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# He throws like a girl (but only when he's sad): Emotion affects sex-decoding of biological motion displays

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ABSTRACT

Gender stereotypes have been implicated in sex-typed perceptions of facial emotion. Such interpretations were recently called into question because facial cues of emotion are confounded with sexually dimorphic facial cues. Here we examine the role of visual cues and gender stereotypes in perceptions of biological motion displays, thus overcoming the morphological confounding inherent in facial displays. In four studies, participants' judgments revealed gender stereotyping. Observers accurately perceived emotion from biological motion displays (Study 1), and this affected sex categorizations. Angry displays were overwhelmingly judged to be men; sad displays were judged to be women (Studies 2–4). Moreover, this pattern remained strong when stimuli were equated for velocity (Study 3). We argue that these results were obtained because perceivers applied gender stereotypes of emotion to infer sex category (Study 4). Implications for both vision sciences and social psychology are discussed.



## 1. Introduction

Social categorization has long been and continues to be considered a highly efficient, and arguably inevitable process (Allport, 1954; Macrae & Quadflieg, 2010; Tajfel, 1969, 1974). Faced with an abundance of visual cues and armed with fine tuned social perception skills, perceivers readily categorize others according to their social category membership. Importantly, it is well established that social categorization elicits stereotyped cognitions that bias subsequent other aspects of social perception (Brewer, 1988; Devine, 1989). Although facial cues are undeniably important for social categorization (see e.g., Bruce & Young, 1998; Zebrowitz, 1997), body motion cues compel social categorization reliably (for recent work, see e.g., de Gelder, 2006; Johnson & Tassinary, 2005; Pollick, Kay, Heim, & Stringer, 2005; Pollick, Paterson, Bruderlin, & Sanford, 2001), and their perception utilizes similar processes (Magnée, Stekelenburg, Kemner, & de Gelder, 2007). Here we examine how the perception of emotion category systematically biases the perception of sex category in biological motion displays depicting a person throwing a ball.

## 2. Social stereotypes and structural cues

The notion that sex and emotion categories may bias one another's perception is founded on a well-established link between gender[2] stereotypes and other social judgments. A considerable amount of research has documented the pervasiveness and consequences of gender stereotyping,

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[2] Throughout the current manuscript, we follow the recommendations of Unger (1979) and Unger and Crawford (1993) for the distinction of sex and gender. We use the term *sex* to refer to a target's actual or perceived biological sex category (i.e., male or female). We use the term *gender* to refer to perceptions or expectations about whether a characteristic is more typical for men versus women (i.e., masculine or feminine).

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(for reviews, see Rudman & Glick, 2008; Wood & Eagly, 2010). Mere perception of a person's sex category elicits stereotyped assumptions that impact evaluations across the lifespan and in a variety of contexts (Biernat & Manis, 1994; Eagly & Mladinic, 1989; Fagot, 1977; Heilman, 2001; Johnson & Tassinary, 2007; Martin, 1990).

Gender stereotypes, for example, impact both the production and perception of emotions. Although women are presumed to both experience and express most emotions to a greater degree than men (Fisher, 1993; Grossman & Wood, 1993; Hess, Blairy, & Kleck, 1997; Johnson & Schulman, 1988; Plant, Hyde, Keltner, & Devine, 2000), two exceptions to this general rule are noteworthy. First, relative to women, men are thought to experience and express the emotions anger and pride more frequently and with greater intensity intensely (Plant et al., 2000). Second, ambiguous or mixed emotion states are disambiguated in gender stereotypical ways (Plant, Kling, & Smith, 2004; Plant et al., 2000; see also Condry & Condry, 1976). An ambiguous emotion displayed by a woman, for example, is likely to be interpreted as sadness. The same expression displayed by a man is likely to be interpreted as anger. Moreover, the perceived appropriateness for expressions of sadness and anger differs for men and women (Lewis, 2000). Collectively, prior research highlights a non-orthogonal relation between perceptions of sex and emotion. In early demonstrations, scholars argued that these effects reveal the pervasiveness of gender stereotypes – an interpretation that is consistent with much of the extant data.

Recently, however, research has demonstrated a remarkable morphological similarity between certain facial expressions of emotion, specifically anger and happiness, and sexually dimorphic facial features. Men's faces tend to have thicker brows and squared jaws, a morphology that is structurally similar to the facial expression of anger (Becker, Kenrick, Neuberg, Blackwell, & Smith, 2007; Sinor, Phillips, Barnes, & David, 1999). Women's faces, in contrast, have more neotenous features such as large eyes and rounder cheeks, a morphology that is related to judgments of warmth and approachability, themselves characteristics that are prone to gender stereotyping (Berry & Brownlow, 1989; Berry & McArthur, 1986). Moreover, the facial morphology of women and men also evoke perceptions of the stereotyped dispositions affiliation and dominance, respectively (Hess, Adams, & Kleck, 2004; see also Hess, Adams, & Kleck, 2005). These overlaps in facial appearance for sex and emotion categories called into question the exclusivity of a gender stereotype interpretation of prior research. Indeed when these factors were controlled (i.e., by removing sexually dimorphic features or equating faces for apparent affiliation and dominance), the effects that previously looked like gender-stereotyping were substantially reduced (Becker et al., 2007) or even reversed (Hess et al., 2004). Thus, data that were once interpreted as evidence for the stereotyped perception of emotion may have been obtained, at least in part, due to overlapping cues.

The insights demonstrating the conflation between the facial cues to sex and emotion categories has made it difficult to evaluate the possibility that sex stereotyping may nevertheless operate in conjunction with common appearance to produce sex-specific patterns for emotion perception. Indeed, a majority of prior research has focused exclusively on face perception making the two possibilities difficult to disentangle. The overlaps in facial appearance are likely to continually frustrate efforts to examine the independent role that stereotyping may play. This suggests that it may be beneficial to examine these relations outside the domain of face processing. Additionally, a majority of prior research examined this question unidirectionally, examining the impact of sex category on perceptions of emotion. To the extent that gender stereotypes of emotion exist, their effects may be more pervasive. Sex category may affect the perception of emotion, and emotion category may also affect the perception of sex category. We propose that perceived emotion may, under some circumstances, serve as a cue to disambiguate sex category membership. We now turn our attention to which cues, other than facial cues, may provide insights into this question.

## 3. Emotional and gendered body motion

The face is not alone in its ability to reveal both sex and emotion categories to observers. Point-light displays depicting the body's motion, for example, provide sufficient cues for perceivers to categorize both sex (Barclay, Cutting, & Kozlowski, 1978; Kozlowski & Cutting, 1977; Mather & Murdoch, 1994; Pollick et al., 2005; Troje, 2002) and emotion (Atkinson, Dittrich, Gemmell, & Young, 2004; Atkinson, Tunstall, & Dittrich, 2007; Chouchourelou, Matsuka, Harber, & Shiffrar, 2007; Dittrich, Troscianko, Lea, & Morgan, 1996). Indeed, emotion perception from body cues tends to occur spontaneously (de Gelder & Hadjikhani, 2006); tends to be accurate, even when based only on the movements of isolated body parts (Pollick et al., 2001; Sawada, Suda, & Ishii, 2003); and tends to incorporate both kinematic and configural information (Atkinson et al., 2007).

Interestingly, several labs have reported that observers show a unique sensitivity to anger displays (Chouchourelou et al., 2007; Dittrich et al., 1996; Walk & Homan, 1984; see also; Grèzes, Pichon, & de Gelder, 2007). Such effects are theorized to occur because perceiving anger is relevant for one's own physical well-being. This has led some to speculate that it may be adaptive to decode the emotions of others, especially under threatening circumstances (de Gelder, 2006). Thus, it appears that perceivers can decode a range of emotions from body motion, but that anger displays are privileged.

Thus, the body's motion contributes to numerous aspects of person perception including two domains of social information, sex and emotion categories, that may be linked via gender stereotypes. In spite of the importance of the body in both emotion and sex perception, the possible influence of gender stereotypes in body perception has only recently been acknowledged for sex categorization (Johnson & Tassinary, 2005), and it has yet to be examined in the perception of emotional body movements. Because of the considerable attention recently devoted to gender stereotyping of emotional facial displays, examining such effects for the perception of body motion is timely.

