CHAPTER 15

Social Constraints on the Visual Perception of Biological Motion

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The importance of the human face as a cue for person construal has been well established by decades of research. Its privileged status, however, has been rivaled by a growing literature that identifies the dynamic human body as a potent cue to meaningful social information. In fact, some (here and elsewhere) have even argued that under some circumstances, perception of the body may be the primary means of social perception (see de Gelder this volume and 2005). The body, for example, can be perceived at a physical distance or a visual vantage point that precludes face perception. Moreover, the body is unique in its ability not only to convey an emotional state elicited by a certain circumstance, but also to suggest an appropriate behavioral response to a given context. For these reasons among others, an emerging consensus is developing carving a special role for body perception as a vehicle to social perception.

Studies investigating the perception of the body in motion were once the exclusive domain of vision scholars (for a review of this history, see Shiffrar, Chapter 14, this volume). These researchers sought to understand either the physical parameters that enabled observers to distinguish between biological and nonbiological motion or the cues that led observers to accurately categorize biological motion displays according to social categories, personal identities, and psychological states (e.g., emotional state). Although such questions necessarily involved social judgments, the vast majority of

this work treated such social categorizations as perceptual endpoints, not as a part of social perception more generally.

In a largely independent field of research, social psychologists were at the same time appreciating the profound consequences of perceiving the social categories that vision scholars had long sought to understand. These social researchers examined the effects of social categorization on interpersonal processes including stereotyping, evaluation, and person construal more generally. By and large, these scholars treated social categorization as a given, and used category knowledge as a beginning point to understand its effect on other aspects of person perception, with little concern for how the categorization emerged in the first place. Thus, social psychologists and vision scholars used categorization quite differently in their pursuit to understand social perception.

This chapter aims to shed light on how the once-clear distinctions between the visual and social approaches to social categorization of the human body have begun to blur. First, we will review findings from classic studies of biological motion perception that bear directly on domains that social psychologists care deeply about—the perception of social categories, identities, and psychological states. Then we describe two ways in which these basic patterns are constrained by social psychological processes. First, we review evidence that social categorization shapes the interpretation of low-level aspects of visual perception.

Other researchers quickly sought to determine which categories of information could be perceived from biological motion displays. These next steps examined whether and how identity-relevant information could be conveyed by body motion. This shift in focus from distinguishing between human and nonhuman to a focus on the perception of social identities
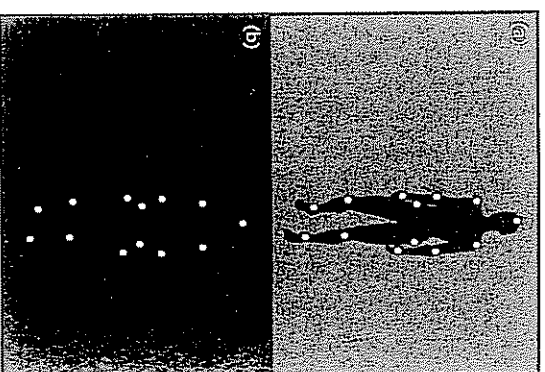
and evaluation of dynamic body motion for evaluative social judgments. Then, we present data that highlight how knowledge structures (i.e., stereotypes) can bias one's basic perception of the human body in motion.

SOMETHING (IN THE WAY SHE MOVES)

The scientific study of biological motion perception grew to its current level within the vision sciences with the development of an elegant technique to isolate body motion in visual displays. Borrowing from early observations of filmed motion (e.g., Marcy 1884), Johansson (1973) created what came to be known as point-light or biological-motion displays. These quickly became a mainstay of modern biological-motion-perception research. In its most primitive form, illuminated bulbs (or reflective markers) were affixed to the body's major joints, and the person was filmed engaging in a variety of activities. When replayed, the resulting film depicted the action as a coordinated set of lights against a dark background (see Figure 15.1). In spite of their impoverished nature, early reports suggested that point-light displays compelled reliable perceptions among observers. In fact, observers readily reported the clips to depict human motion and also accurately identified the depicted activities (Johansson, 1973; 1975). Thus, Johansson's work could be characterized as one of the first empirical demonstrations of observers' remarkable ability to recover the human form from motion cues alone. Building on this basic foundation, a considerable amount of research has sought to understand the perceptual mechanisms that enable observers to discriminate human from nonhuman motion, and much of that work focused on understanding low-level aspects of visual perception.

paved the way for a yoking between vision and social processes, in part because vision scholars were asking observers to make judgments that carry interpersonal consequences.

Three domains of percepts that are supported by biological motion, for example, have a long-standing tradition of research in social psychology. These include social categorization, the identification of others (i.e., personal identities), and the appreciation of another's psychological state. For each domain, we describe their theoretical and interpersonal significance from a social perspective and briefly review evidence that biological motion is a potent cue for its perception.

Perceiving Social Categories

Social categorization has long been characterized as a central factor in how observers perceive

Figure 15.1 Point-Light Display. (a) When generating point-light displays, researchers affix reflective or infrared markers to the body's major joints, depicted here superimposed over a computer animated body. (b) When presented to participants, only the points of light are visible. Though static here, these lights would depict the dynamic motion of each light over time.

