems to affect the ability to identify the sex of presented actors.

Model Development and Testing

People have the ability to perceive biological motion and interpret great amounts of information from point-light displays (Johansson, 1973). The ability to judge the sex of the actor has been suggested to come from either sex-based differences in the position of the center of moment (Cutting et al., 1978) or the lateral sway of the actor's shoulders or hips (Mather & Murdoch, 1994); however, facing angle may factor into when observers use either information from an actor’s center of moment or the lateral sway of that actor’s shoulders and hips (Pollick et al, 2005). Motion information (Pollick et al., 2001) and postural changes (Roether et al., 2009) that make up the physical expression of emotion interfere with an observer’s ability to judge the sex of point-light actors (Pollick et al., 2002). Much of the previous research has dealt with motion processing in biological motion perception — the present research focuses on how form and structural changes affect the ability to judge biological sex in point-light stimuli.

Pilot Study

The purpose of the model being created for this study was to measure how form cues in point-light stimuli contribute to the ability to judge the sex of the actor represented in the stimuli. For a pilot study, stimuli were created ranging from extremely male to extremely female on the linear scale for biological sex (Troje, 2002; see Figure 1 for examples). Actors created in this fashion also had their structural cues manipulated through increasing or decreasing the actor's weight (i.e., making them light or heavy) or by attaching an emotional condition (i.e., happiness, sadness, calmness, or nervousness) to the actor (see Figure 2 for examples). Initially, observers were expected to primarily use the structural cues, particularly the distance between major joints, to judge the sex of the actor. Motion information was also integrated into the model to account for unpredicted variations within the happy, sad, calm, and nervous stimuli.

CHAPTER 2

PILOT STUDY METHOD

Model Development

The purpose of this model was to predict how likely an individual would be to judge a walker as male or female, based upon available form and motion cues. Specifically, the purpose was to determine if form information and motion information from different parts of the actor's body is used differently to make judgments about the sex of the actor. For the purposes of this model, form information was based upon the average distance between a point-light walker's shoulder points, elbow points, wrist points, hip points, knee points, and ankle points throughout the step-cycle and motion information was based upon the total distance that each individual dot on a point-light walker moved over the duration of the clip.

Observers

Six observers (three female and four whom were naïve with minimal prior experience with point-light displays) with normal or corrected-to normal vision were recruited to take part in a three-session study. Naïve observers were invited to participate through an email sent to graduate students at the University of Northern Iowa. Observers were not compensated for their participation in the study.

Stimuli

Sixty-three unique video clips depicting a step-cycle for a point-light walker were created through the Walker Data Publisher (Troje, 2002). The walker in each clip was presented facing directly toward the observer (walker example in Figures 1 and 2). Each video clip was normalized[2] to 63 frames and displayed at 60 frames per second. Each clip depicted a walker that ranged inclusively between extremely female and extremely male, or -3 to +3 standard deviations for biological sex respectively (see Figure 1 for examples), with intervals of .75 standard deviations (i.e., clips were created for -3.0, -2.25, -1.5, -0.75, 0, 0.75, 1.5, 2.25, and 3.0 standard deviations of biological sex).

Each clip also depicted a walker with one of seven form-affecting and motion-affecting conditions. Walkers were depicted as being happy (+3 standard deviations of happiness), sad (-3 standard deviations of happiness), nervous (+3 standard deviations of nervousness), calm (-3 standard deviations of nervousness), light (+3 standard deviations of weight), heavy, (+3 standard deviations of weight), or neutral (0 standard deviations for happiness, nervousness, and weight; see Figure 2 for examples). Each of the 63 clips depicted a walker with a sex condition and a form-affecting and motion-affecting condition (e.g., -1.5 standard deviations for sex and -3 standard deviations nervousness) , but multiple form-affecting and motion-affecting conditions were not applied actors.

<u>Presentation Setup</u>

Stimuli were presented on a 27" Apple iMac running OS X 10.8.5. The presentation script ran through MATLAB (2013a, The Mathworks, Inc.) using Psychophysics Toolbox version 3 (Brainard, 1997; Pelli, 1997). During each session,

[2] Because of how the algorithm used in the Walker Data Publisher works, individual point-light displays are created with different frame rates. Walkers that have longer gait cycles (e.g. female walkers) require more frames to complete a full cycle and walkers that have shorter gait cycles (e.g. male walkers) require fewer frames to complete a full cycle. By increasing or decreasing the speed that the walker moves, the number of frames needed to complete the full cycle can be increased or decreased. Sixty-three frames is preferred because a walker that is neutral on both sex and form and motion-affecting conditions requires 63 frames to complete a full gait cycle. This was to ensure that sex judgments could not solely be based on the number of frames presented or the percentage of step-cycle completed.

observers were seated with their head resting in an ophthalmic chin rest positioned approximately 57 cm away from the display in a well-lit room. Responses were input using a wireless keyboard connected through Bluetooth and data was recorded and output through MATLAB.

Procedure

After consenting to participate in the study, individual observers were seated in front of the display and asked to position themselves in the ophthalmic chin rest so that they are able to comfortably view the screen. During the experiment, observers were presented with a fixation cross, followed by one of the video clips of the point-light walkers walking. Each clip was presented for the full 63 frames, with a total duration of 1.05 seconds. After viewing each clip, observers judged the sex of the depicted walker as either male, by pressing the “J” key, or female, by pressing the “F” key, as a two-alternative forced choice. After responding, a fixation cross immediately appeared for the next trial. Each observer judged each of the 63 unique clips (9 levels of biological sex by 7 form and motion-affecting types) ten times per session, across three sessions. The video clips were presented in a random order within each individual session. Each observer judged the sex of the walker in each of the 63 clips a total of 30 times, for a grand total of 1,890 ratings per observer.

CHAPTER 3

PILOT STUDY RESULTS

Model Factor Calculations

Form information was operationalized as the average distance between the left joint and the right joint for each pair of joints, across all 63 frames of animation. The average distance was calculated for the shoulders, elbows, wrists, hips, knees, and ankles for each of the 63 video clips in the study. Motion information was operationalized as the total amount that each dot on the actor moved across all sixty-three frames of animation. The total distance moved was calculated for each of the 15 dots, for each of the 63 actors in the study.

Model Development and Fit

Three different models were developed to test the pilot study data. An unweighted model, where all of the model factors were treated as providing an equal contribution to the sex judgment, was tested initially. Next, a weighted model, where each of the factors was weighted individually, was tested. Finally, models with different weights for the three pairs of conditions (i.e., happy and sad, calm and nervous, and light and heavy) tested independently of each other. Each of the five models developed within the pilot followed the following equation:

$$\begin{matrix} Predicted \\ Response \end{matrix} = \frac{\sum \frac{EXP(Constant + (Slope \times Factor))}{1 + EXP(Constant + (Slope \times Factor))} \times Weight}{\sum Weights}$$

Weights were determined through an iterative process wherein all weights were set to zero and then incrementally increased or decreased, both singularly and in conjunction with other weights, until an optimal fit was determined. This optimal fit was determined by the point where changing any weight by a minimum of .01 hurt the fit or the point where changing a large weight (e.g., see weight for knee distance on the individual models, Tables 6, 7, and 8) began producing diminishing returns.

Unweighted Model

Logistic regressions were calculated for all of the form and motion factors based on how observers judged the sex of the nine actors that varied only on biological sex (i.e., the neutral actors). The model was then applied to the other six conditions. For this model, each factor was weighted equally to test if the factors were being used equally to judge the sex of the actor. Predicted response for each individual stimulus were calculated using the model and tested for fit against the response observed during the study (see Table 2 for the factors included in this model). Overall fit for this model was very poor; the model was only able to accurately predict participant responses for the neutral condition. Beyond that, the heavy condition was the best fit, but the total chi-squared value was still too high to suggest that this model predicted response with any accuracy. The light, sad, happy, calm, and nervous conditions' fits were all high enough to suggest a need for changes to this model. See Table 3 for chi-squared test scores for each stimulus.

Weighted Model

The second model used for this data was identical to the first, except each factor was weighted independently of one another. This led to several of the factors being cut (i.e., having a weight of zero) from the model in order to improve the quality of the fit.

As before, predicted responses were calculated using the model and tested for fit against the response observed during the study. See Table 4 for the factors and weights included in the model. Comparatively, this model fit the observed data better. The model accurately predicted observer responses for the neutral, happy, calm, nervous, light, and heavy conditions. For the sad condition, however, the model was still not accurately fitting the observed response (See Table 5 for chi-squared scores for each stimulus).

Individual Models Per Group of Conditions

The previous two models were unable to fit all seven of the conditions. Although the weighted model was more accurate than the unweighted, it was still unable to make accurate predictions about one of the conditions. To respond to this shortcoming, three different sets of weights were applied in the model to try to create the best possible fit for each pair of conditions (see Tables 6, 7, and 8 for the weights for each included factor for the light and heavy, calm and nervous, and happy and sad models respectively). These models predicted observer responses for the light and heavy (see Table 9), calm and nervous (see Table 10), and happy and sad (see Table 10). For the total chi-squared test values for each condition, see Table 12 and for a visualization of the relative error for each condition under each model, see Figure 4.

CHAPTER 4

PILOT STUDY DISCUSSION

The most successful model tested in the pilot study was the individually weighted model. It was able to predict observer responses for all of the other conditions more accurately than either of the previous models. The shortcomings with the happy and sad conditions, however, were relatively consistent in all three models. All three models, notably, were weakest with the happy and sad stimuli. Although the first weighted model was able to fit the happy stimuli, it did fail to accurately fit the sad stimuli. Even though the individualized models were able to fit the happy and sad data, it did so with higher total chi-squared values than any of the other sets of stimuli (see Table 12).

The consistent issues that were provided by the happy and sad stimuli throughout the pilot study could be attributed to several factors. First, the issues might have arisen from a very high noise ratio. The emotion information conveyed by point-light actors would have made it more difficult for observers to judge the sex of the actor (e.g., Pollick et al., 2002). These actors were created to represent far extremes for happiness and sadness (+3 and -3 standard deviations respectively). This suggests that they would have resorted to guessing the sex of the actor more frequently than they would have for other stimuli. Next, it might be a short coming with the operationalization of form and motion information, or with the factors used to compose the model. Given that no successful combination of factors and weights were found, it might be the case that there were other factors involved that observers were using to make the sex judgments in videos also displaying happiness and sadness. Finally, the postural changes resulting from the happy and sad actors demonstrating far extremes of those emotions affect the form information (See Roether et al., 2009) perceived by observers. These changes to the available form information would have reduced the accuracy of the observers' judgments (e.g. Pollick et al., 2002). Further research could better account for how the posture of the actor (i.e., whether the actor's head is raised or lowered) affects observers' perceptions of the sex of that actor.

The results of the pilot study suggested a need for an expanded study to further understand how form cues factor into sex judgments for biological motion stimuli. Although the pilot study provided a good understanding of which factors contribute most heavily to the overall model, the data set the pilot model was based off of was limited. Based upon the results from the pilot study, it was evident that more precise control was needed over the stimulus manipulation in order to reach solid conclusions regarding the structural factors that influenced the perception of sex in biological motion displays.

CHAPTER 5

THESIS STUDY METHOD

Consistent with previous research (e.g., Pollick et al, 2002), the pilot study suggested that having actors express emotions can make it more difficult for observers to judge the sex of an actor. For the thesis study, this was taken into consideration and stimuli were created that neither expressed emotions nor had varied motion. This allowed for a specific focus on how different aspects of form (i.e., distance between left and right matched joints, shoulder-to-hip ratio, and arm angles) might contribute to sex judgments. Models were developed using observer responses to these stimuli to test how each of the different joints contributed to sex judgments. Based on the 0 standard deviations actor from the previously mentioned set, the distances between key joints were changed to be equal to the distance for those points for an actor who was either extremely male (+3 standard deviations of biological sex; Troje, 2002) or extremely female (-3 standard deviations of biological sex; Troje, 2002). The distance between the shoulders, wrists and knees were changed to match the distance of an extremely male actor and the distance between the hips, elbows, and ankles were changed to match the distance of an extremely female actor. Actors were created with each of the possible combinations (i.e., from one set being changed to all six being changed), and each of the different combinations were presented individually. The new stimuli were used to develop a model to explain how variations in form without variations in motion affect sex judgments, to explain how each of the key joints contributes to observers' judgments of an actor's sex, and to make predictions about how observers would respond to point-light actors with ambiguous sexual characteristics.

Model Development

Created walkers were based off of a completely neutral actor (i.e., 0 standard deviations for sex, affect, and weight). The distance between the dots representing specific joints (e.g., the shoulders) were changed to either the male distance (i.e., changed to match the distance between those points on a walker with 3 standard deviations of biological sex) or the female distance (i.e., changed to match the distance between those points on a walker with -3 standard deviations of biological sex). The shoulders, wrists, and knees were changed by the male distance and the hips, elbows, and ankles were changed by the female distance. This choice was made to ensure that both the shoulders and the hips would never be modified by either both the male or female distance (i.e., if both the shoulder and hip dot pairs used either the male or female distances, then responses might have shifted toward being 100% male or 0% male as more dot pairs were modified). Furthermore, it allows the potential effects from the shoulder and hip joints to cancel each other out. This allowed greater focus on how the other sets of joints affect sex judgments.

Observers

Nine (9) naïve, female observers with normal or corrected-to-normal vision were recruited to participate in a three session study. Observers were recruited via an email sent to all undergraduate students with declared psychology majors and all graduate students within the psychology department at the University of Northern Iowa. Observers were each compensated $5 per session attended, with an additional $5 if they attended all three sessions. Compensation was paid in the form of Amazon gift cards, which was initially agreed upon by all participating parties. Eight observers attended all three sessions, and one observer discontinued her participation after the first session. Only the data from the eight (8) observers who completed all three sessions were included in the study.

Stimuli

Seventy-two unique video clips depicting one step-cycle for a point-light actor were created as stimuli for this study. Nine of those were created using the Walker Data Publisher (Troje, 2002) and the other 63 video clips were modified versions of one of the clips (specifically, the sex-neutral actor). The walker represented in each clip was presented facing directly toward the observer (actor example in Figures 1). Each video clip had a duration of 63 frames and was displayed at 60 frames per second. The nine clips that were created using the Walker Data Publisher depicted a point-light walker who ranged inclusively between extremely female and extremely male, or -3 to +3 standard deviations for biological sex respectively, with intervals of .75 standard deviations (i.e. clips were created for -3.0, -2.25, -1.5, -0.75, 0, 0.75, 1.5, 2.25, and 3.0 standard deviations of biological sex).

The remaining 63 clips were created within MATLAB by modifying the shape of the neutral walker (0 standard deviations of biological sex). Each clip had the distance between their shoulders, elbows, hips, knees, wrists, or ankles increased or decreased by an amount equivalent to the distance between the same dots on an actual point light walker of either +3 or -3 standard deviations of biological sex. For example, the walker whose shoulders were modified had the space between its left shoulder moved further left and its right shoulder moved further right so that the shoulder points matched the locations of the shoulder in a point-light walker with +3 standard deviations of biological sex. Unlike a regular actor in this condition, all of the other joints remained at a sex-neutral location, and all of the motions (including the shoulder joints) were the same as a sex neutral point-light walker. Each of the 63 modified clips represented a walker with at least one set of dots modified, with all possible combinations of modifications included. See Figure 5 for examples of these transformations and Table 13 for a list of the combinations of stimuli used in the study.

Presentation Setup

Presentation was identical to what was used in the pilot study.