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The use of biological motion displays, a technique widely used to study the perception of motion, introduces benefits that increase the potential theoretical impact of the proposed work. Such displays eliminate surface details such as muscularity. This elimination of surface morphology is important because it removes a potential confound that has frustrated interpretations in the face perception literature – the potential overlap between sexually dimorphic body morphology (see e.g., Johnson & Tassinary, 2005) and bodily expressions of emotion. Therefore, sex categorizations are necessarily discerned from the motion cues, and not from extraneous visual cues. This technique may afford unique insights into how perceived emotion category affects basic sex categorization. The use of biological motion displays, therefore, provides a vehicle to examine whether perception of emotion and sex categories are related and whether such effects are due to gender stereotyping of emotions.

To the extent that the perception of emotional body motions evokes gender stereotypes, they may bias how observers disambiguate a target's biological sex. Male-stereotyped emotions such as anger should compel a greater number of "male" categorizations; female-stereotyped emotions such as sadness should compel a greater number of "female" categorizations. Thus, from this perspective, both sex categorizations and their accuracy may reflect strong gender stereotyping for displays that depict the emotions of anger and sadness.

The predictions for biased sex categorization are relatively straightforward from a stereotyping perspective. Yet it is also important to note that a simple kinematic feature of body motions may govern the accuracy of social categorizations. For instance, some research supports the notion that differences in velocity may play a critical role in observers' judgments of both sex and emotion (Pollick, Lestou, Ryu, & Cho, 2002; Pollick et al., 2001). Consequently, this leads to two predictions concerning the impact of velocity, and by extension the impact of emotion, on accuracy.

Differences in velocity across sex and emotion categories may impact the accuracy of judgments indirectly through the application of simple heuristics. Observers appear to use velocity when making social categorizations (Pollick et al., 2001, 2002). Indeed, it may be the case that the average velocities of emotion and sex categories show overlaps that are analogous to those observed in facial expressions. That is, the velocity of emotional movements that are gender stereotyped (e.g., anger and sadness) may covary with differences in velocity that are characteristic of men's and women's movements. If correct, observers may use simple heuristics about velocity to render sex categorizations, resulting in biased judgments. Thus, depending on the precise pattern of velocity across social categories, this possibility may lead to the same predicted pattern of results that was derived from a gender stereotyping perspective.

Alternately, differences in velocity across sex and emotion categories could impact the accuracy of judgments more directly. Indeed, some have argued that motions with higher velocity simply contain more cues that observers can exploit to make a range of judgments (Runeson & Frykholm, 1981, 1983). From this perspective, higher velocity motions should compel more accurate categorization because they contain more information. To the extent that this is correct, sex categorizations should be highest for displays depicting high velocity, but lowest for displays depicting lower velocity. This leads to the interesting possibility that accuracy will vary systematically with emotion category, specifically because velocity varies across emotions (Pollick et al., 2001, 2002).

Thus, prior literature suggests two routes by which sex categorization may be affected by emotion category. The first route, originating in a social stereotypes perspective, predicts that gender stereotypes of emotion will modulate sex perception: perceived emotion category will evoke gender stereotypes that will bias sex categorization in a systematic manner. A second route, emphasizing the importance of low-level kinematic features, predicts that differences in velocity may affect categorizations either heuristically or directly. Motions with higher velocities will be perceived more accurately, relative to those with lower velocities.

## 4. Overview

In the present studies, we examine how the emotion depicted in a biological motion display affects sex categorization. In Study 1 we address two important foundational issues. First, we explore whether sex and emotion categories vary systematically in velocity. Then we confirm that perceivers do, in fact, discern emotion categories in displays depicting point-light throwing motions. In Studies 2 through 4 we examine the central question in this research – how sex categorization is biased by emotion categories. In Study 2 we establish that sex categorization is moderated by emotion categories. In Study 3 we demonstrate that this occurs even when motions have been equated for velocity. Finally, in Study 4 we test the proposed mediating role of gendered perceptions in producing our results.

## 5. Study 1: Preliminary analyses of velocity and emotion perception

Study 1 served two important purposes. First, we examined whether the average velocity of motions varied across different sex and emotion categories. This was important because: (a) velocity may covary for sex and emotion categories thereby leading to heuristic judgments, and (b) prior research suggests that motions with higher velocities contain more information upon which perceivers can make their judgments (Runeson & Frykholm, 1981, 1983). Therefore, any systematic differences in velocity have important implications for the accuracy of a range of social perceptions, including sex categorization.

Equally importantly, we sought to establish that perceivers do, in fact, perceive emotion from biological motion displays. This is theoretically important to our hypothesis that emotion being expressed in biological motion displays may bias the perception of sex categories. The hypothesis rests, in part, on the assumption that perceivers can

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distinguish emotion categories at levels that exceed chance. Prior research suggests that this is likely (e.g., Pollick et al., 2001, 2002). Here we sought to corroborate such effects by examining the accuracy of emotion categorizations for point-light throwing motions.

### 5.1. Method

#### 5.1.1. Participants

Seventeen undergraduate students (eight males, nine females) participated in exchange for course credit or £5.

#### 5.1.2. Stimuli

Stimuli depicted the point-light displays of 29 targets (14 male, 15 female) throwing a ball in four emotion states (angry, happy, neutral, and sad). These motion files are part of a larger library of biological motions performed in different emotion states (see Ma, Paterson, and Pollick (2006), for a full description of motion capture specifications). For our subset of these stimuli, actors first read a paragraph designed to induce a particular emotion (angry, happy, neutral, and sad). Then, the actor threw a ball into a bucket on the floor five times. This procedure was repeated for each emotion state, yielding a total of 580 motion files. Using these motion files, we generated point-light displays that depicted five markers (one each affixed to the shoulder, elbow, wrist, and two affixed to the hand) as a black dot on a white background. Displays presented the motion from a side view to ensure that the full range of the arm's motion could be seen.

#### 5.1.3. Procedure

We used a 4-alternative forced choice paradigm in which participants categorized the emotional expression of each stimulus (i.e., angry, happy, neutral, or sad). Stimuli were presented on an Apple Macintosh computer running MATLAB 5 (MathWorks, Natick, MA). Participants judged the emotion for a total of 348 trails. Trials included one randomly selected display from each emotion state for each actor, repeated over three blocks. Each display was scaled to the same height, and displays subtended an approximate maximum viewing angle of $5.7^\circ \times 4.5^\circ$, though the horizontal extent of each action varied across stimuli. For each display, participants categorized each actor to be angry, happy, neutral, or sad by depressing keys labeled with each emotion. Participants completed a practice phase consisting of six trials. Then, after any questions were fully answered, participants completed the main set of trials. Participants were not informed of the distribution of emotion displays in the stimulus set, nor did they receive feedback regarding their performance.

### 5.2. Results

#### 5.2.1. Preliminary analysis of velocity

First we examined whether the velocity of throwing motions varied as a function of sex category and emotion. First we computed the average Velocity for each display. Then, we analyzed Velocity using a 2 (Sex) by 4 (Emotion) by 5 (Trial) mixed-model ANOVA with repeated-measures on the final two factors. Overall, Velocity varied as a function of Emotion, $F(3, 81) = 87.187$, $p < .0001$. Angry throws ($M = 120.987$, $SE = 3.668$) had the highest velocity, followed by Happy ($M = 94.327$, $SE = 2.846$), Neutral ($M = 88.698$, $SE = 2.476$), and Sad throws ($M = 81.208$, $SE = 2.215$). With the exception of one comparison, all pairwise contrasts reached significance with $F$s(1, 27) ranging from 13.464 to 187.293, all $p$s < .01 with a Bonferroni correction.[3] The only contrast that did not reach significance was between Happy and Neutral throws, $F(1, 27) = 5.206$, $p = .18$. Neither the main effect of Sex nor the interaction reached significance, all $F$s < 2.43, *ns*.

#### 5.2.2. Accuracy of emotion categorization

Next we examined the accuracy of emotion categorizations. Participants judged the emotion of point-light displays that varied in actual Sex (male, female) and Emotion (angry, happy, neutral, sad).

Our first tests examined whether participants' judgments were above chance. Overall accuracy was moderate (48.66%), but was significantly above chance (i.e., 25%), one-sample $t(16) = 20.132$, $p < 0.001$. This was true within each individual emotion, $t$s(16) = 17.862, 6.752, 5.515, and 4.157 for angry, happy, neutral, and sad displays respectively, all $p$s < .001. Thus, participants were above chance at categorizing all emotions.