others. Among all of the possible categories into which an individual might fall, three in particular tend to dominate social perception: sex, race, and age. Categorizing others along these dimensions has been argued to be an efficient cognitive strategy (e.g., Allport, 1954), and it unleashes a cascade of subsequent interpersonal events. Social category knowledge, for example, evokes category-based expectations have been shown to carry profound implications for subsequent interactions and evaluations (Brewer, 1988; Devine, 1989; Fiske & Neuberg, 1990). Because of this widespread importance, such categories have been labeled *master status categories*, and many have argued that categorization of others according to sex, race, and age is an obligatory and automatic process (Bargh, 1999; Brewer, 1988; Devine, 1989; Dovidio, Evans, & Tyler, 1986). Much of this work has measured social categorization indirectly by assessing the activation of category-relevant knowledge structures (i.e., stereotypes) after a target is visually perceived. Though the tendency to perceive social categories may remain strong, some evidence suggests that the activation of category stereotypes may be moderated by experimental manipulations that either change a perceiver's goals or restrict category-relevant visual cues (e.g., Blair, 2002; Gilbert & Hixon, 1991; Kurzban, Tooby, & Cosmides, 2001; Macrae & Bodenhausen, 2000). Such demonstrations of moderation notwithstanding, social categorization retains a central role in person construal. Martin and Macrae (2007) noted, "...it [social categorization] may be the norm rather than the exception during most social interactions (p. 814)." Cues to sex category, in particular, are visually apparent in the face and body and thus appear to be highly likely to elicit compulsory categorization (Martin & Macrae, 2007).

Perhaps it is unsurprising; therefore, that a range of sexually dimorphic body cues support the perception of sex category membership. Body motion is diagnostic of sex category membership, and it is the category that has received the most attention within the perceptual literature. In a collection of studies, James Cutting and colleagues examined the extent to which observers could identify the sex category membership of point-light walkers. In an initial report, Kozlowski & Cutting (1977) found that sex category judgments of point-light walkers exceeded chance responding, even when judgments were based on few points of light. Moreover, observers' accuracy was highly correlated with self-reported confidence, implying a systematic appreciation of sexually dimorphic body motion. Indeed, later work corroborated the supposition that the *production of biological motion* is inextricably tied to the morphological differences among individuals. Because men's and women's bodies differ, not only in absolute, but also in relative proportions, body motion is also likely to vary accordingly (Mather & Murdoch, 1994). This perspective implicated motion as a potentially stable and reliable cue to sex category membership. Indeed, a biomechanical invariant, the *center of moment*, was later established as a sexually dimorphic cue in reality, and a potent determinant of perceptual accuracy (Cutting, Proffitt, & Kozlowski, 1978).

Subsequent research in this area has applied more sophisticated modeling techniques to identify the spatio-temporal parameters that compel observers' accuracy. Work by Cutting and colleagues, for example, identified the temporal boundaries (Barclay, Cutting, & Kozlowski, 1978) and the spatial parameters that affect observers' perception of sex category (Cutting, 1978). Troje (2002) developed a linear classifier that reliably extracts category-diagnostic gait parameters and demonstrated its performance on perception of sex category. Pollick, Kay, Heim, and Stringer (2005) reviewed all previous data on judging sex category and coupled this with modeling the distributions of male and female centers of moment to calculate how efficiently observers use the available structural information to make sex category judgments. These results indicated that although the proportion correct for sex categorization is not typically very high, observers do appear to be very efficient at extracting the relevant information.

Collectively, these data highlight a privileged role of body motion for the perception of

at least one social category—biological sex—that has profound interpersonal implications. The extent to which other social categories (e.g., race and age) can be discerned from biological motion displays has not been explored as extensively. Some evidence suggests, however, that gait may support the identification of both factors. Age-related aspects of gait, for example, lead observers to draw stereotype-consistent inferences about targets (Montepare & Zebrowitz-McArthur, 1988), and this tendency is cross-culturally consistent (Montepare & Zebrowitz, 1993). These findings suggest that motion parameters can support age recognition and elicit group-based normative judgments.

Likewise, race category membership may also be conveyed via biological motion. Korean and American women exhibit different walking speeds relative to their male counterparts. Whereas American women appear to compensate for shorter stride lengths with an increased walking cadence, Korean women do not and thus walk more slowly than Koren men, suggesting that this category distinction might be cued by body motion. Additionally, preliminary evidence suggests that the race categories black and white are apparent in silhouetted images depicting a dynamic human body, again suggesting that biological motion may play a role in observers' ability to identify race category membership from a distance (Eberhardt, Goff, Ambady, Toosi, & Choi, 2010).

Perceiving Identities

Many social psychological theories of person perception identify distinct processes for social categorization, described earlier, and the process of individuation (see Brewer, 1988; Fiske & Neuberg, 1990). Whereas social categorization involves general processes of perception that are theorized to be efficient because of their ability to evoke category-based expectations, individuation entails a finer discrimination of a person's unique qualities which, at times, may contradict common assumptions about their social category membership. Therefore, individuation is presumed to be a more complex and effortful process in social perception. In spite of the effort required for individuation, it remains an important component of interpersonal interactions because it permits people to overcome biased assumptions based on social categorization alone.

The same basic logic that underscored research on perceiving sex categories from biological motion also led researchers to speculate that individual identities might be specified by unique motion patterns as well. If correct, such patterns should be appreciable in point-light displays. Early studies investigated this possibility by inviting groups of friends to the lab who were each filmed while walking. Researchers transformed the films into point-light displays and showed them to each member of the group with the task of correctly identifying the depicted individual. This research found that observers of point-light walkers could identify oneself and others with accuracy that exceeded chance (Cutting & Kozlowski, 1977; see also Beardsworth & Buckner, 1981; Richardson & Johnston, 2005), presumably due to stable individual differences in movement (Troje, Westhoff, & Lavrov, 2005; Westhoff & Troje, 2007). Moreover, confidence and accuracy were highly correlated. Observers seemed to know what they were doing. Subsequent research established that recognition ability is due both to the perceiver's extensive visual experience with the body motions of close others (Jacobs, Pinto, & Shiffrar, 2004) and to the perceiver's own prior motor experiences (Loula, Prasad, Harber, & Shiffrar, 2005). Furthermore, exaggerating the spatiotemporal parameters of point-light motion enhanced observer's ability to identify general motion styles (Pollick, Fidopiastis, & Braden, 2001) and to recognize individual identities (Hill & Pollick, 2000).