Procedure

Procedure was identical to what was used in the pilot study, except for the stimuli used. Each observer rated each of the 72 unique video clips ten times per session, across three sessions. The video clips were presented in a random order within each individual session. Each observer judged the sex of the actor in each of the 72 video clips a total of 30 times, for a grand total of 2,160 ratings per observer.

CHAPTER 6

THESIS STUDY RESULTS

Model Factor Calculations

Form information was operationalized the same way as it was in the pilot study and the same joints were used for the study. The average distance between each pair of joints across 63 frames of animation was calculated for each of the 72 stimuli. Given how the new stimuli were designed (i.e., horizontal distance changes to between one and six of the key joints), motion information for all of the modified stimuli was the same as the default actor (0 standard deviations for sex). Therefore, motion information was not included in any of the models. Additionally, given how little motion cues affected the model in the pilot study, there was insufficient evidence to suggest that there was a need to integrate it into the final model. In addition to the first-order form cues (i.e., distance between key joints), several second order factors were included in the final model. These include shoulder-to-hip ratio (see 5A), which was included based upon existing literature (e.g., Johnson & Tassinary, 2005) and left and right arm inner angle[3] (see Figure 6B), which was included based upon observations of the stimuli. Male response rate was calculated for each stimulus using the mean observer responses, averaged across session and individual observers (see Table 14 for the mean male response per observer across all three sessions; for the mean male response per session for each participant, see Tables 15 through 22).

[3] Although the distances between the shoulder distance, elbow distance, and wrist distance still matter on their own, changes to any combination of these factors will also change the inner arm angles.

Model Development and Fit

Four different models were developed to test the study data. An additive model, based on participant responses to actors with single changes, was initially tested. Next, a model using first-order factors without weights was tested. This was followed by a model wherein weights were individually applied to each factor was tested. Finally, a model was developed using weighted variations on first order (i.e., distance between paired joints) and second order (i.e., shoulder-to-hip ratio and inner arm angle) factors. The unweighted model and weighted models with and without second order factors followed the following equation:

$$\begin{matrix} Predicted \\ Response \end{matrix} = \frac{\sum \frac{EXP(Constant + (Slope \times Factor)}{1 + EXP(Constant + (Slope \times Factor)} \times Weight}{\sum Weights}$$

For the weighted models, weights were determined by the same process as was used in the pilot study.

Additive Model

This model was based on mean observer responses to the sex-neutral actor and the mean responses to the actors with only one of the six first order factors modified. For each of the stimuli where one pair of joints was changed, the average difference in observed response from the neutral actor was recorded. Next, the additive model was used to predict responses for when two or more joints were changed by adding the average effect of each single change to the observed response for the neutral stimulus. For example, the difference between the average observed response for the actor with only their shoulder distance modified and the average observed response for the neutral actor was calculated. To predict responses for the actors with the shoulder and knee distance changed, the differences for just the shoulder changing and just the knee changing would summed and then added to the average response for the neutral actor. The equation for the model is presented below.

$$\begin{matrix} Predicted \\ Response \end{matrix}(Actor) = 66.25\% + \sum_{x \epsilon Actor} \begin{matrix} x = S;\ +3.75\% \\ x = E;\ -12.08\% \\ x = W;\ +3.33\% \\ x = H;\ -10.42\% \\ x = K;\ +5\% \\ x = A;\ -20\% \end{matrix}$$

In the equation, the male changes increased the probability that an observer would judge an actor as being male and female changes decreased the probability that an observer would judge an actor as being male. For this dataset, we quantified the fits overall, and per each of the six factors. Overall, the additive model did fit the data. See Table 23 for chi-squared test results for each stimulus. Although the model did fit the data, the pilot study results did suggest that a more accurate model based around logit fits could be produced to fit the data.

<u>Unweighted and Weighted First-Order Model</u>

Similar to the unweighted and weighted models from the pilot study, logistic regressions were calculated for all of the form factors based on how observers judged the sex of the nine actors that varied only on biological sex (see Figure 7 for logistic regression of observer responses to the nine computer-generated actors). For the unweighted model, all six joints were weighted equally (see Table 24 for included factors and weights) and the model was used to calculate the predicted responses. The unweighted model performed poorly overall (see Table 25 for chi-squared test results for each stimulus).

For the weighted first order model, each factor was weighted independently. As in the pilot study, this led to some factors being removed from the model (i.e., being given a weight of zero). Predicted responses were calculated and compared against the observed responses. See Table 26 for included factors and weights. In contrast to the unweighted model, this version of the model fit the data very well overall (see Table 27 for full table of chi-squared fits for each stimulus).

Weighted Model with First and Second Order Factors

The weighted model provided a much more accurate model for the observed responses than the other two models. Based on this, the weighted model was expanded using two additional factors: shoulder-to-hip ratio based on the literature (e.g., Johnson & Tassinary, 2005) and internal arm angles based on observation of major sex-based differences. See Table 28 for the factors included in the model and their associated weights. This final version of the model is quite accurate. Overall, the model fits the data very well (see Table 29 for a full table of chi-squared fits for each stimulus). As well as the model fits, it is only a small improvement over the model without second order factors ($\chi^2(62) = 25.60$ compared to $\chi^2(62) = 28.03$).

CHAPTER 7

THESIS STUDY DISCUSSION

The final weighted model that included second order factors was able to accurately fit the data (See Figure 8 for a visualization of the relative error of each model). In this model, the weights indicate that the distance between the ankle dots, the distance between the elbow dots, and the shoulder-to-hip ratio were used heavily by observers to judge the sex of the actor. Previous literature gives a basis for why the shoulder-to-hip ratio might be heavily utilized for these judgments (e.g., Johnson & Tassinary, 2005). The distance between the elbow dots varies noticeably between the extremely male and extremely female actors (see Table 1 for the distance between neutral male and female actors), which may explain why it had such a large contribution. The difference in weight may not necessarily reflect a difference in importance between factors, but rather may be compensating for the differences in how much each factor changes between stimuli relative to the other factors within an individual stimulus.

The different models developed during the thesis study provided better information for predicting how individuals will respond to the stimuli. The goal with the additive model was to determine how accurately changes to a single joint would predict changes to multiple joints. Although the additive model did fit in terms of chi-squared values (see Table 23), a better fit was possible using a model based on the outputs from logistic regressions. The poor fit of the unweighted model (see Table 25) suggested that the factors needed to be weighted to either compensate for differences in how much they contributed to prediction, or to compensate for differences in how much that factor changes between an extremely female and an extremely male actor.

The weighted models provided information on how the individual joints on the point-light actor are being used. A common feature to both of the weighted models was that almost all or all of the factors were included in the final weights. This suggests, consistent with earlier research by Kozlowski and Cutting (1977), that the process for perceiving biological sex from point-light stimuli is a distributed, holistic process. The weighted model that included second order factors did fit the data better than the model without second order factors (see Tables 28 and 26 respectively), suggesting that the inclusion of these factors does improve how well individuals were able to judge the sex of the actor. Of note, the second order factors include information that would have been captured somewhat by first-order factors (i.e., shoulder-to-hip ratio is based off of the shoulder and hip distances; arm angle is dependent on the shoulder, elbow, and wrist distances). Changing any of these first order factors, or any combination of them, would change the related second order factor. That the second-order factors, in addition to the first-order factors, increase the model accuracy may further suggest that observers are integrating multiple elements of the form information to judge the sex of the actor.

Although the models were primarily evaluated on how accurately the overall model fit all of the stimuli (i.e., using a sum of all of the chi-squared values), there is value in examining at how the models perform with individual stimuli. For the most part, the weighted models do not have major issues fitting most of the data; however, the additive model, weighted model, and weighted model with second-order factors had very poor fits for the stimulus wherein all six joint-distances were changed. By contrast, the unweighted model fit this stimulus very well, relative to how it performed on many of the other stimuli. This may suggest that participant responses to this stimulus weighted certain factors disproportionately to how they might have with other stimuli.

CHAPTER 8

GENERAL DISCUSSION

The models created in the pilot study were able to accurately fit the data from all of the conditions overall. The model created in the thesis study accurately predicted observer responses, except for the stimulus where all six of the joints were changed ($\chi^2(0) = 6.96$[4]). The pilot study models combined form and motion cues predict how probable it is for an observer to judge a point-light actor as male across multiple conditions. All three of the final models in the pilot study heavily used the knee distance, but there was some variation in how much the other distance and movement factors were used. For the thesis study, multiple models that included no motion variation were developed and tested. The thesis study models did not account for motion because the stimuli used did not have any motion variation. The final model developed using the current study data used individual weights for each of the factors included in the model. This model suggested that the ankle distance, elbow distance, and shoulder-to-hip ratio, in particular, contributed more to judgments about the sex of an actor.

Implications

Overall, the model suggests that when an individual is visually judging the sex of another person, they are likely to rely heavily on cues from shoulder-to-hip ratio, ankle distance, and elbow distance. In most circumstances, however, an individual is unlikely to encounter a person who is composed entirely of dots of light freely moving through

---

[4] This was the only fit with a test value greater than critical value for a comparison with one degree of freedom $\chi^2(1) = 3.841$. This comparison was used because any value that would fit a theoretical zero degrees of freedom critical value should also be below the critical value for a chi-squared test with one degree of freedom.

space. However, as discussed earlier, people do categorize others based on visually-available, socially relevant information (e.g., sex or race; Stangor et al, 1992). Although with real people, versus point-light actors, will have more visible cues (e.g., secondary sexual characteristics, clothing), observers can still utilize the form information present in the other person. In low-light conditions, for instance, many secondary cues are less visible or less salient. An individual observer would still be able to make judgments about the sex of another person based on form information. However, he or she would be making these judgments based off the silhouetted outline of the other person rather than through using points of light.

The model in the thesis study was developed to accurately predict how an average individual uses form information to judge the biological sex of an actor with ambiguous sex-based form characteristics. Largely, the model suggests that observers pull information from cues present throughout the body of the actors, but put emphasis on how broad the actor's shoulders and hips are relative to each other, how the actor's arms move throughout their gait, and how the actor's feet move during their gait.

Although many of the relevant social features that people look for in others are unavailable in point-light display, observers probably still relied on the same heuristics they would have used for making judgments about real people. Consistent with existing literature, shoulder-to-hip ratio contributes to the ability to discern the sex of others (e.g., Cutting et al., 1978). Arm and hand motion factor into social communication (e.g., Allison et al, 2000; Puce & Perrett, 2003); participants may have attended to the elbows on actors to extract some socially-relevant information related to potential actions.

Finally, as discussed, individuals can interpret social information from gait (e.g., identity; Cutting & Kozlowski, 1977), and observers may have been attending to the ankles of the actors as a metric for speed or direction. Body motion (i.e., center of moment, gait) and hand moment have been shown to prompt increased activation of the STS in individuals and are highly correlated with interpretation of socially relevant structural and motion information.

Model Limitations and Future Directions

Consistent with much of the literature in psychophysics, both the pilot and current studies used small samples compared to what would be conventional in much of psychology research. That said, both the pilot study and thesis study were sufficiently powered (pilot study post-hoc power analysis = .94; thesis study post-hoc power analysis = .99) and provide little justification for suggesting that the sample size negatively impacted the results of the study.

The potential effects of the gender of observers on their judgments about the video clips were not analyzed in either the pilot study or the thesis study. Although it was suggested as an interaction to consider following analysis of the pilot study, the all-female sample used in the thesis study made the analyses impossible. Recent research suggests neurological differences between how men and women process biological motion stimuli (Anderson et al., 2013). Specifically, they found differences between male and female adults, with women having greater activation of areas involved in salience detection and social perception. Women, compared to men, also showed greater connectivity between the right amygdala and regions associated with social cognition.

Because of this, future research may particularly want to assess if this affects the probability that an individual will judge an actor as male.

The pilot and thesis studies are both limited by the angle the actor is facing relative to the observer. Previous research (see Pollick et al., 2005) showed that the angle an actor is viewed from can affect how observers perceive the sex of the represented person. The models discussed in this study were all developed and tested using actors represented exclusively from a forward-facing angle. Because of this, these models may only fit responses to other forward-facing actors. Future research could expand this model to account for actors represented by other viewing angles. This could be accomplished through determining what factors are useful from different angles (e.g., lateral body sway; see Mather & Murdoch, 1994).

Future research could also add to this model by changing joint distances in the opposite direction from what was used in the thesis study (i.e., the distance between an actor's shoulder, wrist, and knee dots could be changed by the extremely female distances, and the elbows, hips and ankle distances could be changed to match the extremely male distances). Future research could have observers respond to all of the possible combinations of form changes to test the predictions that the current model makes about what information observers use to judge the sex of actors. Furthermore, the outcomes of this research could allow for a more comprehensive model to be developed.

Applications

There are several potential applications for the data produced by this study. Gait information is unique between individuals and serves as a soft biometric (Boyd & Little, 2005; Kim, Moon, Chung, & Pan, 2012). Multiple methods have been developed using gait information to identify specific individuals through pattern matching (Ning, Tan, Wang, & Hu, 2004; Kale et al., 2004; Wang, Ning, Hu, & Tan, 2002), symmetry analysis (Hayfron-Acquah, Nixon, & Carter, 2003), and floor-based sensors (Yun, 2011).

Larsen, Simosen, and Lynnerup (2008) suggested that the generally poor quality of security camera footage stands in the way of gait biometrics being usable as evidence in criminal trials. If the gait data is supported by form cues from photogrammetry, then it may be useful for excluding potential suspects. Further developments in surveillance technology would be required in order to exclusively use gait biometrics as forensic evidence. Later research, however, does suggest that gait biometrics and photogrammetry are sufficiently individualized to be used as forensic evidence (Lynnerup & Larsen, 2014).

Observers can accurately predict whether individuals will engage in either neutral or criminal activity when viewing CCTV footage. (Troscianko et al., 2004). Furthermore, it is possible with computer analysis to use CCTV footage to match gaits of unique individuals across multiple points of time. Through matching joints on individuals via computer software when viewed from different angles, unique individuals were able to be matched accurately in multiple surveillance footage samples. Furthermore, increasing the number of source frames decreased the error rate for matching (Bouchrika, Goffredo, Carter, & Nixon, 2011). Overall, this research supports the application of both gait measurements and form measurements collected through photogrammetry as a form of forensic evidence for identifying suspects in criminal cases.

The photogrammetric analysis discussed in the previous research helps to illustrate where the current study would fit into forensic applications. Particularly, the model developed in the current study provides the probability that an observer would judge an actor to be male. This research may contribute to understanding error in identifying individuals represented in low-quality CCTV footage.

REFERENCES

Allison, T., Puce, A., & McCarthy, G. (2000). Social perception from visual cues: Role of the STS region. *Trends in Cognitive Science, 4,* 267-278. doi:10.1016/S1364-6613(00)01501-1

Anderson, L. C., Bolling, D. Z., Schelinski, S., Coffman, M. C., Pelphrey, K. A., & Kaiser, M. D. (2013). Sex differences in the development of brain mechanisms for processing biological motion. *NeuroImage, 83,* 751-760. doi:10.1016/j.neuroimage.2013.07.040

Atkinson, A. P., Dittrich, W. H., Gemmell, A. J., & Young, A. W. (2004). Emotion perception from dynamic and static body expression in point-light and full-light displays. *Perception, 33*, 717-746. doi:10.1068/p5096

Barclay, C. D., Cutting, J. E., & Kozlowski, L. T. (1978). Temporal and spatial factors in gait perception that influence gender recognition. *Perception & Psychophysics*, *23*, 145-152. doi:10.3758/BF03208295

Blake, R., & Shiffrar, M. (2007). Perception of human motion. *Annual Review of Psychology, 58,* 47-73. doi: 10.1146/annurev.psych.57.102904.190152

Bouchrika, I., Goffredo, M., Carter, J., & Nixon, M. (2011). On using gait in forensic biometrics. *Journal of Forensic Science, 56,* 882-889. doi:10.1111/j.1556-4029.2011.10793.x

Boyd, J. E., & Little, J. J. (2005). Biometric gait recognition. In M. Tistarelli, J. Bigun, & E. Grosso (Eds.), *Advanced studies in biometrics: Summer school on biometrics, Alghero, Italy, revised selected lectures and papers* (pp. 19-42). doi:10.1007/11493648_2

Brainard, D. H. (1997). The Psychophysics Toolbox. *Spatial Vision,* 10, 433-436.