We also examined whether accuracy varied systematically, depending on the sex and emotion of the display. We computed each participant's proportion correct for each of the 8 cells in the design. Then we analyzed proportion correct using a 2 (Sex) by 4 (Emotion) repeated-measures ANOVA. Accuracy did not vary for Sex, $F(1, 16) = 1.769$, $p = ns$, but it did vary across Emotion, $F(1.792, 28.671) = 27.360$, $p < 0.001$ (Greenhouse–Geisser control for sphericity). Post-hoc tests of this main effect revealed that judgments of anger displays were significantly more accurate than the other three emotion categories, $t$s(15) = 4.598, 4.714, and 6.739, for the comparison with happy, neutral, and sad displays, respectively, all $p$s < .01. No other comparison reached significance, all $t$s < 2.15, *ns*.

Importantly, the main effect of Emotion was qualified by a significant Sex by Emotion interaction, $F(3, 48) = 22.011$, $p < 0.001$ (Greenhouse–Geisser corrected for sphericity). As seen in Fig. 1, this interaction was obtained primarily due to the high level of accuracy for a single cell – angry men. In post-hoc tests, we compared the accuracy for judgments of men and women, separately within each emotion category. The only comparison that reached significance was for angry displays in which judgments of men were significantly more accurate than judgments of women, $t(15) = 10.114$, $p < .01$. Comparisons of men and women within other emotion categories did not reach significance, all $t$s < 4.20, *ns*. This pattern was illuminated by follow-up analyses of bias.

To further probe this pattern of results, we were interested to know whether the errors associated with each emotion category were systematically biased, or equally

[3] Note: In this and all post-hoc tests hereinafter, we report significance while using a Bonferroni correction.

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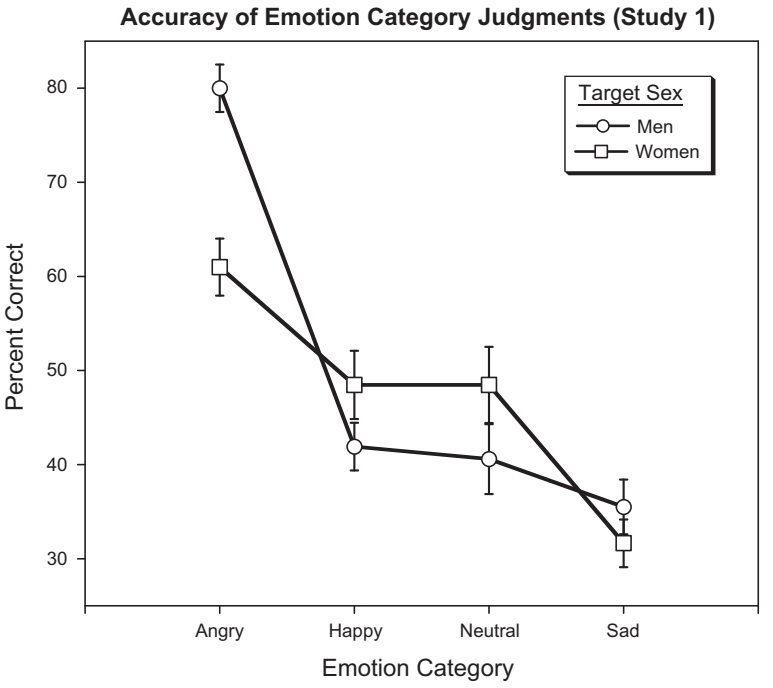


**Fig. 1.** Accuracy of emotion category judgments in Study 1 as a function of targets' actual sex and emotion category. Error bars depict standard errors.

distributed across the alternatives. Unfortunately, the experimental design (four-alternative forced choice) did not permit a standard signal detection analysis. Therefore, we used a measure of entropy – uncertainty or randomness in a system – to determine the extent to which false positives were equally distributed across the incorrect emotion categories (Shannon, 1948).[4] To the extent that there is no systematic bias in the system, we expected an equal distribution of false positives, yielding maximum entropy. Deviation from this, therefore, reflected bias.

Entropy varied across the emotions (angry = 1.096, happy = 0.994, neutral = 0.996, and sad = 0.908). This affected the distance from maximal entropy (1.099) in turn (angry = 0.003, happy = 0.105, neutral = 0.102, and sad = 0.191). This pattern implies that whereas errors made when judging angry throws showed no systematic bias to be mistaken for other emotions, errors made when judging the other categories of throws did. For instance, the errors for happy throws tended to be "neutral" categorizations; errors for neutral throws tended to be "happy" or "sad" categorizations; and errors for sad throws tended to be "neutral" categorizations.

### 5.3. Discussion

These data provide a foundation for our hypothesis that emotion category will bias sex categorization in a systematic fashion. First, we found that the average velocity of throwing motions varied as a function of emotion category. Yet unlike findings in studies of face perception (Becker et al., 2007; Hess et al., 2004, 2005) these velocity differences were not conflated with sex category. Importantly, this pattern helps rule out one way in which low-level velocity cues may lead to systematic biases in judgments. Because velocity did not vary by sex, it seems unlikely that perceivers would use a general heuristic based on actual sex differences in velocity that would lead to a systematic moderation of sex categorization from emotion category. Thus, if emotion categories are erroneously used to infer sex categories, it is not due to common differences in velocity.

Additionally, our findings for emotion categorization are consistent with prior work. First, the finding that observers are above chance in discerning emotion category from throwing motions corroborates existing research (Atkinson et al., 2004, 2007; Pollick et al., 2001) and extends this pattern to a new category of movement. Second, although observers' accuracy was above chance for all emotion categories, categorizations of anger were substantially more accurate than other displays. This is consistent with other findings in which the perception of anger appears to enjoy a perceptual privilege (see e.g., Chouchourelou et al.,

[4] In doing so, the probability mass function $P(x)$ was multiplied by its information content $I(x)$ for each possible outcome. These were summed together to give a measure of the system's entropy. The information content $I(x)$ was therefore defined by the term $\log^b p(x_i)$, and entropy of the system was defined as:

$$H(X) = \sum_{i=1}^{n} p(x_i) \log^b p(x_i)$$

Maximal system entropy was calculated using an equally distributed probability mass function giving a value of 1.098612. To estimate the actual entropy in our participants' judgments, we calculated the mean proportion of false positives received for each of the three incorrect alternatives, separately for each emotion.

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2007), suggesting that it may be unrivaled in its importance, relative to other emotion categories.

Collectively, these findings provide grounds for the notion that sex categorizations are made, at least in part, because of sex stereotypes that arise when emotion is perceived. Anger and sadness, in particular, are highly gender stereotyped (Hess et al., 2005; Plant et al., 2000, 2004). To the extent that angry motions are perceived as masculine and sad motions perceived as feminine as prior research suggests, these perceptions may be used to infer the target's sex category membership. Thus, just as other indirect routes to sex categorization has been documented in social perceptions based on full body motion (Johnson & Tassinary, 2005), it seems likely that similar processes may operate at the intersection of sex and emotion. We turn to this possibility in Study 2.

## 6. Study 2: Sex categorization

In Study 1, we found that perceivers were above chance in decoding the emotion being expressed in biological motion displays. This provided an important foundation for our proposal that emotion may bias judgments of an orthogonal social category – biological sex. In Study 2, we examined this directly by testing the extent to which sex category judgments (and their accuracy) varied as a function of emotion.

### 6.1. Method

#### 6.1.1. Participants

Twenty-seven undergraduate students (nine males, 18 females) participated in exchange for course credit or £5.

#### 6.1.2. Stimuli and procedure

Stimuli and their presentation were identical to those in Study 1, yet the judgments made by participants differed. We used a two-alternative forced choice paradigm in which participants categorized the biological sex of a subset of point-light throwers. Participants judged the sex and provided confidence assessments for a total of 232 displays, presented in random order. These included 2 randomly selected displays from each emotion state for each of the 29 actors. For each display, participants categorized the sex of each actor by depressing keys labeled "male" and "female." Then participants indicated their degree of confidence in their judgment using a 0–9 point Likert-type scale with anchors at 0 – guessing, 5 – fairly sure, and 9 – completely sure. Participants completed a practice phase consisting of six trials. Then, after any questions were fully answered, participants completed the main set of trials. Participants were not informed of the distribution of men and women in the stimulus set, nor did they receive feedback regarding their performance.

### 6.2. Results

#### 6.2.1. Accuracy

Participants judged the sex of point-light displays that varied in actual Sex (male, female) and Emotion (angry, happy, neutral, sad) via keyboard press. We computed each participants' proportion correct for each of the eight cells in the design. This served as our primary dependent measure. Where appropriate, these analyses were augmented with signal detection analyses.