Perceiving Psychological States

An ability to discern information about another individual's internal state is extremely important for interpersonal interactions. Of all possible internal states, emotion has long been theorized to be elemental in social perception (Darwin, 1872; Ekman & Friesen, 1975). The ability to discern anger from sadness, for example, can help one determine whether it would be most appropriate to avoid or approach another

person. Misreading such information can be catastrophic. Moreover, though the vast majority of emotion-recognition studies have involved face perception (see chapters in this volume), the distinction between facial and bodily expressions of emotions has long been recognized (e.g., Ekman, 1965) and has received increasing attention in recent years. Moreover, some scholars have suggested that the perception of emotion from the body is more important than other forms of emotion perception because of its informative value. De Gelder (2005), for example, argued for the primacy of body perception in emotion recognition stating, "When we see a bodily expression of emotion, we immediately know what specific action is associated with a particular emotion, leaving little need for interpretation of the signal, as is the case for facial expressions (p. 583)." Put simply, emotion detection is an important perceptual skill, and it may be supported by multiple visual cues.

Like other domains of social relevance, body motion supports accurate emotion perception. In an early demonstration of this, actors were asked to convey various emotional states while being filmed. Later, participants judged the emotional state depicted in the resulting videos of body motions (but not facial expressions). The accuracy of the judgments highlighted a profound sensitivity to perceiving emotional state from body cues (Montepare, Goldstein, & Clausen, 1987). These data provided a glimpse into the influence of body cues for emotion recognition, but they could not fully disentangle the relative impact of body motion and body form or postural information because the full body videos contained both types of information. Indeed, static images of body postures tend to affect emotion processing across domains (e.g., Van den Stock, Righart, & de Gelder, 2007), leaving open the question of how body motion may uniquely serve emotion recognition.

A growing body of evidence suggests that body motion does, in fact, play an important role in the perception of emotion. By decoupling body form from body motion through the use of point-light techniques, researchers isolated the motion associated with distinct emotions and

assessed their potency for emotion recognition. Across a variety of motions including both full body (Atkinson, Tunstall, & Dittrich, 2007; Chouchourelou, Matsuka, Harber, & Shiffrar, 2007; Dittrich, Troscianko, Lea, & Morgan, 1996) and partial body motions (Pollick, Paterson, Bruderlin, & Sanford, 2001; Sawada, Suda, & Ishii, 2003), observers of point-light displays depicting emotional body motions discern the emotional state of others with surprising accuracy from such sparse displays. This success is due in part to systematic encoding of the distinct emotions with the underlying dynamic motion patterns (Pollick et al., 2001). Some evidence suggests that these perceptual skills are highly tuned to perceive anger or fear in others, arguably due to its importance for one's own physical well-being (Chouchourelou et al., 2007; Dittrich et al., 1996; Walk & Homan, 1984; see also; Grèzes, Pichon, & de Gelder, 2007). Furthermore, such perceptions can occur without conscious intent (de Gelder & Hadjikhani, 2006) and appear to be the product of both kinematic and configural information (Atkinson et al., 2007). Chapter 14 by Shiffrar (this volume) reviews this evidence extensively.

In addition to emotion states, biological motion reveals information about other internal states, such as intention. After viewing a point-light display of an actor lifting a box, for example, observers can estimate the relative weight of the box based solely on the dynamic information specified by the motion (Runeson & Frykholm, 1981). These weight estimates that are based on the passive viewing of point-light displays rival estimates made by participants who had actual physical experience with the box. Observers can also identify a target's deceptive intent in such actions. For example, when actors in point-light displays were asked to appear as though the weight of the box differed from its actual weight, observers accurately perceived this intent to deceive (Runeson & Frykholm, 1983). In other studies, actors were asked to convey a particular social category. Observers of these displays accurately distinguished between sequences in which the actor's goal was to exaggerate their own sex-typical

walk pattern and sequences in which the actor's goal was to feign an opposite-sex walk pattern (Runeson & Frykholm, 1983)—the actual sex of the target and the sex-typed walk motion being conveyed—permitting them to ascertain that a target was a man who was walking with feminine motion. Finally, the perception of motion cues can be used as a foundation for future interactions based on the perceptions they engender. Observers of point-light displays are quite adept at evaluating a target's vulnerability to attack based solely on motion cues (Gunns, Johnston, & Hudson, 2002), and people can be trained to alter their gait to convey less vulnerability to others (Johnston, Hudson, Richardson, Gunns, & Garner, 2004).

In sum, the body's dynamic motion provides sufficient information for observers to render judgments about domains that have been and remain central to social psychology. These include the perception of social categories, personal identity, and internal states. With few exceptions, studies in the visual perception of biological motion have focused heavily on the stimulus parameters that give rise to these perceptual ends. As such, they treated the judgment as the final point in their investigations. Social psychologists, in contrast, have tended to begin their investigations with these factors as a starting rather than an ending point, and subsequently explored the downstream consequences thereof. Yet the simple fact remains that person construal occupies the entire spectrum of the perceptual process—from the apprehension of visual cues to the ultimate effects of the judgments and interactions that they affect. Although some scholars have historically treated social judgments as dependent variables, and other scholars have treated social judgments as independent variables, a comprehensive understanding of social perception requires substantial integration of these seemingly different approaches.

COME TOGETHER

Person-perception research conducted by vision and social psychologists has historically shown little overlap, in part due to methodological

and theoretical gaps. Yet these gaps are slowly beginning to close due to research conducted at the boundary of social and cognitive science. The Shiffrar Chapter 14 in this volume, for example, reviews neurophysiological evidence highlighting considerable anatomical links between social and visual brain regions. Additionally, she and her colleagues describe behavioral studies in which the perception that a body is in motion depends on social context. Thus, a growing body of boundary-crossing work demonstrates that the visual and social psychologists will continue to come together in meaningful ways.