Brooks, A., Schouten, B., Troje, N. F., Verfaillie, K., Blanke, O., & van der Zwan, R. (2008). Correlated changes in perceptions of the gender and orientation of ambiguous biological motion figures. *Current Biology, 18,* 728-729. doi:10.1016/j.cub.2008.06.054

Cutting, J. E., & Kozlowski, L. T. (1977). Recognizing friends by their walk: Gait perception without familiarity cues. *Bulletin of the Psychonomic Society, 9,* 353-356. Retrieved from http://link.springer.com/article/10.3758/BF03337021

Cutting, J. E., Proffitt, D. R., & Kozlowski, L. T. (1978). A biomechanical invariant for gait perception. *Journal of Experimental Psychology: Human Perception and Performance, 4,* 357-372.

Decety, J., & Grèzes, J. (1999). Neural mechanisms subserving the perception of human actions. *Trends in Cognitive Science, 3,* 172-178. doi:10.1016/S1364-6613(99)01312-1

Fitzgerald, S.-A., Brooks, A., van der Zwan, R., & Blair, D. (2014). Seeing the world topsy-turvy: The primary role of kinematics in biological motion inversion effects.
i-Perception, 5, 120-131. doi:10.1068/i0612

Fraiman, D., Saunier, G., Martins, E. F., & Vargas, C. D. (2014). Biological motion coding in the brain: Analysis of visually driven EEG functional networks. *PLoS ONE, 9,* 1-9. doi:10.1371/journal.pone.0084612

Gilaie-Dotan, S., Kanai, R., Bahrami, B., Rees, G., & Saygin, A. P. (2013). Neuroanatomical correlates of biological motion detection. *Neuropsychologia, 51,* 457-463. doi:10.1016/j.neuropsychologia.2012.11.027

Grossman, E., Donnelly, M., Price, R., Pickens, D., Morgan V., Neighbor, G., & Blake, R. (2000). Brain areas involved in the perception of biological motion. *Journal of Cognitive Neuroscience, 12,* 711-720. doi:10.1162/089892900562417

Hayfron-Acquah, J. B., Nixon, M. S., & Carter, J. N. (2003). Automatic gait recognition by symmetry analysis. *Pattern Recognition Letters, 24*, 2175–2183. doi:10.1016/S0167-8655(03)00086-2

Hiris, E. (2007). Detection of biological and nonbiological motion. *Journal of Vision, 7,* 1-16. doi:10.1167/7.12.4

Johansson, G. (1973). Visual perception of biological motion and a model for its analysis. *Perception & Psychophysics, 14,* 201-211. doi:10.3758/BF03212378

Johnson, K. L., & Tassinary, L. G. (2005). Perceiving sex directly and indirectly: Meaning in motion and morphology. *Psychological Science, 16,* 890-897. doi:10.1111/j.1467-9280.2005.01633

Kale, A., Sundaresan, A., Rajagopalan, A. N., Cuntoor, N. P., Roy-Chowdhury, A. K., Krüger, V., & Chellappa, R. (2004). Identification of humans using gait. *IEEE Transactions on Image Processing, 13,* 1163-1173. doi:10.1109/TIP.2004.832865

Kim, M.-G., Moon, H.-M., Chung, Y., & Pan, S.B. (2012). A survey and proposed framework on the soft biometrics technique for human identification in intelligent video surveillance system. *Journal of Biomedicine and Biotechnology, 2012,* 1-7, doi:10.1155/2012/614646

Kozlowski, L. T., & Cutting, J. E. (1977). Recognizing the sex of a walker from a dynamic point-light display. *Perception & Psychophysics*, *21*, 575-580. doi:10.3758/BF03198740

Krakowski, A. I., Ross, L. A., Snyder, A. C., Sehatpour, P., Kelly, S. P., & Foxe, J. J. (2011). The neurophysiology of human biological motion processing: A high-density electrical mapping study. *NeuroImage, 56,* 373-383. doi:10.1016/j.neuroimage.2011.01.058

Lange, J., Georg, K., & Lappe, M. (2006). Visual perception of biological motion by form: A template-matching analysis. *Journal of Vision, 6,* 836-849. doi:10.1167/6.8.6

Larsen, P. K., Simosen, E. B., & Lynnerup, N. (2008). Gait analysis in forensic medicine. *Journal of Forensic Science, 53*, 1149-1153. doi:10.1111/j.1556-4029.2008.00807.x

Lynnerup, N. & Larsen, P. K. (2014). Gait as evidence. *Institution of Engineering and Technology: Biometrics, 3,* 47-54. doi:10.1049/iet-bmt.2013.009

Mather, G., & Murdoch, L. (1994). Gender discrimination in biological motion displays based on dynamic cues. *Proceedings: Biological Sciences, 258,* 273-279. Retrieved from http://www.jstor.org/stable/50091

MATLAB 8.1 and Statistics Toolbox Release 2013a. [Computer software]. Natick, MA: The Mathworks, Inc.

Neri, P., Morrone, M. C., & Burr, D. C. (1998). Seeing biological motion. *Nature, 395,* 894-896. doi:10.1038/27661

Ning, H., Tan, T., Wang, L., & Hu, W. (2004). Kinematics-based tracking of human walking in monocular video sequence. *Image and Vision Computing, 22,* 429-441. doi:10.1016/j.imavis.2004.001

Pelli, D. G. (1997). The VideoToolbox software for visual psychophysics: Transforming numbers into movies. *Spatial Vision,* 10, 437-44.

Pollick, F. E., Kay, J. W., Heim, K., & Stringer, R. (2005). Gender recognition from point-light walkers. *Journal of Experimental Psychology: Human Perception and Performance*, *31*, 1247-1265. doi:10.1037/0096-1523.31.6.1247

Pollick, F. E., Lestou, V., Ryu, J., & Cho, S.-B. (2002). Estimating the efficiency of recognizing gender and affect from biological motion. *Vision Research, 42*, 2345-2355. doi:10.1016/S0042-6989(02)00196-7

Pollick, F. E., Paterson, H. M., Bruderlin, A., & Sanford, A. J. (2001). Perceiving affect from arm movement. *Cognition, 82,* B51-B61. doi:10.1016/S0010-0277(01)00147-0

Puce, A., & Perrett, D. (2003). Electrophysiology and brain imaging of biological motion. *Philosophical Transactions of the Royal Society B, 358,* 435-445. doi:10.1098/rstb.2002.1221

Richardson, M. J., & Johnston, L. (2005). Person recognition from dynamic events: The kinematic specification of individual identity in walking style. *Journal of Nonverbal Behavior, 29,* 25-44. doi:10.1007/s10919-004-0888-9

Roether, C. L., Omlor, L., Christensen, A., & Giese, M. A. (2009). Critical features for the perception of emotions from gait. *Journal of Vision, 9,* 1-32. doi:10.1167/9.6.15

Runeson, S., & Frykholm, G. (1983). Kinematic specification of dynamics as an informational basis for person-and action perception: Expectation, gender recognition, and deceptive intention. *Journal of Experimental Psychology: General, 112,* 585-615. doi:10.1037/0096-3445.112.4.585

Saunders, D. R., Williamson, D. K., & Troje, N. F. (2010). Gaze patterns during perception of direction and gender from biological motion. *Journal of Vision*, *10,* 1-10. doi:10.1167/10.11.9

Schouten, B., Troje, N. F., Brooks, A., van der Zwan, R., & Verfaillie, K. (2010). The facing bias in biological motion perception: Effects of stimulus gender and observer sex. *Attention, Perception, & Psychophysics, 72,* 1256-1260. doi:10.3758/APP.72.5.1256

Schouten, B., Troje, N. F., & Verfaillie, K. (2011). The facing bias in biological motion perception: Structure, kinematics, and body parts. *Attention, Perception, & Psychophysics, 73,* 130-143. doi:10.3758/s13414-010-0018-1

Stangor, C., Lynch, L., Duan, C., & Glass, B. (1992). Categorization of individuals on the basis of multiple social features. *Journal of Personality and Social Psychology, 62.* 207-218, doi:10.1037/0022-3514.62.2.207

Troje, N. F. (2002). Decomposing biological motion: A framework for analysis and synthesis of human gait patterns. *Journal of Vision*, *2*. 371-387. doi:10.1167/2.5.2

Troje, N. F., Westhoff, C., & Lavrov, M. (2005). Person identification from biological motion: Effects of structural and kinematic cues. *Perception & Psychophysics, 67,* 667-675. doi:10.3758/BF03193523

Troscianko, T., Holmes, A., Stillman, J., Mirmehdi, M., Wright, D., & Wilson, A. (2004). What happens next? The predictability of natural behavior viewed through CCTV cameras. *Perception, 33*, 87-101. doi:10.1068/p3402

Wang, L., Ning, H., Hu, W., & Tan, T. (2002, September 22-24). *Gait recognition based on Procrustes Shape Analysis.* Paper presented at the 9th IEEE International Conference on Image Processing, Rochester, New York.

Weech, S., McAdams, M., Kenny, S., & Troje, N. F. (2014). What causes the facing-the-viewer bias in biological motion? *Journal of Vision, 14,* 1-15. doi:10.1167/14.12.10

Yun, J. (2011). User identification using gait patterns on UbiFloorII. *Sensors, 11*, 2611–2639. doi:10.3390/s110302611

Table 1

Form and Motion Changes in Point-Light Walkers across Conditions

	Form Changes						Motion Changes	
	Shoulder	Hip	Elbow	Knee	Wrist	Ankle	Rate	Distance
Happy	+5.85	-5.31	+12.12	+4.43	-1.32	+8.18	+	+
Sad	-5.72	+5.47	-11.85	-4.32	+7.90	-8.10	-	-
Nervous	-20.15	-35.16	-52.44	-9.45	-40.53	-0.98	+	+
Calm	+20.48	+35.27	+52.78	+9.56	+41.53	+1.78	-	-
Heavy	+28.66	-5.64	+58.72	+39.32	+37.59	+22.32	-	-
Light	-27.50	+5.87	-56.61	-37.21	-36.06	-19.99	+	+
Male	+14.23	-29.72	+32.28	+35.08	+6.12	+26.81	+	+
Female	-13.82	+29.92	-31.21	-31.88	-5.67	-25.22	-	-

Note: Table lists how each condition changes the actor, relative to a neutral actor. Form changes are presented as increases or decreases in pixel distance between a pair of dots. Motion changes are represented as either a plus (indicating an increase in either distance or velocity) or a minus (indicating a decrease in either distance or velocity).

Table 2

Constants, Slopes, and Weights for Factors Included in Unweighted Model

Factor	Constant	Slope	Weight
Shoulder Distance	-73.78	0.202	1
Hip Distance	18.431	-0.095	1
Elbow Distance	-38.865	0.089	1
Knee Distance	-12.095	0.084	1
Wrist Distance	-243.498	0.481	1
Ankle Distance	-14.422	0.109	1
Head Movement	-10.535	0.057	1
Chest Movement	-18.001	0.101	1
Left Shoulder Movement	-14.17	0.08	1
Left Elbow Movement	-20.595	0.113	1
Left Wrist Movement	-48.825	0.201	1
Right Shoulder Movement	-14.31	0.08	1
Right Elbow Movement	-10.646	0.059	1
Right Wrist Movement	26.553	-0.12	1
Waist Movement	-25.572	0.145	1
Left Hip Movement	-39.984	0.236	1
Left Knee Movement	14.971	-0.076	1
Left Ankle Movement	-27.471	0.082	1
Right Hip Movement	-49.652	0.289	1
Right Knee Movement	-13.904	0.076	1
Right Ankle Movement	-64.451	0.19	1

Note: Constants and slopes calculated from logistic regression for each of the factors included in the model.

Table 3

Predicted and Actual Mean Male Response Based on Sex and Condition in Unweighted Model

Sex	Predicted	Actual	Chi-square	Predicted	Actual	Chi-square	Predicted	Actual	Chi-square
	Sad			Neutral			Happy		
-3	13.29	5.56	4.50	15.55	7.22	4.46	59.23	9.44	41.85
-2.25	15.52	10.56	1.59	21.45	15.56	1.62	64.72	15.56	37.34
-1.5	18.75	25.00	2.09	31.06	27.78	0.35	71.21	21.67	34.47
-0.75	23.47	36.11	6.81	44.10	44.44	0.00	77.62	40.56	17.70
0	30.10	56.67	23.46	59.38	68.33	1.35	83.02	52.78	11.02
0.75	38.39	70.00	26.03	73.73	73.89	0.00	86.95	76.11	1.35
1.5	47.61	81.11	23.57	84.06	90.00	0.42	89.37	81.67	0.66
2.25	56.91	95.00	25.50	89.58	94.44	0.26	90.56	85.56	0.28
3	64.44	94.44	13.97	91.07	92.22	0.01	90.89	90.00	0.01
	Calm						Nervous		
-3	27.88	20.00	2.23				45.72	5.00	36.27
-2.25	31.26	27.22	0.52				50.08	6.11	38.60
-1.5	35.35	41.67	1.13				55.03	13.89	30.76
-0.75	40.01	66.11	17.02				60.52	23.89	22.17
0	45.77	82.78	29.92				66.11	41.67	9.04
0.75	52.69	90.56	27.20				70.97	55.00	3.59
1.5	59.94	97.22	23.19				74.55	67.22	0.72
2.25	65.78	97.22	15.02				77.06	73.33	0.18
3	69.54	96.67	10.58				79.05	81.11	0.05
	Light						Heavy		
-3	28.32	1.67	25.08				51.39	64.44	3.32
-2.25	26.84	2.78	21.57				61.54	80.56	5.87
-1.5	26.53	1.11	24.35				71.14	93.89	7.28
-0.75	28.32	5.56	18.30				78.59	94.44	3.20
0	32.63	9.44	16.47				82.10	97.78	2.99
0.75	38.87	11.11	19.83				83.26	97.22	2.34
1.5	46.37	20.00	15.00				84.56	97.78	2.06
2.25	54.43	30.00	10.96				85.56	99.44	2.25
3	62.21	47.22	3.61				87.20	99.44	1.72

Note: Chi-squared response table for the unweighted model developed in the pilot study

Table 4

Constants, Slopes, and Weights for Factors Included in Weighted Model

Factor	Constant	Slope	Weight
Shoulder Distance	-73.78	0.202	0.5
Hip Distance	18.431	-0.095	0
Elbow Distance	-38.865	0.089	0
Knee Distance	-12.095	0.084	35
Wrist Distance	-243.498	0.481	1.9
Ankle Distance	-14.422	0.109	5
Head Movement	-10.535	0.057	0
Chest Movement	-18.001	0.101	0
Left Shoulder Movement	-14.17	0.08	0
Left Elbow Movement	-20.595	0.113	0
Left Wrist Movement	-48.825	0.201	0
Right Shoulder Movement	-14.31	0.08	0
Right Elbow Movement	-10.646	0.059	0
Right Wrist Movement	26.553	-0.12	0
Waist Movement	-25.572	0.145	0
Left Hip Movement	-39.984	0.236	0
Left Knee Movement	14.971	-0.076	0
Left Ankle Movement	-27.471	0.082	0
Right Hip Movement	-49.652	0.289	0
Right Knee Movement	-13.904	0.076	0
Right Ankle Movement	-64.451	0.19	0

Note: Constants and slopes calculated from logistic regression for each of the factors included in the model.