When collapsed across all emotion categories, overall accuracy was quite low (52.57%). Nevertheless, the overall proportion correct was significantly above chance, one sample $t(26) = 2.561$, $p = 0.017$. This was also evident in the signal detection analysis, average $d' = .22$, $t(26) = 3.69$, $p < .01$. When analyzed individually for each emotion, however, only sex categorizations of angry displays exceeded chance responding, $t(26) = 5.041$, $p < .01$; sex categorizations of other emotions failed to reach significance, all $ts < 1.4$, *ns*.

The possibility that gender stereotypes of emotion would modulate the perception of sex category membership and bias judgments lead us to predict that accuracy would vary as a function of both Sex and Emotion category. To test this, we analyzed proportion correct using a 2 (Sex) by 4 (Emotion) repeated-measures ANOVA. Overall, accuracy did not vary by Sex, $F(1, 26) = 0.446$, $p = ns$, but it did vary across Emotion, $F(3, 78) = 6.295$, $p < 0.001$. Post-hoc tests probing this main effect revealed that the difference in accuracy was significant between angry and happy displays, $t(25) = 4.0473$, $p < .05$, but not others, $ts$ $(25) < 4.05$, *ns*.

More importantly, we observed a significant effect for the predicted Sex by Emotion interaction (see Fig. 2a), $F(1.330, 34.585) = 38.015$, $p < 0.001$ (Greenhouse–Geisser control for sphericity). In post-hoc tests, we compared the accuracy of judgments across each emotion category, separately for judgments of male and female targets. Judgments of male targets were significantly more accurate for angry displays, relative to the other three emotions, $ts(25) = 5.984$, 7.094, and 7.197 for comparisons with happy, neutral, and sad emotions, respectively, all $ps < .01$. Judgments of female targets, in contrast, were significantly more accurate for both sad and neutral, relative to angry displays, $ts$ $(25) = -5.104$ and $-5.032$, $ps < .05$. Other comparisons of emotions within each sex category did not reach significance, all $ts < 3.44$, *ns*.

A signal detection analysis corroborated the patterns described above. As seen in Table 1, sensitivity varied across Emotion, $F(3, 78) = 4.23$, $p < .01$. Contrast analyses revealed that sensitivity was higher for Anger displays, relative to the other three emotions, all $Fs > 15.8$, $ps < .001$; other contrasts did not reach significance. Estimates of bias ($C$) also differed across Emotion, $F(3, 78) = 36.35$, $p < .001$ (see Table 1). Judgments of Anger displays showed a significant "male" bias in a one-sample $t$-test against a Criterion = 0, $t(25) = -5.64$, $p < .01$; judgments of Neutral and Sad displays showed a significant "female" bias in one-sample $t$-tests against a Criterion = 0, $ts(25) = 3.81$ and 6.04, respectively, all $ps < .01$; judgments of Happy displays did not show significant bias, $t(25) = 1.11$, *ns*.

#### 6.2.2. Confidence

We were also interested in participants' level of confidence in the judgments that they rendered. We reasoned that confidence estimates would provide insight into the

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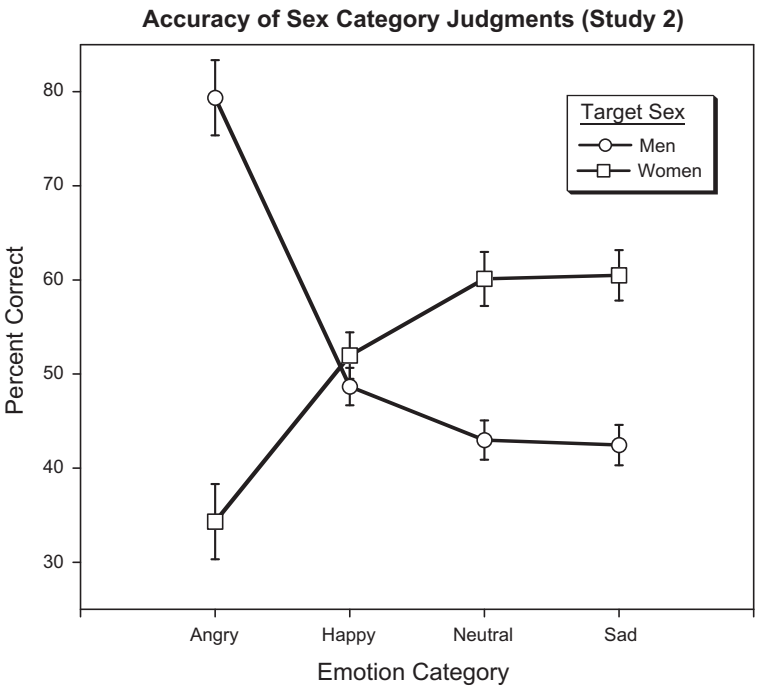


**Fig. 2a.** Accuracy of sex categorizations in Study 2 as a function of targets' actual sex and emotion being expressed. Error bars depict standard errors.

**Table 1**
Sensitivity and bias measures for sex category judgments in Study 1.

| | Emotion Category | | | |
|---|---|---|---|---|
| | Angry | Happy | Neutral | Sad |
| *d′* | .562 | .064 | .119 | .148 |
| *C′* | -.708 | 0.052 | 0.222 | 0.255 |

process of categorization. Indeed, some of the earliest work examining the perception of biological motion reported a tight coupling between perceivers' accuracy and their level of confidence (Kozlowski & Cutting, 1977). Therefore, we were interested to know whether participants' confidence reflected the systematically lower levels of accuracy for specific intersections of sex and emotion – specifically for angry women and sad men.

Participants indicated their degree of confidence for each sex categorization using a 9 point Likert-type scale. We computed participants' average confidence for each of the 8 stimulus categories.

Then we analyzed these data using a 2 (Sex) by 4 (Emotion) repeated-measures ANOVA. Overall, participants' confidence did not vary by Sex, $F(1, 26) = 3.617$, $p = ns$. It did, however, vary across Emotion, $F(2.01, 52.14) = 26.736$, $p < .001$ (see Fig. 2b; Greenhouse-Geisser control for sphericity). Post-hoc tests of this main effect revealed that participants were more confident in their judgments of angry throws, relative to all other emotions, all $ts(25) > 4.50$, all $ps < .01$. No other post-hoc comparisons reached significance, $ts < 2.3$, *ns*.

The main effect of Emotion was qualified by a significant Sex by Emotion interaction, $F(2.11, 54.87) = 6.105$, $p < .01$. In post-hoc tests, we compared the confidence for judgments across each emotion category, separately for judgments of male and female targets. Confidence for judgments of male targets was significantly higher for angry displays, relative to the other emotions, $ts(25) = 9.543$, 14.272, and 12.686 for comparisons with happy, neutral, and sad emotions, respectively, all $ps < .01$. Additionally, confidence was higher for judgments of men's happy, relative to neutral, displays, $t(25) = 4.728$, $p < .05$. Similarly, confidence for judgments of female targets were significantly higher for angry displays, relative to all other emotions, $ts(25) = 5.499$, 8.392, and 6.177 for comparisons with happy, neutral and sad emotions, $ps < .01$. Other comparisons of emotions within each sex category did not reach significance, all $ts < 4.37$, *ns*. Thus, although they differed in magnitude, confidence was similar in form across emotions for judgments of men and women.

### 6.3. Discussion

Collectively, these results provide insights concerning the way in which emotion biases sex categorization. Sex categorizations varied as a function of the throwers actual sex and the emotion being expressed. Angry throws were overwhelmingly categorized as men, and observers were highly confident in their judgments. Sad throws were more likely to be categorized as women, and again, observers were quite confident in their judgments. These findings have implications for perceptual research, generally, and the questions posed within this paper, specifically.