Though undoubtedly merely two of many (see chapters by de Gelder and Shiffrar), we now turn our attention to ways in which the visual perception of motion might be constrained by social processes. First, the perception of a social category is likely to constrain the way that other cues are interpreted and evaluated. Second, prior expectations are likely to constrain the perception of cues that can bias fundamental social perception.

Categorization Constrains Other Social Judgments

One way that social processes constrain the perception of biological motion is in observers' interpretation of motion cues. Social categorization has been described as a likely, if not inevitable aspect of person construal, and it can be appreciated from a variety of sexually dimorphic cues that appear in the face and body. Though biological motion displays isolate the body's motion, some have argued that observers' ability to discern sex category from such displays is due primarily to the ability to recover structural information about the target's body. The extent to which structural mediation accounts for sex categorization ability in observers of point-light displays remains hotly debated, but the notion that body shape conveys meaningful information to observers is unassailable.

In some ways, this debate is purely theoretical. "In the wild," observers typically perceive body motion combined with its shape. Therefore, body shape need not be recovered from body motion but can be perceived
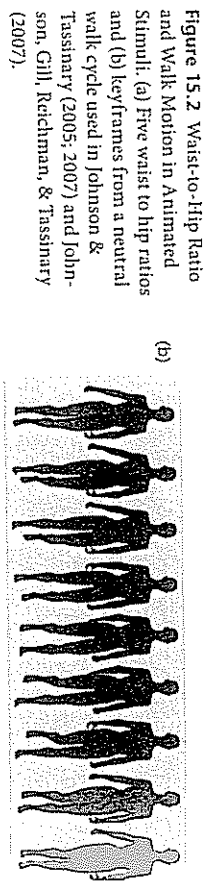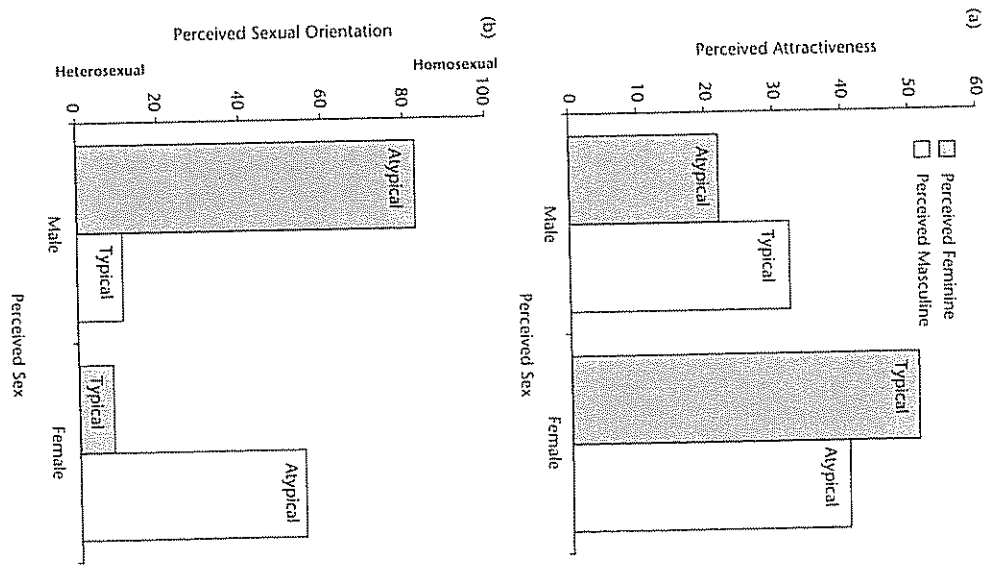
directly. The question of whether structural or dynamic factors determine social perception changes substantially when observers are viewing full bodies in motion, and modern technology makes it possible to manipulate independently the body shape and motion of computer-generated human animations. Therefore, the direct impact of both structure and motion for social perception can be measured independently.

Johnson and Tassinary (2005) examined the relative importance for body shape and motion. They asked observers to judge the sex category membership of animations that varied orthogonally in two sexually dimorphic cues (see Figure 15.2). Walkers varied statically in body shape (waist-to-hip ratios from 0.5 to 0.9) and dynamically in gait (from a masculine shoulder swagger to a feminine shoulder sway). When this was done, body shape proved to be a more compelling cue to sex category membership; body motion was a potent cue for the perceived degree of masculinity/femininity (Johnson & Tassinary, 2005) A final study in this same set found that sex-category judgments that relied on body motion were the product of inference. Observers first perceived body motion in terms of masculinity/femininity and then inferred the appropriate sex-category label. Moreover, the ability to infer sex category from body shape emerges by age 5 (Johnson, Murphy, & Tassinary, in press).

The primacy of body shape for sex-category judgments has important implications for other social perceptions. Once sex categorization has

occurred, sexually dimorphic body motion is likely to be perceived, not only as masculine or feminine, but also as either gender-typical or gender-atypical, given the perceived sex category of the target. Additionally, sex categorization based on body shape will constrain the expected range of body motions within what is normative for the sex category. Thus, as in other domains (see Biernat & Manis, 1994; Biernat, Manis, & Nelson, 1991), the perception and evaluation of body motion will be highly dependent upon the sex-category judgment that precedes it. Early judgments of sex category from body shape, therefore, constrain both evaluative judgments and related social categorizations that incorporate body motion.