Table 5

Predicted and Actual Mean Male Response Based on Sex and Condition in Weighted Model

Sex	Predicted	Actual	Chi-square	Predicted	Actual	Chi-square	Predicted	Actual	Chi-square
		Sad			Neutral			Happy	
-3	9.65	5.56	1.74	9.20	7.22	0.42	13.56	9.44	1.25
-2.25	14.64	10.56	1.14	16.09	15.56	0.02	22.75	15.56	2.27
-1.5	22.85	25.00	0.20	27.13	27.78	0.02	36.07	21.67	5.75
-0.75	35.32	36.11	0.02	42.48	44.44	0.09	52.38	40.56	2.67
0	51.39	56.67	0.54	59.86	68.33	1.20	68.58	52.78	3.64
0.75	67.93	70.00	0.06	75.35	73.89	0.03	81.51	76.11	0.36
1.5	81.30	81.11	0.00	86.39	90.00	0.15	90.07	81.67	0.78
2.25	90.08	95.00	0.27	93.03	94.44	0.02	94.99	85.56	0.94
3	95.05	94.44	0.00	96.59	92.22	0.20	97.57	90.00	0.59
		Calm						Nervous	
-3	22.37	20.00	0.25				4.63	5.00	0.03
-2.25	32.91	27.22	0.98				8.35	6.11	0.60
-1.5	47.05	41.67	0.62				14.87	13.89	0.07
-0.75	62.78	66.11	0.18				25.39	23.89	0.09
0	76.81	82.78	0.46				40.08	41.67	0.06
0.75	86.97	90.56	0.15				56.77	55.00	0.06
1.5	93.20	97.22	0.17				71.63	67.22	0.27
2.25	96.61	97.22	0.00				82.16	73.33	0.95
3	98.36	96.67	0.03				88.47	81.11	0.61
		Light						Heavy	
-3	0.80	1.67	0.93				68.27	64.44	0.21
-2.25	1.30	2.78	1.69				80.99	80.56	0.00
-1.5	2.20	1.11	0.54				89.62	93.89	0.20
-0.75	3.86	5.56	0.75				94.69	94.44	0.00
0	6.88	9.44	0.96				97.39	97.78	0.00
0.75	12.22	11.11	0.10				98.75	97.22	0.02
1.5	21.04	20.00	0.05				99.41	97.78	0.03
2.25	34.01	30.00	0.47				99.73	99.44	0.00
3	50.06	47.22	0.16				99.87	99.44	0.00

Note: Chi-squared response table for the weighted model developed in the pilot study

Table 6

Constants, Slopes, and Weights for Factors Included in the Individual Model for the Light and Heavy Conditions

Factor	Constant	Slope	Weight
Shoulder Distance	-73.78	0.202	1.5
Hip Distance	18.431	-0.095	0.33
Elbow Distance	-38.865	0.089	1
Knee Distance	-12.095	0.084	15
Wrist Distance	-243.498	0.481	0
Ankle Distance	-14.422	0.109	0.21
Head Movement	-10.535	0.057	0
Chest Movement	-18.001	0.101	0
Left Shoulder Movement	-14.17	0.08	0
Left Elbow Movement	-20.595	0.113	0
Left Wrist Movement	-48.825	0.201	0
Right Shoulder Movement	-14.31	0.08	2.1
Right Elbow Movement	-10.646	0.059	0
Right Wrist Movement	26.553	-0.12	0
Waist Movement	-25.572	0.145	0
Left Hip Movement	-39.984	0.236	0
Left Knee Movement	14.971	-0.076	0
Left Ankle Movement	-27.471	0.082	0
Right Hip Movement	-49.652	0.289	0
Right Knee Movement	-13.904	0.076	0
Right Ankle Movement	-64.451	0.19	0

Note: Constants and slopes calculated from logistic regression for each of the factors included in the model.

Table 7

Constants, Slopes, and Weights for Factors Included in the Individual Model for the Nervous and Calm Conditions

Factor	Constant	Slope	Weight
Shoulder Distance	-73.78	0.202	0
Hip Distance	18.431	-0.095	0
Elbow Distance	-38.865	0.089	0
Knee Distance	-12.095	0.084	35
Wrist Distance	-243.498	0.481	1.1
Ankle Distance	-14.422	0.109	0
Head Movement	-10.535	0.057	0
Chest Movement	-18.001	0.101	0
Left Shoulder Movement	-14.17	0.08	0
Left Elbow Movement	-20.595	0.113	0
Left Wrist Movement	-48.825	0.201	0
Right Shoulder Movement	-14.31	0.08	0
Right Elbow Movement	-10.646	0.059	0
Right Wrist Movement	26.553	-0.12	1.2
Waist Movement	-25.572	0.145	0
Left Hip Movement	-39.984	0.236	0
Left Knee Movement	14.971	-0.076	0
Left Ankle Movement	-27.471	0.082	0
Right Hip Movement	-49.652	0.289	0
Right Knee Movement	-13.904	0.076	0
Right Ankle Movement	-64.451	0.19	0

Note: Constants and slopes calculated from logistic regression for each of the factors included in the model.

Table 8

Constants, Slopes, and Weights for Factors Included in the Individual Model for the Happy and Sad Conditions

Factor	Constant	Slope	Weight
Shoulder Distance	-73.78	0.202	2.8
Hip Distance	18.431	-0.095	-10.6
Elbow Distance	-38.865	0.089	-5
Knee Distance	-12.095	0.084	50
Wrist Distance	-243.498	0.481	-0.1
Ankle Distance	-14.422	0.109	-1.8
Head Movement	-10.535	0.057	0
Chest Movement	-18.001	0.101	-1
Left Shoulder Movement	-14.17	0.08	0
Left Elbow Movement	-20.595	0.113	0
Left Wrist Movement	-48.825	0.201	0
Right Shoulder Movement	-14.31	0.08	0
Right Elbow Movement	-10.646	0.059	0
Right Wrist Movement	26.553	-0.12	1
Waist Movement	-25.572	0.145	0
Left Hip Movement	-39.984	0.236	0
Left Knee Movement	14.971	-0.076	0
Left Ankle Movement	-27.471	0.082	-1
Right Hip Movement	-49.652	0.289	0
Right Knee Movement	-13.904	0.076	0.3
Right Ankle Movement	-64.451	0.19	-0.2

Note: Constants and slopes calculated from logistic regression for each of the factors included in the model.

Table 9

Predicted and Actual Mean Male Response Based on Sex and Condition in the Individual Model for the Light and Heavy Conditions

Sex	Predicted	Actual	Chi-square	Predicted	Actual	Chi-square	Predicted	Actual	Chi-square
		Light			Neutral			Heavy	
-3	1.87	1.67	0.02	9.35	7.22	0.49	68.48	64.44	0.24
-2.25	2.28	2.78	0.11	16.15	15.56	0.02	80.60	80.56	0.00
-1.5	3.14	1.11	1.31	27.06	27.78	0.02	89.10	93.89	0.26
-0.75	4.79	5.56	0.12	42.30	44.44	0.11	94.29	94.44	0.00
0	7.78	9.44	0.36	59.67	68.33	1.26	97.15	97.78	0.00
0.75	12.92	11.11	0.25	75.25	73.89	0.02	98.62	97.22	0.02
1.5	21.25	20.00	0.07	86.39	90.00	0.15	99.35	97.78	0.02
2.25	33.46	30.00	0.36	93.06	94.44	0.02	99.69	99.44	0.00
3	48.69	47.22	0.04	96.63	92.22	0.20	99.86	99.44	0.00

Note: Chi-squared response table for the individual model developed for the neutral, light, and heavy conditions in the pilot study.

Table 10

Predicted and Actual Mean Male Response Based on Sex and Condition in the Individual Model for the Nervous and Calm Conditions

Sex	Predicted	Actual	Chi-square	Predicted	Actual	Chi-square	Predicted	Actual	Chi-square
		Nervous			Neutral			Calm	
-3	21.22	20.00	0.07	9.17	7.22	0.41	3.99	5.00	0.25
-2.25	32.99	27.22	1.01	16.49	15.56	0.05	7.33	6.11	0.20
-1.5	48.12	41.67	0.86	27.77	27.78	0.00	13.32	13.89	0.02
-0.75	64.09	66.11	0.06	42.97	44.44	0.05	23.31	23.89	0.01
0	77.84	82.78	0.31	60.03	68.33	1.15	37.79	41.67	0.40
0.75	87.56	90.56	0.10	75.21	73.89	0.02	54.74	55.00	0.00
1.5	93.24	97.22	0.17	85.95	90.00	0.19	70.09	67.22	0.12
2.25	95.63	97.22	0.03	92.16	94.44	0.06	80.97	73.33	0.72
3	95.87	96.67	0.01	94.80	92.22	0.07	87.36	81.11	0.45

Note: Chi-squared response table for the individual model developed for the neutral, nervous, and calm conditions in the pilot study.

Table 11

Predicted and Actual Mean Male Response Based on Sex and Condition in the Individual Model for the Happy and Sad Condition

Sex	Predicted	Actual	Chi-square	Predicted	Actual	Chi-square	Predicted	Actual	Chi-square
		Happy			Neutral			Sad	
-3	9.33	9.44	0.00	9.95	7.22	0.75	10.24	5.56	2.14
-2.25	16.99	15.56	0.12	16.93	15.56	0.11	15.66	10.56	1.66
-1.5	29.01	21.67	1.86	27.76	27.78	0.00	24.85	25.00	0.00
-0.75	45.10	40.56	0.46	42.57	44.44	0.08	38.74	36.11	0.18
0	62.24	52.78	1.44	59.47	68.33	1.32	56.19	56.67	0.00
0.75	76.48	76.11	0.00	74.73	73.89	0.01	73.36	70.00	0.15
1.5	86.02	81.67	0.22	85.66	90.00	0.22	86.35	81.11	0.32
2.25	91.52	85.56	0.39	92.04	94.44	0.06	94.15	95.00	0.01
3	94.39	90.00	0.20	94.88	92.22	0.07	97.68	94.44	0.11

Note: Chi-squared response table for the individual model developed for the neutral, happy, and sad conditions in the pilot study.

Table 12

Total Chi-Squared Values for Each Condition, per Model

	Conditions						
Model	Neutral	Happy	Sad	Calm	Nervous	Light	Heavy
Unweighted	8.48	127.51	144.67	126.82	141.39	130.10	27.72
Weighted	2.15	3.98	18.25	2.84	2.73	4.72	0.26
Individual	2.31	4.57	4.69	2.62	2.18	2.63	0.31

Note: Total Chi-squared values were calculated as the sum of the chi-square fits for each stimulus in that condition. Each value is compared against a Critical Value of 15.507. Fit listed for the individual model neutral condition is the mean of the neutral fits for all three models

Table 13

List of the Stimuli Present within the Study.

Base	1 set	2 sets	3 sets	4 sets	5 sets	All sets
-3	S	SE	SEW	SEWH	WHKA	SEWHKA
-2.25	E	SW	SEH	SEWK	SEWHK	
-1.5	W	SH	SEK	SEWA	SEWHA	
-0.75	H	SK	SEA	SEHK	SEWKA	
0	K	SA	SWH	SEHA	SEHKA	
0.75	A	EW	SWK	SEKA	SWHKA	
1.5		EH	SWA	SWHK		
2.25		EK	SHK	SWHA		
3		EA	SHA	SWKA		
		WH	SKA	SHKA		
		WK	EWH	EWHK		
		WA	EWK	EWHA		
		HK	EWA	EWKA		
		HA	EHK	EHKA		
			EHA			
			EKA			
			WHK			
			WHA			
			WKA			
			HKA			

Note: Coding is as follows: “S”, “E”, “H”, “K”, “W”, and “A” refer to the shoulder, elbow, hip, knee, wrist, and ankle dots on the actor. If the stimulus name includes a letter, then the distance for the associated set of joints will be changed by the male or female distance. Male and female distance changes are applied to the “0” base.

Table 14

Mean Male Response Across Three Sessions For All Participants

	Observers									Observers							
Stimuli	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Stimuli**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
-3	.6	.1	.33	0	.03	.07	.13	.37	**SWA**	.13	.13	.63	.1	.53	.37	.97	.53
-2.25	.8	.2	.43	0	.07	.2	.37	.23	**SHK**	.87	.6	.7	.27	.63	.53	1	.6
-1.5	.9	.33	.5	.1	.43	.43	.57	.37	**SHA**	.03	.27	.63	.2	.37	.23	.83	.77
-.75	.9	.37	.7	.13	.37	.43	.9	.63	**SKA**	.13	.3	.8	.27	.47	.43	.97	.53
0	.9	.6	.6	.37	.6	.83	.9	.5	**EWH**	.83	.47	.43	.03	.27	.37	.8	.63
.75	.9	.6	.67	.9	.83	.9	.97	.43	**EWK**	.9	.4	.57	.23	.4	.77	.73	.5
1.5	.87	.67	.8	1	.9	.93	1	.57	**EWA**	.1	.33	.53	.1	.3	.43	.43	.53
2.25	.9	.8	.9	.93	1	1	1	.53	**EHK**	.87	.63	.57	.2	.33	.6	.87	.5
3	1	.87	.9	.97	1	1	.97	.57	**EHA**	.07	.47	.43	0	.13	.17	.7	.6
S	.93	.5	.73	.4	.67	.83	.93	.6	**EKA**	.1	.1	.6	.1	.13	.3	.6	.23
E	.9	.47	.47	.17	.3	.8	.67	.57	**WHK**	.9	.67	.53	.37	.5	.67	1	.6
W	.87	.53	.73	.47	.83	.8	.87	.47	**WHA**	0	.23	.6	.03	.33	.1	.77	.47
H	.8	.53	.53	.23	.37	.43	.9	.67	**WKA**	.03	.5	.6	.33	.37	.37	.93	.3
K	.93	.63	.57	.5	.7	.77	1	.6	**HKA**	.03	.33	.67	.2	.3	.3	.87	.4
A	.1	.37	.63	.13	.53	.4	.93	.6	**SEWH**	.93	.5	.43	.1	.27	.43	.73	.43
SE	.9	.43	.47	.27	.37	.77	.83	.53	**SEWK**	.93	.73	.53	.1	.5	.67	.8	.47
SW	.93	.47	.7	.43	.73	.87	.93	.53	**SEWA**	.1	.2	.47	.03	.5	.23	.53	.6
SH	.83	.47	.6	.23	.57	.53	1	.6	**SEHK**	.93	.43	.5	.23	.3	.43	.93	.63
SK	.97	.37	.77	.43	.8	.83	.97	.5	**SEHA**	.13	.27	.37	0	.33	.07	.47	.63
SA	.13	.43	.6	.17	.77	.37	.9	.43	**SEKA**	.23	.13	.67	.17	.3	.33	.63	.4
EW	1	.47	.53	.23	.6	.7	.83	.53	**SWHK**	.93	.5	.63	.37	.83	.73	.97	.77
EH	.9	.53	.47	.03	.4	.5	.53	.73	**SWHA**	.07	.33	.57	.1	.47	.27	.8	.67
EK	.87	.5	.6	.2	.63	.8	.7	.37	**SWKA**	.03	.33	.8	.37	.53	.4	.9	.63
EA	.13	.2	.47	.07	.27	.33	.5	.4	**SHKA**	.1	.23	.63	.17	.4	.4	.9	.6
WH	.93	.63	.57	.27	.43	.53	.93	.63	**EWHK**	.9	.63	.4	.03	.37	.77	.83	.73
WK	.93	.5	.7	.6	.67	.87	.93	.6	**EWHA**	.07	.23	.4	.07	.33	.07	.57	.8
WA	.07	.2	.77	.13	.57	.37	.87	.63	**EWKA**	.13	.23	.5	.1	.27	.43	.63	.43
HK	.9	.63	.57	.5	.6	.7	.93	.83	**EHKA**	.07	.47	.33	.03	.03	.13	.67	.7
HA	.03	.17	.7	.33	.27	.3	.87	.83	**WHKA**	.07	.4	.57	.07	.47	.2	.73	.6
KA	.1	.2	.63	.23	.57	.37	.9	.63	**SEWHK**	.9	.6	.37	.17	.37	.5	.83	.67
SEW	1	.43	.5	.1	.47	.73	.8	.67	**SEWHA**	.1	.43	.6	.03	.13	.23	.47	.53
SEH	.97	.63	.47	.07	.3	.33	.8	.87	**SEWKA**	.03	.23	.47	.1	.37	.23	.63	.73
SEK	.93	.67	.4	.27	.47	.87	.93	.6	**SEHKA**	.07	.27	.47	.03	.23	.23	.57	.6
SEA	.03	.23	.53	.1	.4	.27	.27	.6	**SWHKA**	.13	.43	.43	0	.2	.23	.57	.47
SWH	.93	.4	.8	.33	.8	.53	.97	.8	**EWHKA**	.07	.27	.5	.1	.47	.27	.47	.4
SWK	.93	.63	.7	.63	.73	.73	1	.53	**SEWHKA**	.07	.33	.67	.13	.6	.43	.87	.8

Note: Male response rate for each of the eight observers whom participated in the thesis study. Response rate for each stimulus represents that observer's average response to that stimulus across three sessions.