At a general level, these findings provide an important addition to the perceptual literature that has focused

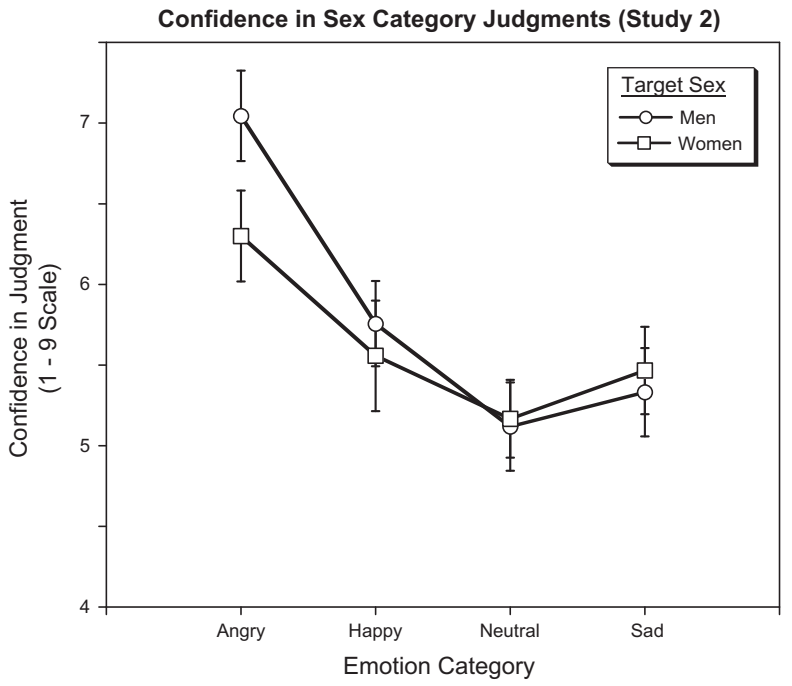


**Fig. 2b.** Confidence for sex category judgments in Study 2 as a function of targets' actual sex and emotion being expressed. Error bars depict standard errors.

primarily on the accuracy of perceptions of biological motion displays. Indeed, a substantial and growing body of work attests to the efficiency with which perceivers extract meaningful social information such as categories from minimal motion cues (see e.g., Pollick et al., 2002, 2005). Consistent with this prior work, when we collapsed across all emotion categories, we found that sex categorization was above chance. Yet this overall accuracy showed biases that led to systematic errors in judgment. Indeed, for angry and sad motions, categorizations were *below* chance for female and male targets, respectively, $ts(28) = -3.895$ and $-3.675$, both $ps = .001$. Although similar forms of bias have been demonstrated in the face perception literature (e.g., Hess et al., 1997), this is – to our knowledge – the first empirical evidence for such biases in the perception of biological motion. At a minimum, therefore, this finding suggests that researchers examining social perception should consider secondary factors more broadly.

At a more specific level, these results also speak to the predictions for how emotion category may affect sex categorization. Overall, these findings provide only weak support for Runeson & Frykholm's (1981, 1983) prediction that higher velocity motions will afford more accurate judgments. From this perspective, accuracy of sex categorizations should have also varied with emotion because of their pronounced differences in velocity (Study 1). If correct, accuracy should have been highest for angry throws and followed by happiness, neutral, and sad throws – in that order. Although we observed a significant main effect of Emotion for proportion correct, the effect was qualified by a sizable interaction with target sex. This pattern is inconsistent with the notion that higher velocity will lead to more accurate judgments. Instead, we observed a systematic bias that was tethered to the emotion being displayed resulting in low levels of accuracy for certain groups, specifically sad men and angry women.

Indeed, we predicted and found that accuracy varied as a function of emotion in a manner that is consistent with the gender stereotyping of emotions (e.g., Plant et al., 2000, 2004). If correct, accuracy should have varied by sex and emotion category. Consistent with this proposition, angry throws were more likely to be categorized as men, and sad throws were more likely to be categorized as women, resulting in only moderate overall levels of accuracy. We propose that this occurred because anger is stereotypically masculine and sadness is stereotypically feminine. The patterns that we observed in our data are consistent with this interpretation.

Nevertheless, an alternative explanation for these effects remains viable. In Study 1 we found no reliable sex difference in the velocity of throwing motions, and we noted that heuristic judgments that were grounded in actual sex differences were therefore unlikely. Yet just because it is not a valid heuristic does not mean that perceivers do not use it. Thus, it is important to note that the pattern of accuracy for sex categorizations in Study 2 could have been obtained if perceivers used velocity as a cue to categorize stimuli. This possibility may be particularly likely for the current stimulus set, relative to other biological motion displays, because the motion itself – throwing – may arouse presumptions about the way that men and women throw a ball. Importantly, these presumptions may be prone to involve velocity. For example, if high velocity motions were attributed to men and low velocity motions were attributed to women, this would lead to the exact pattern of results that we report in Study 2. Thus,

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even though we found no reliable differences in the velocity for throws made my men and women (Study 1), observers may nevertheless use this heuristic for sex categorization, especially when viewing throwing motions.

The results of Study 2 are consistent with both our proposed mechanism that operates through the gender stereotyping of emotion and an alternative mechanism that is based on a simple heuristic. We designed Study 3 to differentiate between these two possibilities.

## 7. Study 3: Sex categorization without velocity cues

We aimed to better understand whether gender stereotypes or heuristic judgments produced the strong sex by emotion interaction in Study 2 by removing velocity as a potential cue for sex categorizations. To that end, we unconfounded velocity and emotion by velocity-normalizing our point-light displays and replicating Study 2. If gender stereotyped emotions bias sex categorizations, we predicted that the interaction between sex and emotion would remain intact and strong. If, however, a simple velocity heuristic governed sex categorizations, we predicted a sizable and statistically significant reduction (and possible elimination) of the interaction effect. Thus, Study 3 provided a critical test to differentiate between our proposed mechanism and an alternative explanation for our results.

### 7.1. Method

#### 7.1.1. Participants

Ten undergraduate students (two males, eight females) participated in exchange for course credit or £5.

#### 7.1.2. Stimuli and procedure

We normalized the velocity of the point-light displays. First we determined the median wrist speed across all displays. Then we set the average speed of each individual display to the median value of all throws. This was achieved by resampling the trajectory of each marker at a rate that provided a match between the mean speed of the wrist point for that throw and the median wrist speed of all throws. Presentation of these stimuli was identical to Study 1. As in Study 1, participants judged the sex for a total of 232 displays, including 2 randomly selected displays from each emotion state for each of the 29 actors. Participants were not informed of the distribution of men to women in the stimulus set, nor did they receive feedback regarding their performance.

### 7.2. Results and discussion

#### 7.2.1. Accuracy

As before, participants judged the sex of point-light displays that varied in Sex and Emotion via keyboard press. We computed each participants' proportion correct for each of the 8 cells in the design. Analyses focused both on proportion correct and, where appropriate, signal detection.

Overall accuracy was again quite low (54.24%), and was only marginally different from chance for percent correct, one sample $t(9) = 2.199$, $p = 0.055$; however the overall $d' = .316$ differed significantly from zero, $t(9) = 3.051$, $p = .01$. Our central predictions, however, involved the effects of sex and emotion.

We analyzed accuracy using a 2 (Sex) by 4 (Emotion) repeated-measures ANOVA. Overall, the accuracy of sex categorizations did not vary by Sex, $F(1, 9) = 0.594$, $p = ns$, but it did vary by Emotion, $F(3, 27) = 4.203$, $p = .015$. Although the overall effect did reach significance, post-hoc tests on proportion correct revealed no significant pairwise contrasts, all $ts(27) < 3.2$, $ns$.

A signal detection analysis across the four emotions revealed a similar pattern, $F(3, 27) = 6.53$, $p < .01$. Contrasts involving $d'$ revealed significantly higher sensitivity for Anger versus both Neutral and Sad displays, $Fs(1, 9) = 15.38$ and 13.99, respectively, $ps < .05$ (see Table 2); other contrasts did not reach significance. Estimates of bias ($C'$) also differed across the four emotion conditions, $F(3, 27) = 4.625$, $p = .01$. Judgments of Anger displays showed a marginally-significant trend toward a "male" bias in a one-sample $t$-test against a Criterion = 0, $t(26) = -2.17$, $p = .058$; judgments of other the other emotion categories were not significantly biased, all $ts < 2.0$, $ns$.

In Study 2, the analogous effects were interpreted to provide some support, albeit minimal, for the velocity predictions derived from Runeson and Frykholm (1981, 1983). In the current study, however, this explanation is not viable because the velocity of motions has been standardized to the mean velocity of all motions.

More importantly, we again observed a significant effect for the predicted Sex by Emotion interaction (see Fig. 3), $F(1.547, 13.926) = 5.074$, $p < .029$ (Greenhouse–Geisser control for sphericity). In post-hoc tests, we again compared the accuracy for judgments across each emotion category, separately for judgments of male and female targets. Judgments of male targets were significantly more accurate for angry displays, relative to sad displays, $t(25) = 5.043$, $p < .05$. Other comparisons of emotions within each sex category did not reach significance, all $ts < 4.903$, $ns$.