The perception of sex category from a sex diagnostic cue such as body shape, therefore, determines precisely how body motion will be evaluated (e.g., in the perception of attractiveness). Johnson and Tassinary (2007) examined how body shape and motion combined to determine perceived attractiveness. As before, participants viewed computer-generated animations that varied systematically in two sexually dimorphic cues—body shape and body motion. Observers judged the sex, masculinity, femininity, and attractiveness of each walker. Relative to body motion, body shape carried considerably more weight for sex category judgments, again reinforcing it's importance for foundational social categorizations. Once this judgment was made, the perception of masculinity/femininity strongly impacted perceived attractiveness. As seen in Figure 15.3a, when walkers were judged

(a)

0.5   0.6   0.7   0.8   0.9

(b)

Figure 15.2 Waist-to-Hip Ratio and Walk Motion in Animated Stimuli. (a) Five waist to hip ratios and (b) keyframes from a neutral walk cycle used in Johnson & Tassinary (2005; 2007) and Johnson, Gill, Reichman, & Tassinary (2007).

(a)

Perceived Attractiveness

☐ Perceived Feminine
☐ Perceived Masculine

Male   Perceived Sex   Female

Figure 15.3 Effects of Social Categorization on Evaluative and Categorical Social Judgments. Once sex category judgments were made, body motion affected perceived attractiveness (a) and perceived sexual orientation (b) of men and women differently. Figures adapted from Johnson, Gill, Reichman, & Tassinary (2007).

(b)

Perceived Sexual Orientation

Homosexual

Heterosexual

Male   Perceived Sex   Female

to be women, they were deemed more attractive when walking with feminine hip sway; but when walkers were judged to be men, they were deemed more attractive when walking with masculine shoulder swagger. Thus, the perception of sex category determined how body motion was perceived and evaluated.

Importantly, social categorization provides the critical foundation for higher level evaluative judgments. In the case of attractiveness,

for example, there is little reason to expect evaluative judgments to favor either masculine or feminine walk motions. Once such motions become contextualized by the apparent sex of the target, however, the motion is perceived to be not only masculine or feminine, but also typical or atypical for the given sex, and it, therefore, becomes valenced. Although we have focused primarily on mechanisms that affect evaluative judgments through social processes, others have

highlighted the critical role that perceptual fluency plays in evaluative judgments of visual patterns (Winkielman, Halberstadt, Fazendeiro, & Catty, 2006).

The contextualized effects of sex category and typicality in walk motion can also constrain the impact of body motion for other social categorizations that are gender relevant, such as perceived sexual orientation. Johnson, Gill, Reichman, and Tassinary (2007) applied the same experimental paradigm just described to determine whether (and how) judgments of sexual orientation relate to body motion. Across three studies, including both animations and real human targets, observers' judgments of sexual orientation reflected the degree of perceived gender atypicality in walk motion. That is, targets judged to be men were perceived to be gay when they moved with a feminine gait, and targets judged to be women were perceived to be gay when they moved with a masculine gait (see Figure 15.3b). These effects were independent of the effects of attractiveness already described.

These basic perceptions of sex and masculinity/femininity that arise from perceiving the dynamic human body can also help us understand some biases against homosexuality (Johnson & Gill, 2010). One may predict, for example, that gender atypicality in gait would be perceived generally to be intentional and flaunting one's sexuality. From this perspective, evaluative judgments of gay men and lesbian women who exhibit gender atypical body motions should be harsh *because of* the perceived intent of the individual to convey their sexual intent to observers. Indeed, Johnson & Gill (2010) found that gender atypical body motion among gay men and lesbians was perceived by observers to be intentional, with goal to communicate one's sexual identity to others. Instead, Johnson, Gill, & and Reichman (2008) found that *feminine* motion, whether exhibited by a man or a woman, was perceived by observers to be intentional with a goal to communicate one's sexuality to others. This perceived communicative act was also judged to be untoward. Therefore, perceived gender judgments were not the result of perceived gender atypicality or the perception of membership in a stigmatized social category,

per se, but rather a product of perceived communicative intent.

These data shed light on the process by which sex categorization constrains the perception and evaluation of the dynamic human body. Sex categorization is a highly probable, if not inevitable, social judgment that occurs in the earliest stages of person construal. Although undoubtedly supported by multiple physical cues, body shape appears to be a potent determinant of sex category judgments. These judgments set the stage for perceptions of masculinity/femininity, or gender typicality, to affect both evaluative and categorical social judgments. Thus, the perception of biological motion is likely to be constrained by social categorizations that occur early in the perception process.

Stereotyped Knowledge Constrains Social Perception

Another way that social processes constrain the perception of biological motion is through the use of stereotypes. The vast majority of work examining the relation between categorization and stereotypes has presumed a particular directional arrow. Following the lead of Allport (1954), prior work examined the role that categorization plays in unleashing the deleterious effects of stereotypes on judgments, attitudes, and expectations (Brewer, 1988; Devine, 1989; Fiske & Neuberg, 1990). The central argument in much of this work rested in the assumption that stereotypes, even when not personally endorsed, are widely known nevertheless. That knowledge, once activated by perceiving a social category, was argued to be sufficient to trigger stereotype-based behavior and judgments (Bargh, 1999). Because cues to social categories (not necessarily the perception of the category, per se) may set such effects in motion (Martin & Macrae, 2007), understanding the cues from both face and body that support those categorizations was and continues to be important. Yet we propose that the opposite directional arrow is also important, and is another way in which social processes constrain visual perception, especially in the perception of emotion from biological motion.

Sex stereotypes are arguably the most pervasive stereotypes for social categories. The distinction between the sexes has a powerful impact from birth on, and biological sex becomes the first meaningful social category that young children learn (see Ruble, Martin, & Berenbaum, 2006, for a review). Expectations for gender-normative behavior are pervasive by early childhood, and violations of such expectations receive harsh social penalties from childhood on (Fagot, 1977; Fagot & Hagan, 1991; Fagot, Leinbach, & O'Boyle, 1992; Martin, 1990; Sandnabba & Ahlberg, 1999).