Table 15

Mean Male Response Per Session for Participant One

	Session					Session			
Stimuli	**1**	**2**	**3**	**Mean**	**Stimuli**	**1**	**2**	**3**	**Mean**
-3	.6	.5	.7	.6	**SWA**	.2	.1	.1	.13
-2.25	.9	.9	.6	.8	**SHK**	.9	1	.7	.87
-1.5	.8	.9	1	.9	**SHA**	.1	0	0	.03
-0.75	.9	.9	.9	.9	**SKA**	0	.1	.3	.13
0	1	.9	.8	.9	**EWH**	.9	.9	.7	.83
0.75	.9	1	.8	.9	**EWK**	.7	1	1	.9
1.5	.9	.7	1	.87	**EWA**	.1	0	.2	.1
2.25	1	.9	.8	.9	**EHK**	.9	.8	.9	.87
3	1	1	1	1	**EHA**	0	.2	0	.07
S	1	.9	.9	.93	**EKA**	.2	0	.1	.1
E	.9	1	.8	.9	**WHK**	1	.9	.8	.9
W	.8	1	.8	.87	**WHA**	0	0	0	0
H	.7	.9	.8	.8	**WKA**	0	0	.1	.03
K	.9	.9	1	.93	**HKA**	.1	0	0	.03
A	.1	.1	.1	.1	**SEWH**	.8	1	1	.93
SE	.8	.9	1	.9	**SEWK**	.9	1	.9	.93
SW	.9	.9	1	.93	**SEWA**	.2	0	.1	.1
SH	.8	.9	.8	.83	**SEHK**	.9	1	.9	.93
SK	1	.9	1	.97	**SEHA**	0	.2	.2	.13
SA	.1	.1	.2	.13	**SEKA**	.3	.3	.1	.23
EW	1	1	1	1	**SWHK**	.8	1	1	.93
EH	.9	.8	1	.9	**SWHA**	.1	0	.1	.07
EK	.8	.9	.9	.87	**SWKA**	.1	0	0	.03
EA	.1	.1	.2	.13	**SHKA**	.1	0	.2	.1
WH	.9	1	.9	.93	**EWHK**	.8	1	.9	.9
WK	1	1	.8	.93	**EWHA**	.1	0	.1	.07
WA	.1	.1	0	.07	**EWKA**	.1	.1	.2	.13
HK	.9	.9	.9	.9	**EHKA**	0	0	.2	.07
HA	.1	0	0	.03	**WHKA**	.1	.1	0	.07
KA	.2	0	.1	.1	**SEWHK**	.8	1	.9	.9
SEW	1	1	1	1	**SEWHA**	.2	0	.1	.1
SEH	1	.9	1	.97	**SEWKA**	0	0	.1	.03
SEK	.8	1	1	.93	**SEHKA**	.1	0	.1	.07
SEA	.1	0	0	.03	**SWHKA**	.1	.2	.1	.13
SWH	.9	.9	1	.93	**EWHKA**	0	.1	.1	.07
SWK	.9	1	.9	.93	**SEWHKA**	.1	0	.1	.07

Note: Male response rate for participant one. Response rate for each stimulus represents that observer's average response to that stimulus in each of the three sessions. Participant's mean male response to each stimulus across all three sessions included under Mean.

Table 16

Mean Male Response Per Session for Participant Two

	Session					Session			
Stimuli	**1**	**2**	**3**	**Mean**	**Stimuli**	**1**	**2**	**3**	**Mean**
-3	0	0	.3	.1	**SWA**	0	.3	.1	.13
-2.25	0	.1	.5	.2	**SHK**	.5	.6	.7	.6
-1.5	.4	.2	.4	.33	**SHA**	.4	.3	.1	.27
-0.75	.5	.4	.2	.37	**SKA**	.3	.3	.3	.3
0	.8	.4	.6	.6	**EWH**	.4	.3	.7	.47
0.75	.5	.8	.5	.6	**EWK**	.3	.5	.4	.4
1.5	.6	.9	.5	.67	**EWA**	.3	.4	.3	.33
2.25	1	.6	.8	.8	**EHK**	.9	.6	.4	.63
3	.8	.9	.9	.87	**EHA**	.8	.3	.3	.47
S	.3	.7	.5	.5	**EKA**	.1	0	.2	.1
E	.5	.4	.5	.47	**WHK**	.7	.5	.8	.67
W	.7	.4	.5	.53	**WHA**	.4	.3	0	.23
H	.5	.6	.5	.53	**WKA**	.3	.8	.4	.5
K	.7	.5	.7	.63	**HKA**	.5	.3	.2	.33
A	.2	.3	.6	.37	**SEWH**	.6	.4	.5	.5
SE	.6	.2	.5	.43	**SEWK**	.5	.8	.9	.73
SW	.4	.5	.5	.47	**SEWA**	.2	.3	.1	.2
SH	.4	.4	.6	.47	**SEHK**	.4	.2	.7	.43
SK	.4	.3	.4	.37	**SEHA**	.3	.2	.3	.27
SA	.6	.5	.2	.43	**SEKA**	.1	.1	.2	.13
EW	.6	.4	.4	.47	**SWHK**	.4	.6	.5	.5
EH	.8	.4	.4	.53	**SWHA**	.6	0	.4	.33
EK	.3	.5	.7	.5	**SWKA**	.3	.4	.3	.33
EA	.3	.3	0	.2	**SHKA**	.4	.1	.2	.23
WH	.7	.6	.6	.63	**EWHK**	.5	.5	.9	.63
WK	.5	.3	.7	.5	**EWHA**	.2	.3	.2	.23
WA	.3	.1	.2	.2	**EWKA**	.1	.1	.5	.23
HK	.7	.3	.9	.63	**EHKA**	.5	.3	.6	.47
HA	.2	.1	.2	.17	**WHKA**	.6	.3	.3	.4
KA	.3	.2	.1	.2	**SEWHK**	.7	.5	.6	.6
SEW	.5	.4	.4	.43	**SEWHA**	.5	.5	.3	.43
SEH	.6	.6	.7	.63	**SEWKA**	.3	.2	.2	.23
SEK	.6	.7	.7	.67	**SEHKA**	.5	.2	.1	.27
SEA	.2	.3	.2	.23	**SWHKA**	.3	.4	.6	.43
SWH	.6	.5	.1	.4	**EWHKA**	.2	.4	.2	.27
SWK	.4	.8	.7	.63	**SEWHKA**	.2	.5	.3	.33

Note: Male response rate for participant two. Response rate for each stimulus represents that observer's average response to that stimulus in each of the three sessions. Participant's mean male response to each stimulus across all three sessions included under Mean.

Table 17

Mean Male Response Per Session for Participant Three

	Session					Session			
Stimuli	**1**	**2**	**3**	**Mean**	**Stimuli**	**1**	**2**	**3**	**Mean**
-3	.2	.4	.4	.33	**SWA**	.6	.6	.7	.63
-2.25	.2	.6	.5	.43	**SHK**	.7	.7	.7	.7
-1.5	.5	.6	.4	.5	**SHA**	.7	.5	.7	.63
-0.75	.7	.6	.8	.7	**SKA**	.8	.8	.8	.8
0	.6	.7	.5	.6	**EWH**	.4	.5	.4	.43
0.75	.6	.6	.8	.67	**EWK**	.7	.4	.6	.57
1.5	.8	.8	.8	.8	**EWA**	.3	.7	.6	.53
2.25	.9	.9	.9	.9	**EHK**	.5	.6	.6	.57
3	.7	1	1	.9	**EHA**	.4	.5	.4	.43
S	.7	.7	.8	.73	**EKA**	.5	.7	.6	.6
E	.5	.4	.5	.47	**WHK**	.7	.4	.5	.53
W	.8	.8	.6	.73	**WHA**	.5	.8	.5	.6
H	.8	.4	.4	.53	**WKA**	.6	.6	.6	.6
K	.3	.8	.6	.57	**HKA**	.8	.7	.5	.67
A	.5	.6	.8	.63	**SEWH**	.4	.6	.3	.43
SE	.3	.4	.7	.47	**SEWK**	.3	.7	.6	.53
SW	.8	.6	.7	.7	**SEWA**	.5	.5	.4	.47
SH	.7	.6	.5	.6	**SEHK**	.5	.2	.8	.5
SK	.9	.8	.6	.77	**SEHA**	.4	.3	.4	.37
SA	.7	.7	.4	.6	**SEKA**	.6	.7	.7	.67
EW	.7	.5	.4	.53	**SWHK**	.5	.6	.8	.63
EH	.5	.4	.5	.47	**SWHA**	.4	.6	.7	.57
EK	.7	.6	.5	.6	**SWKA**	1	.7	.7	.8
EA	.7	.3	.4	.47	**SHKA**	.4	.7	.8	.63
WH	.6	.6	.5	.57	**EWHK**	.3	.5	.4	.4
WK	.7	1	.4	.7	**EWHA**	.6	.4	.2	.4
WA	.9	.6	.8	.77	**EWKA**	.6	.5	.4	.5
HK	.5	.4	.8	.57	**EHKA**	.6	.1	.3	.33
HA	.6	.7	.8	.7	**WHKA**	.5	.8	.4	.57
KA	.7	.8	.4	.63	**SEWHK**	.3	.7	.1	.37
SEW	.4	.8	.3	.5	**SEWHA**	.5	.6	.7	.6
SEH	.3	.6	.5	.47	**SEWKA**	.5	.4	.5	.47
SEK	.3	.6	.3	.4	**SEHKA**	.4	.5	.5	.47
SEA	.4	.6	.6	.53	**SWHKA**	.5	.4	.4	.43
SWH	.8	.7	.9	.8	**EWHKA**	.7	.4	.4	.5
SWK	.7	.6	.8	.7	**SEWHKA**	.5	.8	.7	.67

Note: Male response rate for participant three. Response rate for each stimulus represents that observer's average response to that stimulus in each of the three sessions. Participant's mean male response to each stimulus across all three sessions included under Mean.

Table 18

Mean Male Response Per Session for Participant Four

	Session					Session			
Stimuli	**1**	**2**	**3**	**Mean**	**Stimuli**	**1**	**2**	**3**	**Mean**
-3	0	0	0	0	**SWA**	.1	.2	0	.1
-2.25	0	0	0	0	**SHK**	.1	.2	.5	.27
-1.5	0	.3	0	.1	**SHA**	.1	.3	.2	.2
-0.75	0	.3	.1	.13	**SKA**	.1	.5	.2	.27
0	.3	.2	.6	.37	**EWH**	.1	0	0	.03
0.75	.8	.9	1	.9	**EWK**	.2	.1	.4	.23
1.5	1	1	1	1	**EWA**	.1	.2	0	.1
2.25	1	.8	1	.93	**EHK**	.2	0	.4	.2
3	1	1	.9	.97	**EHA**	0	0	0	0
S	.2	.3	.7	.4	**EKA**	.2	.1	0	.1
E	.2	.1	.2	.17	**WHK**	.3	.3	.5	.37
W	.3	.5	.6	.47	**WHA**	.1	0	0	.03
H	.2	.2	.3	.23	**WKA**	.2	.6	.2	.33
K	.2	.6	.7	.5	**HKA**	0	.4	.2	.2
A	.2	.2	0	.13	**SEWH**	.1	0	.2	.1
SE	.2	.2	.4	.27	**SEWK**	.1	.1	.1	.1
SW	.2	.5	.6	.43	**SEWA**	.1	0	0	.03
SH	.2	.2	.3	.23	**SEHK**	.1	.1	.5	.23
SK	.2	.4	.7	.43	**SEHA**	0	0	0	0
SA	.2	.3	0	.17	**SEKA**	.3	.2	0	.17
EW	.1	.2	.4	.23	**SWHK**	.3	.4	.4	.37
EH	.1	0	0	.03	**SWHA**	.1	.2	0	.1
EK	.2	.3	.1	.2	**SWKA**	.1	.6	.4	.37
EA	0	.1	.1	.07	**SHKA**	.1	.4	0	.17
WH	.1	.3	.4	.27	**EWHK**	0	.1	0	.03
WK	.6	.4	.8	.6	**EWHA**	0	.1	.1	.07
WA	0	.4	0	.13	**EWKA**	.1	0	.2	.1
HK	.4	.4	.7	.5	**EHKA**	0	0	.1	.03
HA	.3	.6	.1	.33	**WHKA**	.2	0	0	.07
KA	.2	.3	.2	.23	**SEWHK**	.2	.1	.2	.17
SEW	.2	0	.1	.1	**SEWHA**	.1	0	0	.03
SEH	.1	0	.1	.07	**SEWKA**	.3	0	0	.1
SEK	.2	.1	.5	.27	**SEHKA**	.1	0	0	.03
SEA	.2	0	.1	.1	**SWHKA**	0	0	0	0
SWH	.1	.6	.3	.33	**EWHKA**	0	.1	.2	.1
SWK	.5	.4	1	.63	**SEWHKA**	0	.3	.1	.13

Note: Male response rate for participant four. Response rate for each stimulus represents that observer’s average response to that stimulus in each of the three sessions. Participant's mean male response to each stimulus across all three sessions included under Mean.