#### 7.2.2. Comparison of Studies 2 and 3

Participants' judgments in Study 3 showed the same pattern for accuracy was obtained for judgments of the non-velocity controlled stimuli in Study 2. Specifically, the same predicted interaction between Emotion and Sex categories was present in both cases. That said, visual inspection of Figs. 2a and 3 suggests that the magnitude of this interaction may differ across the two studies, with

**Table 2**
Sensitivity and bias measures for sex category judgments in Study 2.

| | Emotion category | | | |
|---|---|---|---|---|
| | Angry | Happy | Neutral | Sad |
| $d'$ | .779 | .343 | .044 | .097 |
| $C'$ | -.367 | -.083 | .099 | .166 |

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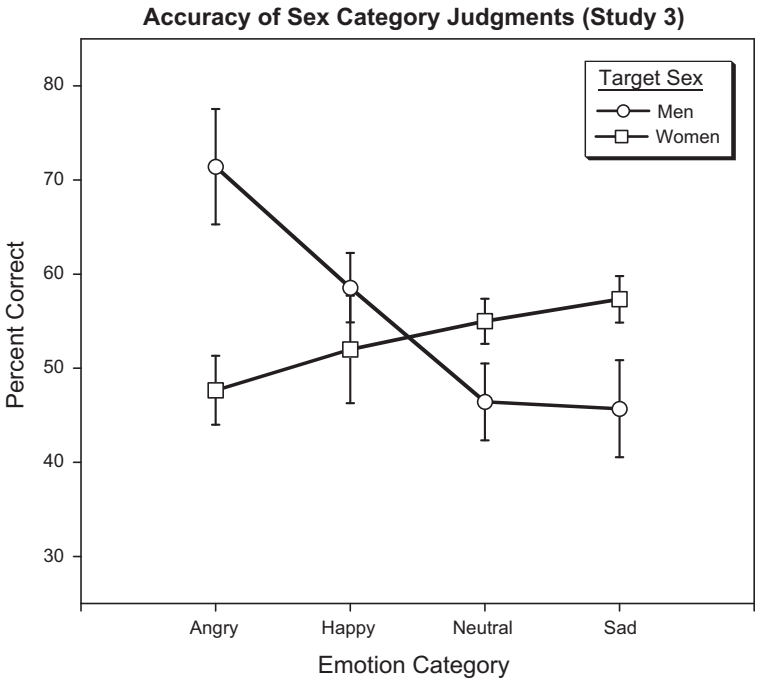


**Fig. 3.** Accuracy of sex category judgments in Study 3 as a function of targets' actual sex and emotion being expressed. Error bars depict standard errors.

a smaller effect in Study 3. This raises the possibility that our velocity control in Study 3 significantly attenuated the effects.

We examined this possibility by analyzing the data from the two studies together, while adding Study as a factor in the analysis. Thus, we analyzed proportion correct using a 2 (Study) by 2 (Sex) by 4 (Emotion) ANOVA. If the magnitude of the Emotion by Sex interaction varied significantly across studies, it would be apparent in the main and interaction effects involving Study.

Not surprisingly, the effects that were significant in the main analyses of Studies 2 and 3 remained so in this analysis. We again found that proportion correct varied across the four emotion categories, $F(3, 105) = 8.413$, $p < .0001$. The interaction between Emotion and Sex was also significant, $F(1.406, 49.212) = 2.686$, *ns* (with Greenhouse-Geisser control for sphericity). Because these effects were examined fully within the results for each study, we elected to omit follow-up analyses here.

Importantly for comparative purposes, no effect involving Study reached significance, all $F$s < 2.7, *n.s.* Thus, although visual inspection of our figures may lead one to presume that the interaction effect between Emotion and Sex was attenuated in Study 3, we found no significant empirical foundation for that conclusion.

Even after controlling for the velocity in the throwing displays, accuracy varied as a function of both sex and emotion category. Based on these results, it seems unlikely the primary mechanism by which emotional expression influences sex categorizations is through heuristics involving velocity. Instead, the findings from Studies 1–3 favor a social stereotypes interpretation.

## 8. Interim summary

Based on the results of Studies 2 and 3, emotion categories appear to bias sex categorization. Because emotions tend to be gender stereotyped (Plant et al., 2000, 2004), it seems likely that observers' judgments reflected participants' application of gender stereotypes to inform sex categorizations. If correct, sex categorization should reflect gender stereotyping that originates in the perception of emotion. In Study 4, we examine this proposed mediation directly.

## 9. Study 4: Mediated sex categorization

In Studies 1–3, we found evidence consistent with our proposal that emotion categories bias sex categorization. This possibility entails not only that perceivers can discern emotion states from biological motion displays, but also that these perceptions are gendered, specifically that anger is perceived as male-typed and sadness is perceived as female-typed. Across three studies, we have presented evidence that is consistent with this possibility. That said, Studies 1–3 have not demonstrated the proposed mediation directly. In Study 4, we test whether sex categorizations are mediated by the perceived masculinity/femininity of the relevant emotion percept.

### 9.1. Method

#### 9.1.1. Participants

Thirty-nine undergraduates (18 males, 20 females, 1 unreported) participated in exchange for course credit.

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*9.1.2. Materials and procedure*

Stimuli included one original display (selected at random) from each of the emotion performed by the actors in the library (i.e., the non-velocity normalized stimuli used in Studies 1 and 2; Ma et al., 2006), yielding 120 stimuli. Stimuli were presented on a 15-inch Macintosh laptop computer running SuperLab software (Cedrus, San Pedro, CA). Each display was normalized to 7.8 × 5.8 cm and subtended an approximate viewing angle of 8.9° × 6.6°. After each throw, participants categorized the target's sex and judged the target's degree of masculinity/femininity, anger, happiness, and sadness using 11-point Likert-type scales. Finally, participants categorized the emotion being depicted in a 4 alternative forced choice (angry, happy, neutral, sad). Participants were not informed of the distribution of emotions or men and women in the stimulus set, nor did they receive feedback regarding their performance.

*9.2. Results and discussion*

We explored the relation between perceptions of emotion and sex categories and whether this relation was mediated by perceptions of gender typicality (i.e., perceived masculinity and femininity). Differences in both experimental design and analytic goals required a slightly different analytic strategy. Specifically, we used generalized estimating equations (Fitzmaurice, Laird, & Ware, 2004) to model the direct and interaction effects of stimulus sex and perceived emotion on sex category judgments. This technique afforded two substantial benefits. First, this technique modeled each observation in a fully nested design, and then calculated the average effect thus exploiting every observation. This was particularly important given the reduction in the number of trials per participant in this study, relative to Studies 1–3. Second, this technique appropriately analyzed logistic values, which was necessary given our shift from analyzing proportion correct to analyzing perceived sex category directly. We report unstandardized regression coefficients throughout this section.

*9.2.1. Conceptual replication*

Given the differences in methodology and analytic strategy between this and the prior studies, our first analysis aimed to conceptually replicate the findings of Studies 2 and 3. We tested whether Perceived Emotion and target Sex had the same effect on accuracy that we observed previously. We regressed accuracy (coded 0 = error, 1 = accurate) onto Perceived Emotion (multicategorical) and Sex (centered to facilitate interpretation; –0.5 = male, 0.5 = female). The effect for neither Sex nor Perceived Emotion was significant, $X^2$s = 0.83 and 3.99, respectively, both *ns*. However, as before, the interaction between Sex and Perceived Emotion was strong and significant, $X^2(3) = 21.36$, $p < .0001$. As seen in Fig. 4, this interaction was obtained primarily because for anger, the accuracy was significantly *above chance* for male targets, $B = .2619$ (.0690), $z = 3.79$, $p < .0001$, but significantly *below chance* for female targets, $B = -0.2381$ (.0746), $z = -3.19$, $p = .001$. The opposite pattern was observed for stimuli showing sadness. For sad stimuli, accuracy was significantly *above chance* for female targets, $B = 0.3605$ (.1004), $z = 3.59$, $p = .0003$, but did not differ from chance for male targets, $B = -0.0898$ (.1133), *ns*. No other cells differed from chance responding.