One facet of sex-based stereotypes involves the experience and expression of emotion. In one early study, participants made judgments about an infant who was crying (Condry & Condry, 1976). When the infant was described as male, "his" crying was perceived to be due to anger; when the infant was described as female, "her" crying was perceived to be due to sadness. This basic demonstration reflects what has been found more generally, lay theories lead people to assume that, relative to men, women tend to express emotions more intensely (Grossman & Wood, 1993; Hess, Blairy, & Kleck, 1997; Fisher, 1993; Johnson & Schulman, 1988; Plant, Hyde, Keltner, & Devine, 2000; Plant, Kling, & Smith, 2004). The experience and expression of anger and pride, however, prove to be exceptions to this general sex-typed lay theory (Plant et al., 2000). Men are presumed to both feel and express these emotions more than women. Judgments of facial expressions tend to reflect these gender-based assumptions (Grossman & Wood, 1993), and such judgments are also underscored by phenotypic confounding between men's faces and an anger expression (Becker, Kenrick, Neuberg, Blackwell, & Smith, 2007) and physical markers of dominance (Hess, Adams, & Kleck, 2007). Though a theoretical debate persists concerning whether stereotypes or phenotypes better explain observed differences in perceptions of expressiveness for men's and women's displays of anger, sadness, and happiness, the existence of gender stereotypes for emotional displays are widespread (Plant et al., 2000).

We have argued elsewhere (Johnson, McKay, & Pollick, 2010) that although the effect of

stereotypes on the perception of facial expressions may be debatable, their effect on the perception of biological motion displays is more straightforward. We reasoned that gender stereotypes for emotional displays, specifically for sadness and anger, might bias observers' ability to discern the sex category membership from motion cues.

We tested this idea in a series of studies that examined how gender-stereotyped emotions affect observers' perceptions of sex-category membership. Actors were filmed throwing a ball in different emotional states while the three-dimensional coordinates of their bodies were recorded (Ma, Paterson, & Pollick, 2006). Using these coordinates, we generated point-light displays for each throw. Specifically, their shoulder, elbow, wrist, and hand coordinates were used to generate point-light displays for each throw. Later, naïve observers judged each point-light display for sex-category membership. Our results stood in stark contrast to prior findings that suggested that sex category membership can be discerned from biological motion displays. Instead of demonstrating a high degree of decoding competence, our observers' judgments hovered near chance. We examined the pattern of accuracy by both sex and emotion categories. When broken down in this way, an intriguing pattern was evident. As seen in Figure 15.4, displays depicting angry throws were overwhelmingly judged to be men, and displays depicting sad throws were overwhelmingly judged to be women. In both cases, observers' confidence was remarkably high—in spite of the fact that approximately half of their judgments yielded errors.

As in face-perception studies, the possibility that the categories male and angry and the categories female and sad bear kinematic similarity cannot be ignored. The nature of our stimuli (point-light displays generated via motion capture) enabled us to remove the most likely parameter that may exhibit such confounding. Specifically, we equated all throws for velocity, a cue that varies reliably with both the sex and emotion of thrower. These studies replicated the prior effects, thus ruling out the possibility that
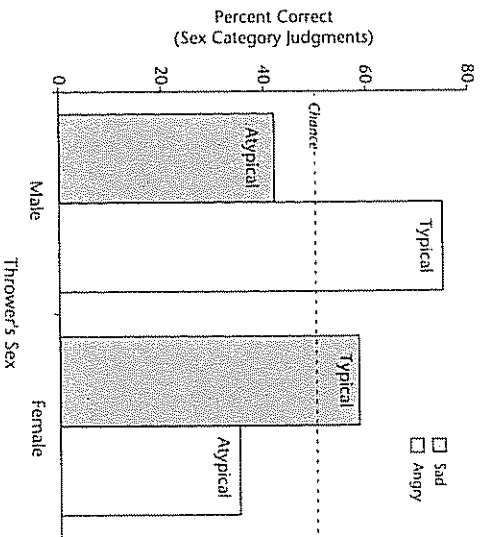
Figure 15.4 Accuracy of Sex Category Judgments from Emotional Arm Movements. Participants' judgments of sex category varied greatly for judgments of sex-typed emotional displays, specifically anger and sadness. Data depicted here represent a portion of those reported in Johnson, McKay, & Pollick (2010).

variation in average velocity across the emotions biased judgments due to analogous sex differences in velocity. Instead, perceived sex was highly dependent on the perceived emotion of the display. When observers perceived a throw to be angry, they also judged the actor to be a man; when observers perceived a throw to be sad, they also judged the actor to be a woman. This pattern of perceptions impacted accuracy (see Figure 15.4).

This pattern of results is consistent with a stereotype, but not a cue overlap, interpretation. Observers perceived the emotion depicted in a point-light throw, and this affected other judgments as well. Because the emotions of sadness and anger correspond to sex-typed lay theories, observers used prior knowledge structures—sex stereotypes for emotion—to help disambiguate the sex of point-light throwing displays. Thus, angry throws were judged to be men, and sad throws were judged to be women due to stereotyped expectations. In sum, the findings from this set of studies highlight an important way in which a traditionally social process, the use of stereotypes, can bias the visual perception of biological motion.

CONCLUSION

Rudyard Kipling famously lamented about the East and the West, questioning whether "Never the twain shall meet." For decades, a similar charge could have been levied to describe the gulf that separated person perception research conducted by vision scholars and social psychologists. We hope that this chapter, and the work described in it, convinces readers that the visual perception of biological motion is indeed a social process and that interdisciplinary work is beginning to realize this potential. Kipling ended his poem with optimistic speculation about what could emerge when "two strong men (or women!) stand face to face." Similarly, we end our chapter with optimism about the future of a social-vision approach to the study of biological motion. It is indeed backed by the strength of many.

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REFERENCES

Allport, G. (1954). *The nature of prejudice*. Reading, MA: Addison-Wesley.