Table 19

Mean Male Response Per Session for Participant Five

	Session					Session			
Stimuli	**1**	**2**	**3**	**Mean**	**Stimuli**	**1**	**2**	**3**	**Mean**
-3	.1	0	0	.03	**SWA**	.7	.6	.3	.53
-2.25	.1	0	.1	.07	**SHK**	.6	.7	.6	.63
-1.5	.6	.3	.4	.43	**SHA**	.2	.2	.7	.37
-0.75	.5	.1	.5	.37	**SKA**	.3	.6	.5	.47
0	.5	.7	.6	.6	**EWH**	.2	.1	.5	.27
0.75	.8	.8	.9	.83	**EWK**	.5	.3	.4	.4
1.5	1	.8	.9	.9	**EWA**	.4	.3	.2	.3
2.25	1	1	1	1	**EHK**	.4	.3	.3	.33
3	1	1	1	1	**EHA**	.1	.2	.1	.13
S	.8	.6	.6	.67	**EKA**	.1	.1	.2	.13
E	.4	.2	.3	.3	**WHK**	.3	.8	.4	.5
W	.8	1	.7	.83	**WHA**	.1	.5	.4	.33
H	.4	.4	.3	.37	**WKA**	.3	.3	.5	.37
K	.8	.7	.6	.7	**HKA**	.3	.2	.4	.3
A	.4	.7	.5	.53	**SEWH**	.1	.3	.4	.27
SE	.4	.5	.2	.37	**SEWK**	.5	.4	.6	.5
SW	.8	.8	.6	.73	**SEWA**	.3	.7	.5	.5
SH	.5	.6	.6	.57	**SEHK**	.4	.1	.4	.3
SK	.8	.8	.8	.8	**SEHA**	.2	.4	.4	.33
SA	.8	.7	.8	.77	**SEKA**	.2	.1	.6	.3
EW	.7	.5	.6	.6	**SWHK**	.7	.8	1	.83
EH	.6	.4	.2	.4	**SWHA**	.2	.7	.5	.47
EK	.9	.4	.6	.63	**SWKA**	.4	.4	.8	.53
EA	.4	.1	.3	.27	**SHKA**	.4	.4	.4	.4
WH	.6	.3	.4	.43	**EWHK**	.4	.3	.4	.37
WK	.6	.5	.9	.67	**EWHA**	.2	.4	.4	.33
WA	.6	.6	.5	.57	**EWKA**	.4	.1	.3	.27
HK	.5	.7	.6	.6	**EHKA**	0	0	.1	.03
HA	.4	.1	.3	.27	**WHKA**	.2	.4	.8	.47
KA	.3	.5	.9	.57	**SEWHK**	.4	.3	.4	.37
SEW	.8	.5	.1	.47	**SEWHA**	0	.4	0	.13
SEH	.2	.4	.3	.3	**SEWKA**	.2	.4	.5	.37
SEK	.6	.3	.5	.47	**SEHKA**	.3	.2	.2	.23
SEA	.6	.2	.4	.4	**SWHKA**	0	.3	.3	.2
SWH	.7	.8	.9	.8	**EWHKA**	.6	.6	.2	.47
SWK	.7	.7	.8	.73	**SEWHKA**	.6	.5	.7	.6

Note: Male response rate for participant five. Response rate for each stimulus represents that observer's average response to that stimulus in each of the three sessions. Participant's mean male response to each stimulus across all three sessions included under Mean.

Table 20

Mean Male Response Per Session for Participant Six

	Session					Session			
Stimuli	**1**	**2**	**3**	**Mean**	**Stimuli**	**1**	**2**	**3**	**Mean**
-3	.1	0	.1	.07	**SWA**	.7	.4	0	.37
-2.25	.1	.3	.2	.2	**SHK**	.3	.7	.6	.53
-1.5	.3	.3	.7	.43	**SHA**	.1	.5	.1	.23
-0.75	.1	.7	.5	.43	**SKA**	.6	.5	.2	.43
0	.9	.9	.7	.83	**EWH**	.3	.2	.6	.37
0.75	.8	.9	1	.9	**EWK**	.6	.9	.8	.77
1.5	.8	1	1	.93	**EWA**	.7	.4	.2	.43
2.25	1	1	1	1	**EHK**	.5	.4	.9	.6
3	1	1	1	1	**EHA**	.1	.3	.1	.17
S	.8	.8	.9	.83	**EKA**	.3	.4	.2	.3
E	.6	.8	1	.8	**WHK**	.6	.6	.8	.67
W	.8	.6	1	.8	**WHA**	.3	0	0	.1
H	.5	.5	.3	.43	**WKA**	.4	.4	.3	.37
K	.6	.9	.8	.77	**HKA**	.3	.5	.1	.3
A	.3	.8	.1	.4	**SEWH**	.5	.2	.6	.43
SE	.5	.8	1	.77	**SEWK**	.4	.8	.8	.67
SW	.7	1	.9	.87	**SEWA**	.5	0	.2	.23
SH	.4	.6	.6	.53	**SEHK**	.4	.5	.4	.43
SK	.9	.7	.9	.83	**SEHA**	.2	0	0	.07
SA	.4	.6	.1	.37	**SEKA**	.5	.3	.2	.33
EW	.4	.8	.9	.7	**SWHK**	.5	1	.7	.73
EH	.4	.7	.4	.5	**SWHA**	.4	.2	.2	.27
EK	.5	.9	1	.8	**SWKA**	.5	.5	.2	.4
EA	.5	.3	.2	.33	**SHKA**	.5	.3	.4	.4
WH	.3	.5	.8	.53	**EWHK**	.5	.8	1	.77
WK	.8	.9	.9	.87	**EWHA**	0	.2	0	.07
WA	.7	.2	.2	.37	**EWKA**	.6	.5	.2	.43
HK	.7	.8	.6	.7	**EHKA**	.2	.2	0	.13
HA	.6	.2	.1	.3	**WHKA**	.2	.4	0	.2
KA	.4	.4	.3	.37	**SEWHK**	.4	.4	.7	.5
SEW	.4	.8	1	.73	**SEWHA**	.2	.4	.1	.23
SEH	.3	.3	.4	.33	**SEWKA**	.3	.4	0	.23
SEK	.8	.9	.9	.87	**SEHKA**	.3	.1	.3	.23
SEA	.4	.4	0	.27	**SWHKA**	.4	.1	.2	.23
SWH	.4	.4	.8	.53	**EWHKA**	.3	.3	.2	.27
SWK	.8	.7	.7	.73	**SEWHKA**	.6	.4	.3	.43

Note: Male response rate for participant six. Response rate for each stimulus represents that observer's average response to that stimulus in each of the three sessions. Participant's mean male response to each stimulus across all three sessions included under Mean.

Table 21

Mean Male Response Per Session for Participant Seven

	Session					Session			
Stimuli	**1**	**2**	**3**	**Mean**	**Stimuli**	**1**	**2**	**3**	**Mean**
-3	.2	.1	.1	.13	**SWA**	.9	1	1	.97
-2.25	.2	.4	.5	.37	**SHK**	1	1	1	1
-1.5	.5	.7	.5	.57	**SHA**	.7	1	.8	.83
-0.75	.8	.9	1	.9	**SKA**	.9	1	1	.97
0	.7	1	1	.9	**EWH**	.8	.8	.8	.8
0.75	.9	1	1	.97	**EWK**	.8	.7	.7	.73
1.5	1	1	1	1	**EWA**	.4	.5	.4	.43
2.25	1	1	1	1	**EHK**	.7	1	.9	.87
3	.9	1	1	.97	**EHA**	.7	.8	.6	.7
S	.9	1	.9	.93	**EKA**	.7	.6	.5	.6
E	.6	.6	.8	.67	**WHK**	1	1	1	1
W	.6	1	1	.87	**WHA**	.7	.8	.8	.77
H	.9	.8	1	.9	**WKA**	.8	1	1	.93
K	1	1	1	1	**HKA**	.7	.9	1	.87
A	.8	1	1	.93	**SEWH**	.8	.8	.6	.73
SE	.7	.9	.9	.83	**SEWK**	.9	.8	.7	.8
SW	.9	.9	1	.93	**SEWA**	.5	.4	.7	.53
SH	1	1	1	1	**SEHK**	1	.9	.9	.93
SK	.9	1	1	.97	**SEHA**	.6	.6	.2	.47
SA	.8	.9	1	.9	**SEKA**	.5	.7	.7	.63
EW	.8	1	.7	.83	**SWHK**	.9	1	1	.97
EH	.7	.3	.6	.53	**SWHA**	.7	.9	.8	.8
EK	.6	.8	.7	.7	**SWKA**	.7	1	1	.9
EA	.5	.7	.3	.5	**SHKA**	1	.8	.9	.9
WH	1	.8	1	.93	**EWHK**	.9	.9	.7	.83
WK	.8	1	1	.93	**EWHA**	.8	.4	.5	.57
WA	.8	.9	.9	.87	**EWKA**	.6	.8	.5	.63
HK	1	.9	.9	.93	**EHKA**	.7	.6	.7	.67
HA	1	.7	.9	.87	**WHKA**	.4	.9	.9	.73
KA	.8	.9	1	.9	**SEWHK**	.9	.8	.8	.83
SEW	.9	.6	.9	.8	**SEWHA**	.6	.6	.2	.47
SEH	.8	.7	.9	.8	**SEWKA**	.5	.8	.6	.63
SEK	.8	1	1	.93	**SEHKA**	.9	.3	.5	.57
SEA	.2	.2	.4	.27	**SWHKA**	.5	.6	.6	.57
SWH	1	1	.9	.97	**EWHKA**	.5	.4	.5	.47
SWK	1	1	1	1	**SEWHKA**	.9	.9	.8	.87

Note: Male response rate for participant seven. Response rate for each stimulus represents that observer's average response to that stimulus in each of the three sessions. Participant's mean male response to each stimulus across all three sessions included under Mean.

Table 22

Mean Male Response Per Session for Participant Eight

	Session					Session			
Stimuli	**1**	**2**	**3**	**Mean**	**Stimuli**	**1**	**2**	**3**	**Mean**
-3	.4	.6	.1	.37	**SWA**	.3	.6	.7	.53
-2.25	.3	.4	0	.23	**SHK**	.5	.5	.8	.6
-1.5	.5	.5	.1	.37	**SHA**	.4	.9	1	.77
-0.75	.4	.5	1	.63	**SKA**	.4	.6	.6	.53
0	.4	.2	.9	.5	**EWH**	.5	.9	.5	.63
0.75	.2	.1	1	.43	**EWK**	.1	.7	.7	.5
1.5	.4	.3	1	.57	**EWA**	.4	.5	.7	.53
2.25	.4	.2	1	.53	**EHK**	.3	.7	.5	.5
3	.4	.4	.9	.57	**EHA**	.8	.6	.4	.6
S	.6	.4	.8	.6	**EKA**	.1	.4	.2	.23
E	.4	.3	1	.57	**WHK**	.7	.5	.6	.6
W	.5	.1	.8	.47	**WHA**	.5	.4	.5	.47
H	.5	.6	.9	.67	**WKA**	.4	.4	.1	.3
K	.3	.5	1	.6	**HKA**	.5	.7	0	.4
A	.4	.4	1	.6	**SEWH**	.5	.7	.1	.43
SE	.2	.4	1	.53	**SEWK**	.4	.6	.4	.47
SW	.6	.3	.7	.53	**SEWA**	.3	.7	.8	.6
SH	.6	.8	.4	.6	**SEHK**	.4	.8	.7	.63
SK	.2	.6	.7	.5	**SEHA**	.7	.6	.6	.63
SA	.2	.5	.6	.43	**SEKA**	.3	.3	.6	.4
EW	.1	.5	1	.53	**SWHK**	.7	1	.6	.77
EH	.7	.5	1	.73	**SWHA**	.7	.6	.7	.67
EK	.2	0	.9	.37	**SWKA**	.5	.5	.9	.63
EA	.4	.5	.3	.4	**SHKA**	.4	.4	1	.6
WH	.6	.5	.8	.63	**EWHK**	.9	.6	.7	.73
WK	.3	.5	1	.6	**EWHA**	.8	.7	.9	.8
WA	.6	.4	.9	.63	**EWKA**	.2	.4	.7	.43
HK	.8	.9	.8	.83	**EHKA**	.6	.8	.7	.7
HA	.8	.7	1	.83	**WHKA**	.3	.7	.8	.6
KA	.4	.5	1	.63	**SEWHK**	.5	.7	.8	.67
SEW	.4	.6	1	.67	**SEWHA**	.8	.8	0	.53
SEH	.7	.9	1	.87	**SEWKA**	.7	.8	.7	.73
SEK	.4	.5	.9	.6	**SEHKA**	.2	.7	.9	.6
SEA	.5	.5	.8	.6	**SWHKA**	.5	.8	.1	.47
SWH	.5	1	.9	.8	**EWHKA**	.4	.3	.5	.4
SWK	.3	.7	.6	.53	**SEWHKA**	.9	.9	.6	.8

Note: Male response rate for participant eight. Response rate for each stimulus represents that observer's average response to that stimulus in each of the three sessions. Participant's mean male response to each stimulus across all three sessions included under Mean.

Table 23

Predicted and Actual Mean Male Response in Additive Model

Condition		Predicted	Actual	Chi-Square	Condition		Predicted	Actual	Chi-Square
1 set	S	70	70.00	0.00	4 sets	SEWH	50.83	47.92	0.17
	E	54.17	54.17	0.00		SEWK	66.25	59.17	0.76
	W	69.58	69.58	0.00		SEWA	41.25	33.33	1.52
	H	55.83	55.83	0.00		SEHK	52.50	55.00	0.12
	K	71.25	71.25	0.00		SEHA	27.50	28.33	0.03
	A	46.25	46.25	0.00		SEKA	42.92	35.83	1.17
2 sets	SE	57.92	57.08	0.01		SWHK	67.92	71.67	0.21
	SW	73.33	70.00	0.15		SWHA	42.92	40.83	0.10
	SH	59.58	60.42	0.01		SWKA	58.33	50.00	1.19
	SK	75.00	70.42	0.28		SHKA	44.58	42.92	0.06
	SA	50.00	47.50	0.12		EWHK	52.08	58.33	0.75
	EW	57.50	61.25	0.24		EWHA	27.08	31.67	0.78
	EH	43.75	51.25	1.29		EWKA	42.50	34.17	1.63
	EK	59.17	58.33	0.01		EHKA	28.75	30.42	0.10
	EA	34.17	29.58	0.61	5 sets	WHKA	44.17	38.75	0.66
	WH	59.17	61.67	0.11		SEWHK	55.83	55.00	0.01
	WK	74.58	72.50	0.06		SEWHA	30.83	31.67	0.02
	WA	49.58	45.00	0.42		SEWKA	46.25	35.00	2.74
	HK	60.83	70.83	1.64		SEHKA	32.50	30.83	0.09
	HA	35.83	43.75	1.75		SWHKA	47.92	30.83	6.09
	KA	51.25	45.42	0.66		EWHKA	32.08	31.67	0.01
3 sets	SEW	61.25	58.75	0.10	6sets	SEWHKA	35.83	48.75	4.66
	SEH	47.50	55.42	1.32					
	SEK	62.92	64.17	0.02					
	SEA	37.92	30.42	1.48					
	SWH	62.92	69.58	0.71					
	SWK	78.33	73.75	0.27					
	SWA	53.33	42.50	2.20					
	SHK	64.58	65.00	0.00					
	SHA	39.58	41.67	0.11					
	SKA	55.00	48.75	0.71					
	EWH	47.08	47.92	0.01					
	EWK	62.50	56.25	0.63					
	EWA	37.50	34.58	0.23					
	EHK	48.75	57.08	1.42					
	EHA	23.75	32.08	2.92					
	EKA	39.17	27.08	3.73					
	WHK	64.17	65.42	0.02					
	WHA	39.17	31.67	1.44					
	WKA	54.58	42.92	2.49					
	HKA	40.83	38.75	0.11					

Note: Chi-squared results calculated using the observed values and values predicted by the additive model. Set with one change was compared against itself, based on how the model was developed. Total $\chi^2(56)= 50.16$; χ^2 critical value = 74.468

Table 24

Constants, Slopes, and Weights for Factors Included in Unweighted Model

Factor	Constant	Slope	Weight
Shoulder Distance	-49.7817	0.137106	1
Hip Distance	12.83271	-0.06435	1
Elbow Distance	-26.075	0.060573	1
Knee Distance	-7.90823	0.057434	1
Wrist Distance	-165.098	0.326941	1
Ankle Distance	-9.48227	0.073922	1
Shoulder-to-Hip Ratio	-9.22513	5.032292	0
Left Arm Angle	26.32855	-0.14394	0
Right Arm Angle	29.55916	-0.16028	0

Note: Constants and slopes calculated from logistic regression for each of the factors included in the model.