Thus, using a different methodological approach, we conceptually replicated the effects observed in Studies

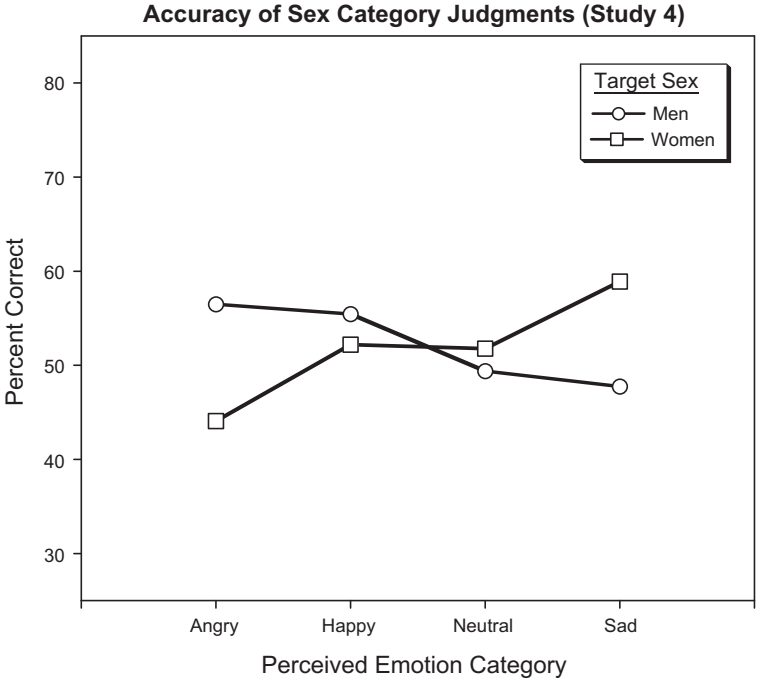


**Fig. 4.** Accuracy of sex categorizations in Study 4 (a conceptual replication) as a function of targets' actual sex and perceived emotion category.

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1–3. Once again, these findings are consistent with the notion that gender stereotypes influence perceived sex via stereotyped inference. This process, although implied, has not been tested directly. A compelling test of this possibility cannot focus exclusively on the accuracy of sex category judgment. Instead, it must also determine what factors compel male versus female judgments and pinpoint any mediating effects that account for the pattern.

*9.2.2. Perceived sex*

We have proposed that the perception of emotion affects sex categorization because emotion perception also evokes gendered stereotypes that are used to infer sex category membership. To examine this, we tested whether perceptions of masculinity/femininity mediated the relation between Perceived Emotion and sex categorization. First, we computed an index of perceived Gender by reverse scoring masculinity judgments and averaging them with femininity judgments. Then, we tested for mediation.

Although grounded in a common analytic approach (i.e., Baron & Kenny, 1986), our specific mediational analysis required some modifications due to the dichotomous DV and multicategorical IV. We focused this analysis on one contrast, in particular – the contrast between stimuli that were perceived to be angry and those that were perceived to be sad. We did this for two related reasons. First, the multicategorical nature of the Emotion variable, forced the mediational analysis to examine specific contrasts. Second, the contrast between sadness and anger was theoretically derived and consistent with the findings from Studies 1–3. Therefore, for this contrast, we examined whether perceptions of Gender mediated the effect of Emotion on perceptions of sex category membership (see Bolger & Amarel, 2007 for a conceptually similar approach to testing the mediation of a specific contrast). To the extent that gender stereotypes of emotion bias sex categorization as we have proposed, we would expect that: (a) sex categorizations will covary with perceived emotion category, (b) perceptions of gender will covary with perceived emotion category, and (c) the relation between sex categorization and perceived emotion category will be eliminated after statistically controlling for perceived gender. We tested each of these predictions in our mediational analysis. All parameters were estimated using generalized estimating equations as described above.

The first step of the mediational analysis established the relation between perceptions of emotion and sex categorization. We regressed Perceived Sex onto Perceived Emotion. As predicted, the overall model was strong and significant, $X^2(3) = 12.94$, $p = 0.005$. Most importantly, the planned contrast between the displays perceived to be sad versus those perceived to be angry was strong and significant (see Fig. 5), $B = -0.5524$ ($SE = 0.1319$), $z = -4.19$, $p < .0001$. Angry throws were 73% *less* likely to be perceived as women, relative to sad throws, Odds Ratio = 1.7374. Moreover, sex categorizations of both angry and sad throws differed significantly from chance – and in opposite directions, $B$s = −.3017 and .2507 (SEs = .1037

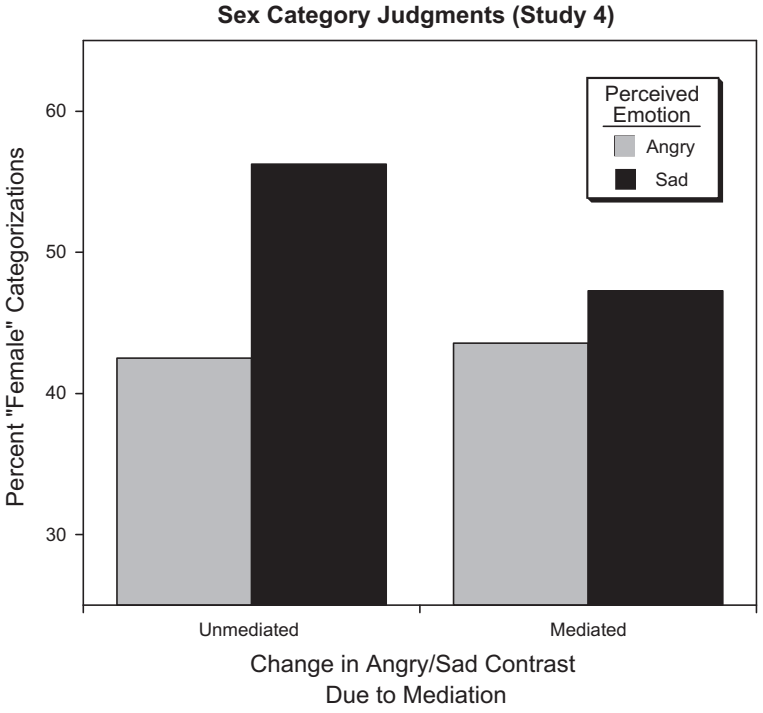


**Fig. 5.** Planned contrasts between judgments for angry and sad throws for the test of mediation in Study 4. Unmediated estimates depict the significant contrast between categorizations of sad and anger displays when perceived sex was regressed onto perceived emotion in the first step of the mediational model; Mediated estimates depict the same contrast, now non-significant, after controlling for gendered perceptions of emotion in the final step of the mediational model.

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and .0985), $zs = -2.91$ and 2.54, respectively, both $ps \leqslant 0.01$.

The next step of the mediational analysis established the relation between perceptions of emotion and perceptions of gender. We regressed Perceived Gender onto Perceived Emotion. As predicted, the overall effect of Perceived Emotion was significant in the model, $X^2(3) = 16.81$, $p < .0001$, and the specific contrast between anger and sadness was also strong and significant, $B = -1.0501$ (0.1944), $z = -5.40$, $p < .0001$. Compared to sad throws, angry throws were perceived to be more masculine/less feminine (by one full point on the scale).

The final step of the mediational analysis tested whether the relation between perceived emotion and sex categorization was mediated by perceived Gender. We tested the mediated effect by estimating the effect of emotion category on sex categorization after controlling for perceived gender. Thus, we regressed Perceived Sex onto Perceived Emotion and Perceived Gender. As predicted, after controlling for the mediating effect of Perceived Gender, the effect of Emotion on sex judgments was no longer significant and the parameter estimate was halved, $X^2(3) = 6.87$, *ns*. More importantly for our interpretation, the contrast between anger and sadness also dropped to non-significance (see Fig. 5), $B = -0.1676$ (0.2256), $z = -0.74$, *ns*. Finally, after controlling for Perceived Gender, sex category judgments for angry and sad throws were indistinguishable from chance, $Bs = -0.2586$ and $-0.0910$ (0.1753 and 0.1581), $zs = -1.48$ and –0.58, respectively, both *ns*.

Thus, the results of our mediational analysis provide direct support for the notion that emotion categories bias sex categorization through gender stereotypes. As predicted, our model established that (a) sex categorizations covaried with perceived emotion category, resulting in a significant contrast for perceptions of angry and sad displays (depicted in the "Unmediated" bars in Fig. 5), (b) perceptions of gender also covaried with perceived emotion category, again resulting in a significant contrast for perceptions of angry and sad displays, and (c) the relation between sex categorization and perceived emotion category was eliminated after statistically controlling for perceived gender, and the contrast between angry and sad displays also dropped to non-significance (depicted in the "Mediated" bars in Fig. 5).