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

Atkinson, A.P., Tunstall, M.L., & Dittrich, W.H. (2007). Evidence for distinct contributions of form and motion information to the recognition of emotions from body gestures. *Cognition, 104*, 59–72.

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

Bargh, J.A. (1999). The cognitive monster: The case against controllability of automatic stereotype effects. In S. Chaiken and Y. Trope (Eds.), *Dual process theories in social psychology*. New York: Guilford Press.

Becker, D.V., Kenrick, D.T., Neuberg, S.L., Blackwell, K.C., & Smith, D.M. (2007). The confounded nature of angry men and happy women. *Journal of Personality and Social Psychology, 92*, 179–190.

Beardsworth, T., & Buckner, T. (1981). The ability to recognize oneself from a video recording of one's own movements without seeing one's body. *Bulletin of the Psychonomic Society, 18*, 19–22.

Biernat, M., & Manis, M. (1994). Shifting standards and stereotype-based judgments. *Journal of Personality and Social Psychology, 66*, 5–20.

Biernat, M., Manis, M., & Nelson, T.E. (1991). Stereotypes and standards of judgment. *Journal of Personality and Social Psychology, 60*, 485–499.

Blair, I.V. (2002). The malleability of automatic stereotypes and prejudice. *Personality and Social Psychology Bulletin, 6*, 242–261.

Brewer, M.B. (1988). A dual process model of impression formation. In T.K. Srull & R.S. Wyer (Eds.) *Advances in Social Cognition* (Vol 1, pp. 1–36). Hillsdale, NJ: Erlbaum.

Chouchourelou, A., Matsuka, T., Harber, K., & Shiffrar, M. (2007). The visual analysis of emotional actions. *Social Neuroscience, 1*, 63–74.

Condry, J., & Condry, S. (1976) Sex differences: A study of the eye of the beholder. *Child Development, 47*, 812–819.

Cutting, J.E. (1978). A program to generate synthetic walkers as dynamic point-light displays. *Behavior Research Methods & Instrumentation, 10*, 91–94.

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.

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.

Darwin, C. (1872). *The expression of the emotions in man and animals*. London: John Murray.

De Gelder, B. (2005). Toward a neurobiology of emotional body language. *Nature Reviews Neuroscience, 7*, 242–249.

De Gelder, B., & Hadjikhani, N. (2006). Nonconscious recognition of emotional body language. *NeuroReport, 17*, 583–586.

Devine, P. (1989). Stereotypes and prejudice: Their automatic and controlled components. *Journal of Personality and Social Psychology, 56*, 5–18.

Dittrich, W.H., Troscianko, T., Lea, S.E.G., & Morgan, D. (1996). Perception of emotion from dynamic point light displays represented in dance. *Perception, 25*, 727–738.

Dovidio, J.F., Evans, N., & Tyler, R.B. (1986). Racial stereotypes: The contents of their cognitive representations. *Journal of Experimental Social Psychology, 22*, 22–37.

Eberhardt, J.L., Goff, P.A., Anbady, N., Toosi, N., & Choi, S. (2010). Race in motion: Perceived body movement cues racial identity and threat. *Manuscript in preparation*.

Ekman, P. (1965). Differential communication of affect by head and body cues. *Journal of Personality and Social Psychology, 2*, 726–735.

Ekman, P., & Friesen, W.V. (1975). *Unmasking the face*. Englewood Cliffs, NJ: Prentice-Hall.

Fagot, B. I. (1977). Consequences of moderate cross-gender behavior in preschool children. *Child Development, 48*, 902–907.

Fagot, B. I., & Hagan, R. (1991). Observations of parent reactions to sex-stereotyped behaviors: Age and sex effects. *Child Development, 62*, 617–628.

Fagot, B. I., Leinbach, M. D., & O'Boyle, C. (1992). Gender labeling, gender stereotyping, and parenting behaviors. *Developmental Psychology, 28*, 225–230.

Fisher, A.H. (1993). Sex differences in emotionality: Fact or stereotype? *Feminism & Psychology*, 3, 303–318.

Fiske, S.T., & Neuberg, S.L. (1990). A continuum of impression formation from category-based to individuating processes: Influences of information and motivation on attention and interpretation. In M. Zanna (Ed.), *Advances in experimental social psychology* (Vol. 23, pp. 1–74). New York: Academic Press.

Gilbert, D.T., & Hixon, J.G. (1991). The trouble of thinking: Activation and application of stereotypic beliefs. *Journal of Personality and Social Psychology*, 60, 509–517.

Grèzes, J., Pichon, S., & de Gelder, B. (2007). Perceiving fear in dynamic body expressions. *Neuroimage*, 35, 959–967.

Grossman, M., & Wood, W. (1993). Sex differences in intensity of emotional experience: A social role interpretation. *Journal of Personality and Social Psychology*, 65, 1010–1022.

Gunns, R.E., Johnston, L., & Hudson, S.M. (2002). Victim selection and kinematics: A point-light investigation of vulnerability to attack. *Journal of Nonverbal Behavior*, 26, 129–158.

Hess, U., Adams, R., & Kleck, R. E. (2007). Who may frown and who should smile? Dominance, affiliation, and the display of happiness and anger. *Cognition & Emotion*, 19, 515–536.

Hess, U., Blairy, S., & Kleck, R. E. (1997). The intensity of emotional facial expressions and decoding accuracy. *Journal of Nonverbal Behavior*, 21, 241–257.

Hill, H., & Pollick, F.E. (2000). Exaggerating temporal differences enhances recognition of individuals from point light displays. *Psychological Science*, 11, 223–228.

Jacobs, A., Pinto, J., & Shiffrar, M. (2004). Experience, context, and human motion perception. *Journal of Vision*, 2, 338.