Table 25

Predicted and Actual Mean Male Response in Unweighted Model

Condition		Predicted	Actual	Chi-Square
Neutral	-3	22.52	20.42	0.20
	-2.25	31.49	28.75	0.24
	-1.5	42.28	45.42	0.23
	-0.75	54.03	55.42	0.04
	0	65.50	66.25	0.01
	0.75	75.51	77.50	0.05
	1.5	83.43	84.17	0.01
	2.25	89.20	88.33	0.01
	3	93.15	90.83	0.06
1 set	S	70.07	70.00	0.00
	E	58.29	54.17	0.29
	W	70.14	69.58	0.00
	H	58.18	55.83	0.09
	K	70.20	71.25	0.02
	A	59.91	46.25	3.12
2 sets	SE	62.86	57.08	0.53
	SW	74.72	70.00	0.30
	SH	62.76	60.42	0.09
	SK	74.78	70.42	0.25
	SA	64.49	47.50	4.47
	EW	62.94	61.25	0.05
	EH	50.98	51.25	0.00
	EK	63.00	58.33	0.35
	EA	52.71	29.58	10.15
	WH	62.83	61.67	0.02
	WK	74.85	72.50	0.07
	WA	64.56	45.00	5.93
	HK	62.89	70.83	1.00
	HA	52.60	43.75	1.49
	KA	64.62	45.42	5.71
3 sets	SEW	67.51	58.75	1.14
	SEH	55.55	55.42	0.00
	SEK	67.57	64.17	0.17
	SEA	57.28	30.42	12.60
	SWH	67.40	69.58	0.07
	SWK	79.42	73.75	0.41
	SWA	69.13	42.50	10.26
	SHK	67.46	65.00	0.09
	SHA	57.17	41.67	4.21
	SKA	69.19	48.75	6.04
	EWH	55.63	47.92	1.07
	EWK	67.64	56.25	1.92
	EWA	57.35	34.58	9.04
	EHK	55.68	57.08	0.04
	EHA	45.40	32.08	3.90
	EKA	57.41	27.08	16.02
	WHK	67.54	65.42	0.07
	WHA	57.25	31.67	11.43
	WKA	69.27	42.92	10.02
	HKA	57.31	38.75	6.01
4 sets	SEWH	60.20	47.92	2.51
	SEWK	72.22	59.17	2.36
	SEWA	61.93	33.33	13.20
	SEHK	60.26	55.00	0.46
	SEHA	49.97	28.33	9.37
	SEKA	61.99	35.83	11.03
	SWHK	72.11	71.67	0.00
	SWHA	61.82	40.83	7.13
	SWKA	73.84	50.00	7.70
	SHKA	61.88	42.92	5.81
	EWHK	60.33	58.33	0.07
	EWHA	50.04	31.67	6.75
	EWKA	62.06	34.17	12.54
	EHKA	50.10	30.42	7.73
5 sets	WHKA	61.95	38.75	8.69
	SEWHK	64.90	55.00	1.51
	SEWHA	54.62	31.67	9.64
	SEWKA	66.63	35.00	15.02
	SEHKA	54.67	30.83	10.40
	SWHKA	66.53	30.83	19.15
	EWHKA	54.75	31.67	9.73
All sets	SEWHKA	59.32	48.75	1.88

Note: Chi-squared results calculated using the observed values and values predicted by the unweighted model. Total $\chi^2(62)= 291.1$; χ^2 critical value = 81.381

Table 26

Constants, Slopes, and Weights for Factors Included in Weighted Model

Factor	Constant	Slope	Weight
Shoulder Distance	-49.7817	0.137106	0.5
Hip Distance	12.83271	-0.06435	0.6
Elbow Distance	-26.075	0.060573	1.8
Knee Distance	-7.90823	0.057434	0.1
Wrist Distance	-165.098	0.326941	0
Ankle Distance	-9.48227	0.073922	6.7
Shoulder-to-Hip Ratio	-9.22513	5.032292	0
Left Arm Angle	26.32855	-0.14394	0
Right Arm Angle	29.55916	-0.16028	0

Note: Constants and slopes calculated from logistic regression for each of the factors included in the model.

Table 27

Predicted and Actual Mean Male Response in Weighted Model

Condition		Predicted	Actual	Chi-Square	Condition		Predicted	Actual	Chi-Square
Neutral	-3	22.55	20.42	0.20	3 sets	SEW	58.88	58.75	0.00
	-2.25	31.49	28.75	0.24		SEH	56.16	55.42	0.01
	-1.5	42.26	45.42	0.24		SEK	59.17	64.17	0.42
	-0.75	54.01	55.42	0.04		SEA	35.74	30.42	0.79
	0	65.48	66.25	0.01		SWH	64.18	69.58	0.45
	0.75	75.51	77.50	0.05		SWK	67.19	73.75	0.64
	1.5	83.43	84.17	0.01		SWA	43.76	42.50	0.04
	2.25	89.21	88.33	0.01		SHK	64.47	65.00	0.00
	3	93.16	90.83	0.06		SHA	41.04	41.67	0.01
1 set	S	66.90	70.00	0.14		SKA	44.05	48.75	0.50
	E	57.46	54.17	0.19		EWH	54.75	47.92	0.85
	W	65.48	69.58	0.26		EWK	57.75	56.25	0.04
	H	62.77	55.83	0.77		EWA	34.32	34.58	0.00
	K	65.77	71.25	0.46		EHK	55.04	57.08	0.08
	A	42.34	46.25	0.36		EHA	31.61	32.08	0.01
2 sets	SE	58.88	57.08	0.05		EKA	34.61	27.08	1.64
	SW	66.90	70.00	0.14		WHK	63.06	65.42	0.09
	SH	64.18	60.42	0.22		WHA	39.63	31.67	1.60
	SK	67.19	70.42	0.16		WKA	42.63	42.92	0.00
	SA	43.76	47.50	0.32		HKA	39.92	38.75	0.03
	EW	57.46	61.25	0.25	4 sets	SEWH	56.16	47.92	1.21
	EH	54.75	51.25	0.22		SEWK	59.17	59.17	0.00
	EK	57.75	58.33	0.01		SEWA	35.74	33.33	0.16
	EA	34.32	29.58	0.65		SEHK	56.45	55.00	0.04
	WH	62.77	61.67	0.02		SEHA	33.02	28.33	0.67
	WK	65.77	72.50	0.69		SEKA	36.03	35.83	0.00
	WA	42.34	45.00	0.17		SWHK	64.47	71.67	0.80
	HK	63.06	70.83	0.96		SWHA	41.04	40.83	0.00
	HA	39.63	43.75	0.43		SWKA	44.05	50.00	0.80
	KA	42.63	45.42	0.18		SHKA	41.34	42.92	0.06
						EWHK	55.04	58.33	0.20
						EWHA	31.61	31.67	0.00
						EWKA	34.61	34.17	0.01
						EHKA	31.90	30.42	0.07
					5 sets	WHKA	39.92	38.75	0.03
						SEWHK	56.45	55.00	0.04
						SEWHA	33.02	31.67	0.06
						SEWKA	36.03	35.00	0.03
						SEHKA	33.31	30.83	0.18
						SWHKA	41.34	30.83	2.67
						EWHKA	31.90	31.67	0.00
					All sets	SEWHKA	33.31	48.75	7.15

Note: Chi-squared results calculated using the observed values and values predicted by the weighted model. Total $\chi^2(62)= 28.03$; χ^2 critical value = 81.381.

Table 28

Constants, Slopes, and Weights for Factors Included in Weighted Model with Second-Order Factors

Factor	Constant	Slope	Weight
Shoulder Distance	-49.7817	0.137106	0
Hip Distance	12.83271	-0.06435	-0.2
Elbow Distance	-26.075	0.060573	2.1
Knee Distance	-7.90823	0.057434	0.16
Wrist Distance	-165.098	0.326941	0.1
Ankle Distance	-9.48227	0.073922	6.1
Shoulder-to-Hip Ratio	-9.22513	5.032292	0.98
Left Arm Angle	26.32855	-0.14394	0
Right Arm Angle	29.55916	-0.16028	0.1

Note: Constants and slopes calculated from logistic regression for each of the factors included in the model.

Table 29

Predicted and Actual Mean Male Response in Weighted Model with Second-Order Factors

Condition		Predicted	Actual	Chi-Square	Condition		Predicted	Actual	Chi-Square
Neutral	-3	21.42	20.42	0.05	3 sets	SEW	58.84	58.75	0.00
	-2.25	30.74	28.75	0.13		SEH	55.67	55.42	0.00
	-1.5	42.05	45.42	0.27		SEK	58.91	64.17	0.47
	-0.75	54.49	55.42	0.02		SEA	34.68	30.42	0.53
	0	67.19	66.25	0.01		SWH	65.45	69.58	0.26
	0.75	74.62	77.50	0.11		SWK	68.70	73.75	0.37
	1.5	83.24	84.17	0.01		SWA	44.47	42.50	0.09
	2.25	89.53	88.33	0.02		SHK	65.61	65.00	0.01
	3	93.80	90.83	0.09		SHA	41.38	41.67	0.00
1 set	S	67.81	70.00	0.07		SKA	44.63	48.75	0.38
	E	57.15	54.17	0.16		EWH	54.97	47.92	0.91
	W	67.09	69.58	0.09		EWK	58.13	56.25	0.06
	H	64.56	55.83	1.18		EWA	33.90	34.58	0.01
	K	67.72	71.25	0.18		EHK	55.04	57.08	0.08
	A	43.49	46.25	0.18		EHA	30.81	32.08	0.05
2 sets	SE	58.39	57.08	0.03		EKA	33.96	27.08	1.39
	SW	68.18	70.00	0.05		WHK	64.98	65.42	0.00
	SH	65.09	60.42	0.33		WHA	40.75	31.67	2.02
	SK	68.33	70.42	0.06		WKA	43.90	42.92	0.02
	SA	44.10	47.50	0.26		HKA	41.38	38.75	0.17
	EW	57.60	61.25	0.23	4 sets	SEWH	56.12	47.92	1.20
	EH	54.52	51.25	0.20		SEWK	59.37	59.17	0.00
	EK	57.67	58.33	0.01		SEWA	35.14	33.33	0.09
	EA	33.44	29.58	0.44		SEHK	56.19	55.00	0.03
	WH	64.46	61.67	0.12		SEHA	31.96	28.33	0.41
	WK	67.61	72.50	0.35		SEKA	35.21	35.83	0.01
	WA	43.38	45.00	0.06		SWHK	65.98	71.67	0.49
	HK	65.09	70.83	0.51		SWHA	41.75	40.83	0.02
	HA	40.86	43.75	0.21		SWKA	44.99	50.00	0.56
	KA	44.01	45.42	0.04		SHKA	41.90	42.92	0.02
						EWHK	55.50	58.33	0.14
						EWHA	31.27	31.67	0.01
						EWKA	34.42	34.17	0.00
						EHKA	31.33	30.42	0.03
					5 sets	WHKA	41.27	38.75	0.15
						SEWHK	56.65	55.00	0.05
						SEWHA	32.42	31.67	0.02
						SEWKA	35.66	35.00	0.01
						SEHKA	32.49	30.83	0.08
						SWHKA	42.27	30.83	3.10
						EWHKA	31.79	31.67	0.00
					All sets	SEWHKA	32.94	48.75	7.59

Note: Chi-squared results calculated using the observed values and values predicted by the weighted model with second order factors. Total $\chi^2(62)= 25.60$; χ^2 critical value = 81.381.

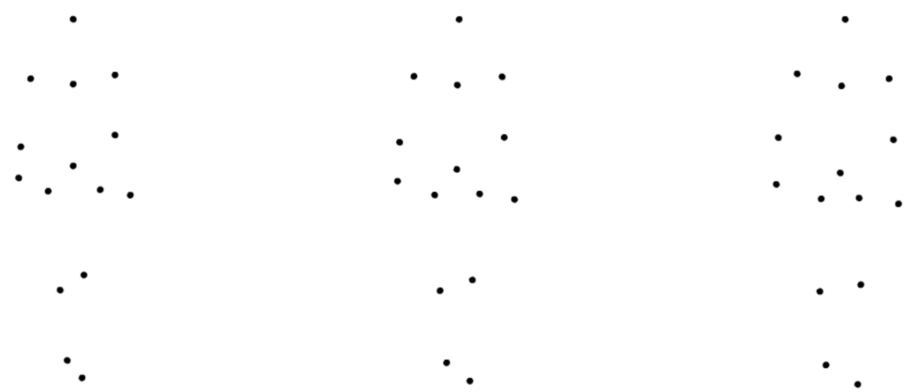

Figure 1. Examples of sex variation in point-light walkers. From left to right are female (-3 standard deviations for sex), neutral (0 standard deviations for sex), and male (+3 standard deviations for sex).

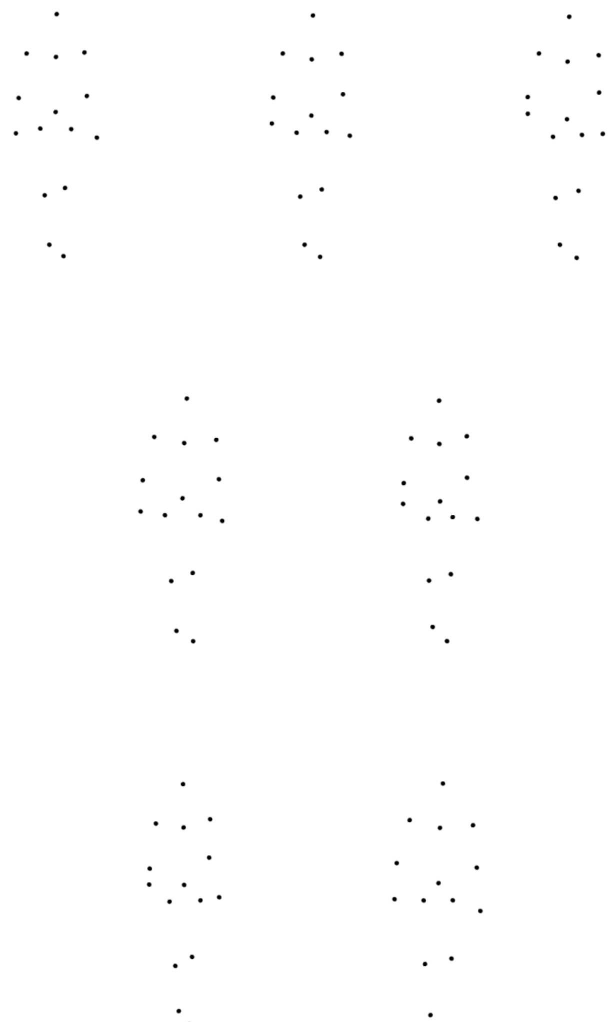

Figure 2. Examples of form and motion varying conditions applied to point-light walkers. Top row: sad, neutral, and happy. Middle row: calm and nervous. Bottom row: light and heavy. See Figure 1 to compare form and motion affecting conditions to effect of sex condition.