One may argue, however, that an alternate model may also account for these effects. Specifically, it may be that observers make stereotyped assumptions about an individuals' emotion state based on the perceived masculinity/femininity of a target. If correct, this alternate model implies that sex differences in biomechanics, not differences based in emotion perception, lead to either masculine or feminine perceptions that are used to infer a target's sex category. We tested this model, and found that it did not account for our pattern of data. Thus, the most likely explanation is that emotions are gender stereotyped and thus affected sex perception via perceptions of masculinity/femininity.

It is also important to note that our participants provided their set judgments together for each display. We ordered these judgments in a way that we thought would minimize any direct influence on our pattern of results. Thus, we collected sex categorizations first and emotion categorizations last. The specific concern would be that the categorization of one factor might impact the categorization of another factor. Interestingly, this is precisely the type of mechanism that we propose underlies our judgments. Thus, we expect this to occur regardless of whether the judgments were collected together or separately. It is therefore important to reiterate that the pattern of data for sex categorizations in this study was consistent with the findings of Studies 2 and 3, thus conceptually replicating the basic pattern of responses using a modified methodology. Moreover, we demonstrated that the impact of concurrent perceptions of emotion and sex categories affects the later because of the gender stereotyping of emotion.

Therefore, the results of this mediational analysis provide compelling evidence that stereotyped associations with perceived emotion category mediate the effect of emotion on perceived sex.

## 10. General discussion

We examined how the emotion depicted in biological motion displays affected observers' sex categorizations. Across 4 studies, a consistent pattern of data emerged. Perceivers' accuracy varied as a function of both emotion state and sex category of a target. Importantly, observers accurately judged emotion category (Study 1), and this impacted sex categorization. Regardless of the actual sex category, angry motions were overwhelmingly judged to be men, and sad motions were consistently judged to be women (Studies 2–4). We ruled out the possibility that a simple heuristic based in velocity could account for these effects (Studies 1 and 3), and thus focused our attention on the possibility that gender stereotypes of emotion biased the perception of sex category membership. Indeed, we demonstrated that gendered perceptions of emotion mediated the relation between emotion category and sex category judgments (Study 4).

### *10.1. Implications for the gender stereotyping of emotion*

These data are an important contribution to understanding how social stereotypes of emotion bias the perception of men and women. Although scholars have long argued that such effects exist (e.g., Condry & Condry, 1976; Plant et al., 2000), recent evidence called into question whether the empirical patterns concerning this emerged exclusively due to overlapping facial appearance between emotion and sex categories (e.g., Becker et al., 2007; Hess et al., 2004, 2005). Specifically, the facial features associated with sexual dimorphism are also common to emotion displays. This confounding made it difficult to disentangle the independent effects of stereotypes and common morphology in what looked like sex-typed patterns of data.

Our studies overcame the difficulties by focusing on a different aspect of social perception – observers' ability to discern personal characteristics from body motion. Indeed, our stimuli isolated the body's motion, minimizing

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the impact of structural cues entirely. Moreover, the nature of the stimuli permitted us to remove velocity as a cue to either sex or emotion category. Consequently, these studies provide a strong test for the impact of gender stereotypes of emotion in social judgments. We found that sex categorizations relied on perceived emotion, biasing observers' judgments in a gender-stereotyped direction and altering accuracy.

That is not to say, however, that there are no other factors operating. There may, for instance, be a kinematic control variable that is yet to be identified in which the motions associated with emotion and sex category are confounded. Additionally, related social perceptions (e.g., affiliation/dominance or social status) may operate in body perception as they do in face perception, insofar as these states are related to both emotion expression and sex category (see e.g., Hess, Blairy, & Kleck, 2002; Hess et al., 2004; Marsh, Henry, Schechter, & Blair, 2009). Such extensions of the current work are beyond the scope of the present manuscript. It seems likely however, that if such variables exist, they operate as different manifestations of a gender stereotyping mechanism. Consequently, we maintain that our results speak directly to the viability of a gender stereotype effect in the perception of emotion. Indeed, we examined the effects of cues that have previously been implicated in body perception – velocity (Pollick et al., 2001, 2002; Runeson & Frykholm, 1981) and masculinity/femininity (Johnson & Tassinary, 2005; Johnson & Tassinary, 2007).

It is also important to note that although we focused our analyses on how the perception of emotion category may bias the perception of sex categorization, the alternate direction of influence remains viable. Much of the relevant work in the face perception literature, for example, examined how sex categories bias emotion perception (see e.g., Condry & Condry, 1976; Plant et al., 2000, 2004). This notion is therefore that implicit sex categorizations that occur when viewing a point-light display might bias emotion categorization. While we did not seek to test this direction of influence, specifically, our data nevertheless speak to the likelihood that such biases might occur. This possibility entails that, once perceived, sex categories will affect the perception of emotions in a gender-stereotyped manner. If correct, this has implications for the relative accuracy of emotion categorizations of men and women, especially for the emotions anger and sadness (and possibly happiness). Throughout our studies, only one such contrast reached significance. In Study 1, judgments of anger displays were more accurate for men, relative to women, but this difference was not significant for the other emotions. Thus, although it remains possible that the perception of sex category may bias the perception of emotion category, it may be that such influence operates primarily through common encoding, rather than stereotyped decoding. Here we have provided a foundation upon which this can be examined in future research.

### *10.2. Implications for social perception research*

More broadly, these findings have implications for social perception work, especially in the domain of body perception. Within this area, the findings we have presented are relatively novel. Specifically, most prior work has focused on one of two questions: a) whether perceivers can achieve accuracy when judging biological motion displays (Pollick et al., 2002), or b) which kinematic feature supports social percepts (Barclay et al., 1978; Cutting, 1978; Cutting, Proffitt, & Kozlowski, 1978; Mather & Murdoch, 1994; Troje, 2002). Our findings stand in contrast to these approaches insofar as we predicted, and found, a systematic bias in one perceptual judgment – sex categorization – based on a secondary factor that was presumably irrelevant to the judgment task, emotion. Thus, these findings highlight the multifaceted nature of social perception – and reveal the sizable impact that orthogonal social categories can have on fundamental judgments. Our findings highlight the importance of examining not only the cues that give rise to specific percepts, but also the concomitant perceptions that may bias social perception as it unfolds.

Similarly, these findings add to a growing body of literature that focuses on the combinatorial nature of social perception (e.g., Johnson, Freeman, & Pauker, submitted for publication). Past studies have tended to focus primarily on a single dimension (e.g., sex), while holding other aspects of identity constant (see e.g., Bodenhausen & Peery, 2009). While this approach afforded a high degree of precision to relate parameters to perceptions, it did little to provide a comprehensive picture of how the perception of others unfolds in real life where social targets vary not only in sex, but also in emotion state, age, race category, sexual orientation, and many other factors. Increasingly, social perception research is incorporating intersecting identities, such as sex and emotion categories, to examine their compound impact on perception (see e.g., Johnson et al., submitted for publication), frequently operating through the top-down influence of prior knowledge structures. Here we add to this growing body of work by expanding it to the study of biological motion.

Indeed, evidence for such top-down modulation of perception is rapidly accumulating. Johnson and colleagues, for example, found that race category exerts a top-down influence over the efficiency of sex category judgments (Johnson et al., submitted for publication). Similar effects emerge for the perception of sexual orientation (Freeman, Johnson, Ambady, & Rule, 2010; Johnson & Ghavami, submitted for publication). In another domain, Shiffrar and her colleagues have reported that the very perception of motion varies depending on the recipient of an action (Shiffrar, Kaiser, & Chouchourelou, 2010). When a motion was directed toward a person, observers reported experiencing strong motion perceptions; when a motion was directed toward an object, they did not. These effects and others appear to be served by top-down modulation of social information on more fundamental aspects of visual perception of bodies (see e.g., Grossman, Donnelly, Price, Pickens, & Morgan et al., 2000) and faces (see e.g., Puce, Allison, Bentin, Gore, & McCarthy, 1998; Hoffman & Haxby, 2000). Thus, growing evidence highlights an important role for social cognitive modulation of perceptual processes.

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### 10.3. Conclusions

Across four studies we reported evidence for top-down modulation of the visual perception of biological motion. Specifically, we found a consistent pattern in which sex categorization was biased by an orthogonal social category, emotion. The research sits at the intersection of two distinct research traditions – vision sciences and social psychology. As such, the findings impact each literature in a different way. For research examining biological motion perception, these findings highlight the role that concomitant percepts have over social perceptual judgments. For research examining the gender stereotyping of emotion, these findings provide a compelling case for the way in which gender stereotypes of emotion exert a top-down modulation of sex categorization.

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