Johansson, G. (1973). Visual perception of biological motion and a model for its analysis. *Perception and Psychophysics*, 14, 201–211.

Johansson, G. (1975). Visual motion perception. *Scientific American*, 232, 76–89.

Johansson, G. (1976). Spatio-temporal differentiation and integration in visual motion perception. *Psychological Research*, 38, 379–393.

Johnson, K.L., & Gill, S. (2010). The role of gender-atypical body motion in perceptions of others' intent to communicate sexuality. Manuscript submitted for publication.

Johnson, K.L. (2007). Swagger, sway, and sexuality: Judging sexual orientation from body motion and morphology. *Journal of Personality and Social Psychology*, 93, 321–334.

Johnson, K.L., McKay, L., & Pollick, F. (2010). He throws like a girl (but only when he's sad): Gender stereotypes affect the perception of biological motion displays. Manuscript submitted for publication. University of California, Los Angeles.

Johnson, K.L., Murphy, L.L., & Tassinary, L.G. (in press). Sex categorization among preschool children: Increasing sensitivity to sexually dimorphic cues. *Child Development*.

Johnson, J. T., & Schulman, G. A. (1988). More alike than meets the eye: Perceived gender differences in subjective experience and its display. *Sex Roles, 19, 67–79.

Johnson, K.L., & Tassinary, L.G. (2005). Perceiving sex directly and indirectly: Meaning in motion and morphology. *Psychological Science*, 16, 890–897.

Johnson, K.L., & Tassinary, L.G. (2007). Compatibility of basic social perceptions determines perceived attractiveness. *Proceedings of the National Academy of Sciences, USA, 104,* 5246–5251.

Johnston, L., Hudson, S.M., Richardson, M.J., Gunns, R.E., & Garner, M. (2004). Changing kinematics as a means of reducing vulnerability to physical attack. *Journal of Applied Social Psychology*, 34, 514–537.

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

Kurzban, R., Tooby, J., & Cosmides, L. (2001). Can race be erased? Coalitional computation and social categorization. *Proceedings of the National Academy of Sciences, USA, 98,* 15387–15392.

Loula, F., Prasad, S., Harber, K., & Shiffrar, M. (2005). Recognizing people from their movement. *Journal of Experimental Psychology: Human Perception and Performance*, 31, 210–220.

Ma, Y., Paterson, E., & Pollick, F.E. (2006). A motion-capture library for the study of identity, gender, and emotion perception from biological motion. *Behavior Research Methods*, 38, 134–141.

Macrae, C.N., & Bodenhausen, G.V. (2000). Social cognition: Thinking categorically about others. *Annual Review of Psychology*, 51, 93–120.

Martin, C.L. (1990). Attitudes and expectations about children with nontraditional

and traditional gender roles. *Sex Roles*, 22, 151–166.

Martin, D., & Macrae, C.N. (2007). A face with a cue: Exploring the inevitability of person categorization. *European Journal of Social Psychology*, 37, 806–816.

Mather, G., & Murdoch, L. (1994). Gender discrimination in biological motion displays based on dynamic cues. *Proceedings of the Royal Society of London: Biological Sciences, 258,* 273–279.

Montepare, J.M., Goldstein, S.B., & Clausen, A. (1987). The identification of emotions from gait information. *Journal of Nonverbal Behaviour*, 11, 33–42.

Montepare, J.M., & Zebrowitz, L.A. (1993). A cross-cultural comparison of impressions created by age-related variations in gait. *Journal of Nonverbal Behaviour*, 17, 55–68.

Montepare, J.M., & Zebrowitz-McArthur, L. (1988). Impressions of people created by age-related qualities of their gaits. *Journal of Personality and Social Psychology*, 55, 547–556.

Plant, E. A., Hyde, J. S., Keltner, D., & Devine, P. G. (2000). The gender stereotyping of emotion. *Psychology of Women Quarterly*, 24, 81–92.

Plant, E. A., Kling, K. C., & Smith, G. L. (2004). The influence of gender and social role on the interpretation of facial expressions. *Sex Roles, 51,* 187–196.

Pollick, F.E., Fidopiastis, C., & Braden, V. (2001). Recognising the style of spatially exaggerated tennis serves. *Perception, 30,* 323–338.

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

Pollick, F.E., Paterson, H.M., Bruderlin, A., & Sanford, A.J. (2001). Perceiving affect from arm movement. *Cognition, 82,* B51–B61.

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.

Ruble, D. N., Martin, C. L., & Berenbaum, S. A. (2006). Gender development. In W. Damon (Ed.), *Handbook of child psychology* (6th Edition, Vol. 3, pp. 858–932). New York: J. Wiley.

Runeson, S., & Frykholm, G. (1981). Visual perception of lifted weight. *Journal of Experimental Psychology: Human Perception and Performance*, 7, 733–740.

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.

Sawada, M., Suda, K., & Ishii, M. (2003). Expression of emotions in dance: Relation between arm movement characteristics and emotion. *Perceptual and Motor Skills, 97,* 697–708.

Sandnabba, N. K., & Ahlberg, C. (1999). Parents' attitudes and expectations about children's cross-gender behavior. *Sex Roles, 40,* 249–263.

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

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

Van den Stock, J., Righart, R., & de Gelder, B. (2007). Body expressions influence recognition of emotions in the face and voice. *Emotion, 7,* 487–494.

Walk, R.D., & Homan, C.P. (1984). Emotion and dance in dynamic light displays. *Bulletin of the Psychonomic Society, 22,* 437–440.

Westhoff, C., & Troje, N.F. (2007). Kinematic cues for person identification from biological motion. *Perception and Psychophysics, 69,* 241–253.

Winkielman, P., Halberstadt, J., Fazendeiro, T., & Catty, S. (2006). Prototypes are attractive because they are easy on the mind. *Psychological Science, 17,* 799–806.