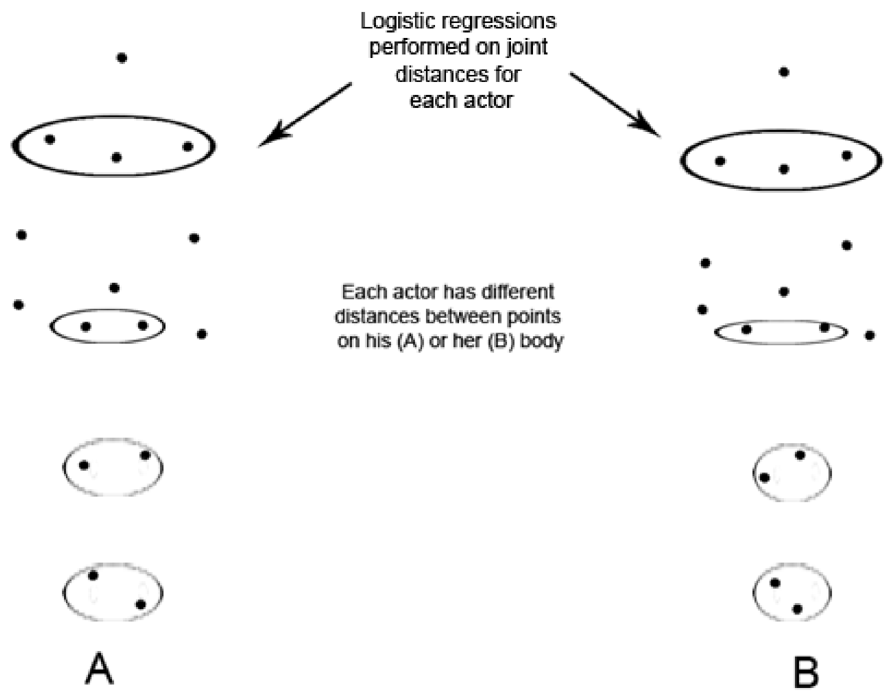

Figure 3. Examples of differences in joint distance on point-light walkers. Logistic regressions were performed on each set of paired joints for each actor. Note that the distance between these points is different for A) very male (+3 standard deviation for sex) and B) very female (-3 standard deviations for sex) actors.

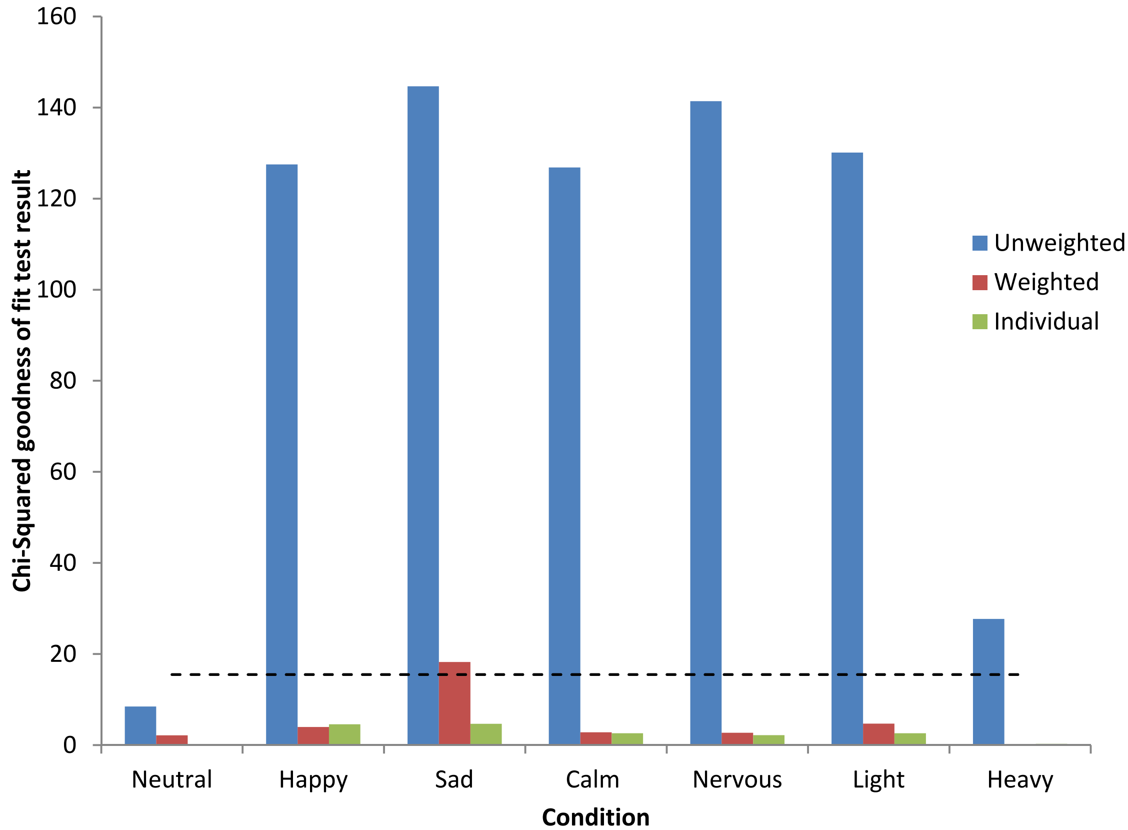

Figure 4. Chi-squared goodness of fit test comparisons for pilot study models. Smaller values represent a better fit. Dotted line represents the critical value for that model. For the neutral and heavy conditions, some models produced fits small enough to not be visible on the graph.

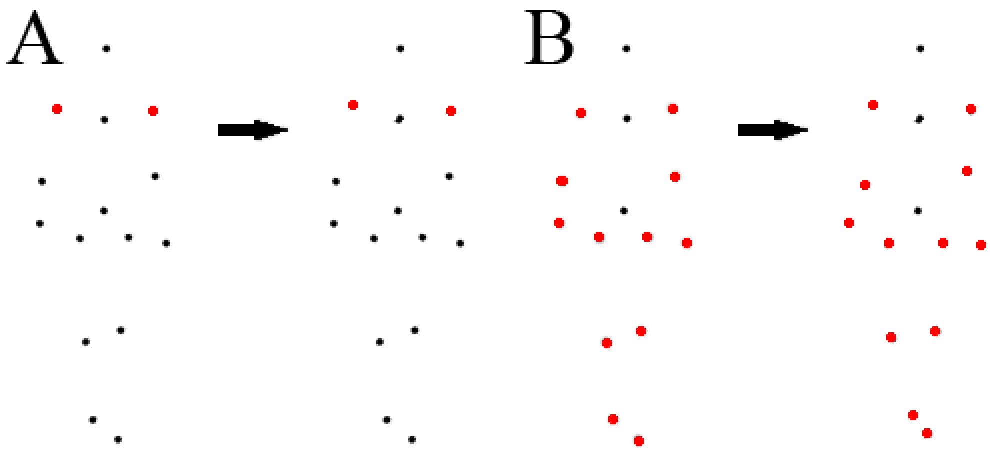

Figure 5. Examples of one-joint and six joint changes. Actors used in this study had the distance between key joints changed to match either an extremely male or extremely female actor. Examples of A) One change (shoulders to extreme male) and B) all six joints changed.

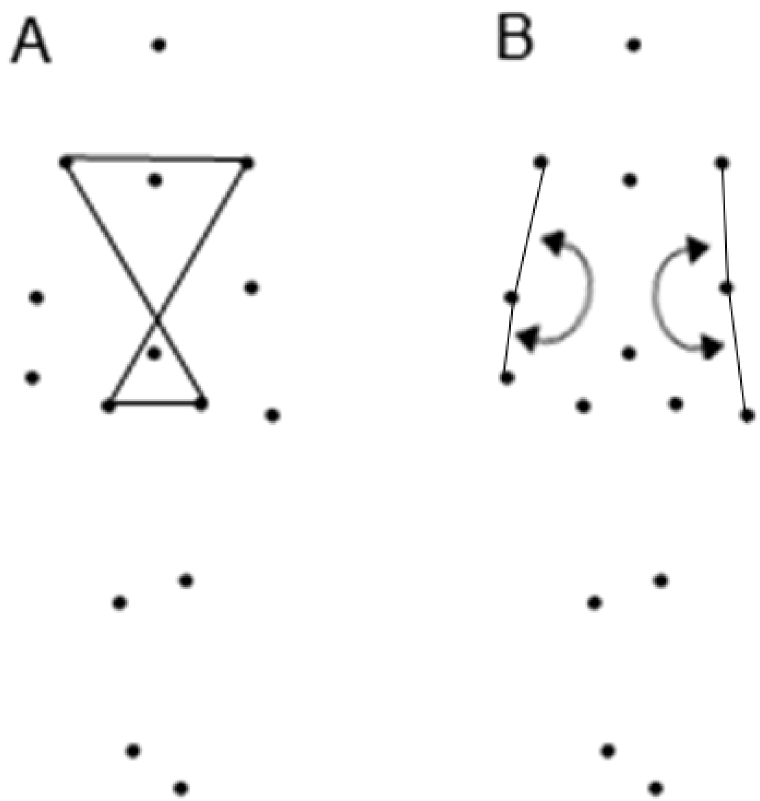

Figure 6. Visualization of shoulder-to-hip ratio and inner-arm angle. Second order factors were included in the second weighted model of the thesis study. Examples of A) shoulder-to-hip ratio (represented by the horizontal lines; junction of oblique lines designates the center of moment), and B) left and right arm inner-angle are represented above. Lines on B were not present on the actual stimuli and were added to better illustrate the arms.

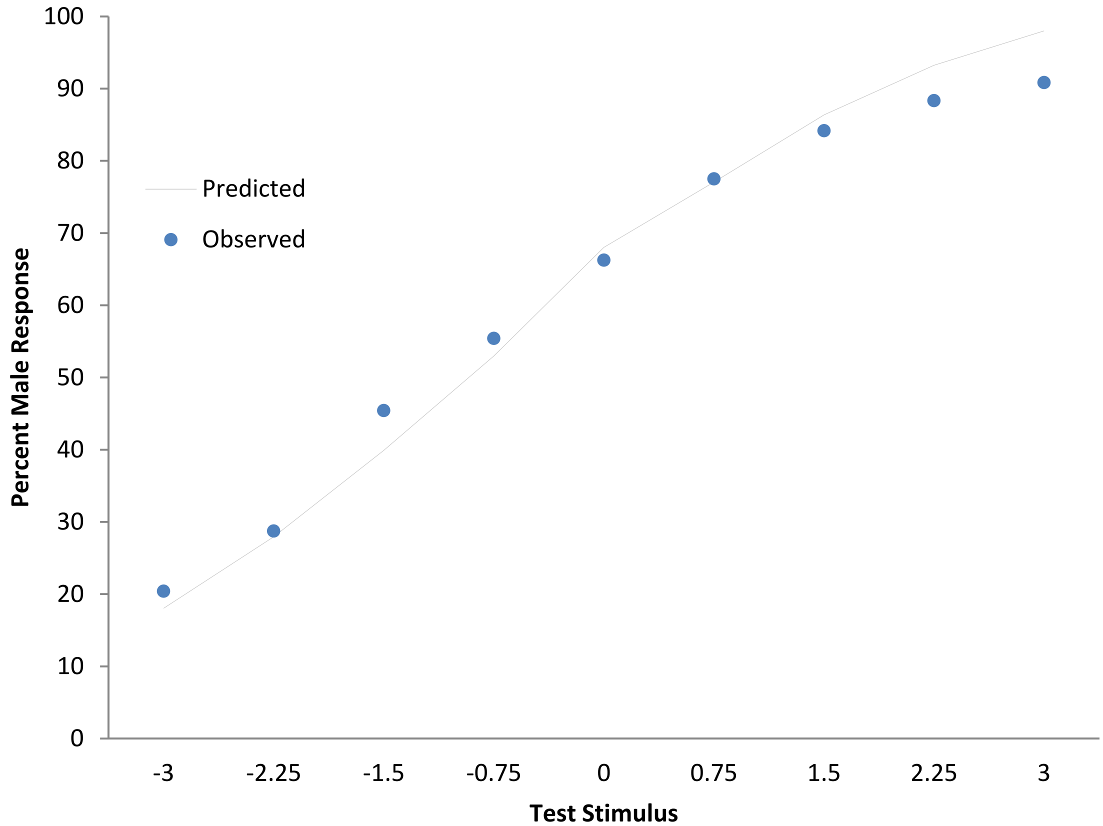

Figure 7. Observed and predicted mean male responses to the computer-generated stimuli in the thesis study. Predicted values based off of weighted model with second-order factors. Stimuli ranged from extremely female (-3 standard deviations) to extremely male (+3 standard deviations).

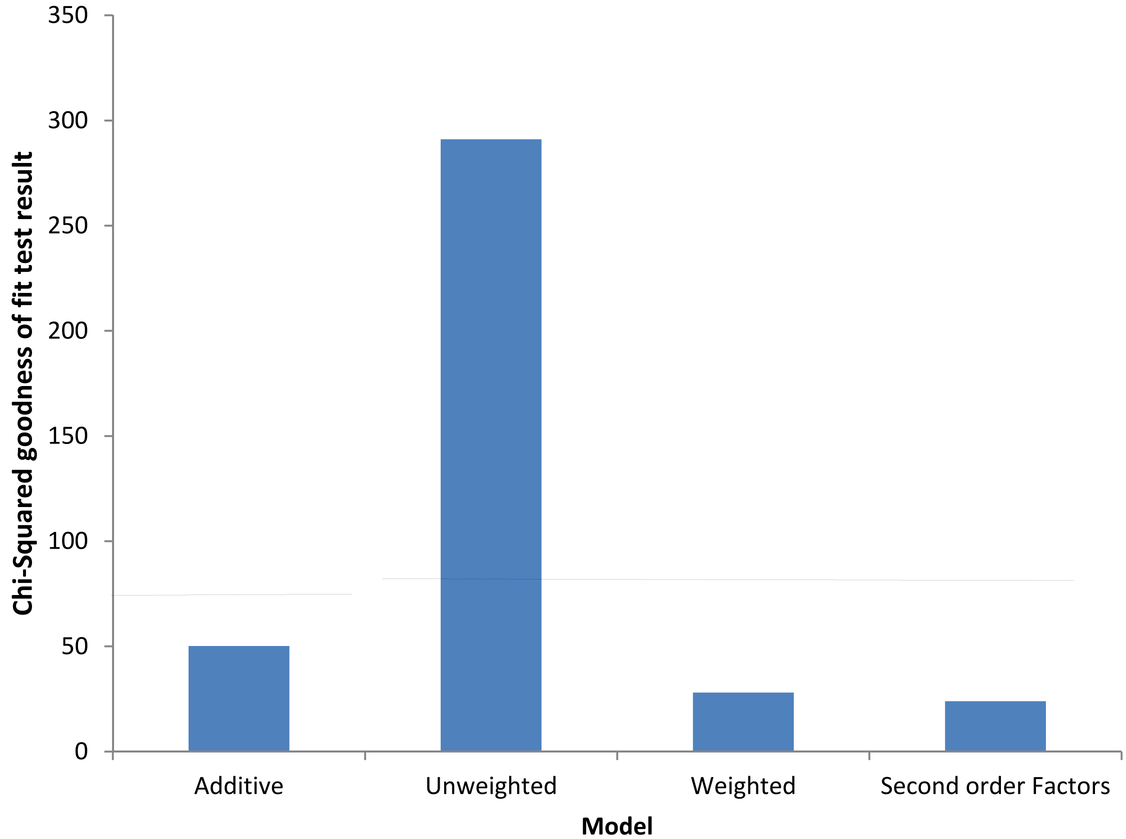

Figure 8. Chi-squared goodness of fit test comparisons for thesis study models. Smaller values represent a better fit. Dotted line represents the critical value for that model.