

# The perception of emotion from body movement in point-light displays of interpersonal dialogue

Tanya J Clarke, Mark F Bradshaw, David T Field<sup>¶</sup>, Sarah E Hampson, David Rose

Department of Psychology, University of Surrey, Guildford, Surrey GU2 7XH, UK;

e-mail: [T.Clarke@surrey.ac.uk](mailto:T.Clarke@surrey.ac.uk); <sup>¶</sup> Department of Psychology, University of Reading, Reading RG6 6AL, UK

Received 5 January 2004, in revised form 24 January 2005

**Abstract.** We examined whether it is possible to identify the emotional content of behaviour from point-light displays where pairs of actors are engaged in interpersonal communication. These actors displayed a series of emotions, which included sadness, anger, joy, disgust, fear, and romantic love. In experiment 1, subjects viewed brief clips of these point-light displays presented the right way up and upside down. In experiment 2, the importance of the interaction between the two figures in the recognition of emotion was examined. Subjects were shown upright versions of (i) the original pairs (dyads), (ii) a single actor (monad), and (iii) a dyad comprising a single actor and his/her mirror image (reflected dyad). In each experiment, the subjects rated the emotional content of the displays by moving a slider along a horizontal scale. All of the emotions received a rating for every clip. In experiment 1, when the displays were upright, the correct emotions were identified in each case except disgust; but, when the displays were inverted, performance was significantly diminished for some emotions. In experiment 2, the recognition of love and joy was impaired by the absence of the acting partner, and the recognition of sadness, joy, and fear was impaired in the non-veridical (mirror image) displays. These findings both support and extend previous research by showing that biological motion is sufficient for the perception of emotion, although inversion affects performance. Moreover, emotion perception from biological motion can be affected by the veridical or non-veridical social context within the displays.

## 1 Introduction

The ability to interpret the emotions of others in our environment from solely non-verbal, movement cues is a considerable asset for effective social interaction (eg Dittrich et al 1996; Wallbott 1998). Rather than thinking of emotions as states that reside only at the intrapersonal level (eg Ekman 1984), emotionality can be thought of as a dynamic relational process that occurs between the individual and the environment (Campos et al 1989; Blair 2003). According to this view, the study of emotions at a social level must be of interest, as emotions have interpersonal or intergroup regulatory outcomes. For example, an emotion such as joy not only has the function of maintaining the individual's behaviour but signals to others to continue their interaction with the individual (Emde 1988). This communicatory function occurs from an early age, as illustrated by the way that infants will look towards their caregiver for assurance that a novel object can be approached. If the caregiver smiles, the child will approach the object; but, if the caregiver expresses fear, disgust, or anger, the child will not (Klinnert et al 1987). However, how emotions are coordinated and integrated between two people is relatively seldom researched. As a first step towards a deeper analysis of the cues involved, we here used reduced-cue stimuli to study the perception of emotion in the body movements of interacting partners engaged in conversations.

Biological-motion cues (Johansson 1973) are sufficient for the perception of emotion. For example, Dittrich et al (1996) showed that surprise, fear, anger, disgust, grief, and joy could be identified when portrayed by dancers in point-light displays. More recently, other stylised movements have also been investigated. Pollick et al (2001) used point-light displays of knocking and drinking arm movements (ie as if knocking on a door angrily), to show that subjects can perceive a range of internal states (eg fear, anger, tiredness) from these actions.

Interpersonal actions between couples have also been studied: actions such as dancing, sparring, or shaking hands can be identified when presented in point-light displays (Dittrich 1993). However, as yet there has been no research with this paradigm used to assess the ability of observers to identify emotion from interpersonal actions. Speech and body movements are closely interconnected (see Birdwhistell 1970; Bull 1990; McClave 2000), and for two people to be engaged in discourse is a very natural situation and one that we encounter on a daily basis. Therefore, from an ecological perspective, we may prove particularly adept at the identification of any displayed emotion from such displays. Also, an important aspect of human interlocution is turn-taking (eg Argyle 1967). Often, social synchrony and patterns of entrainment can be readily perceived in social interactions (McClave 1994). This develops early and is evident in mother–infant interactions (Baron and Boudreau 1987; Bernieri et al 1988; Field et al 1990; Trevarthen 1993). It is reasonable to assume that the temporal patterning of interlocution of some emotions would vary markedly from others and hence may provide a significant cue to the emotion displayed. Moreover, feedback from the listener to the speaker is primarily non-verbal and so may provide important cues to the nature of the emotional content of the exchange.

The questions we explore in the present paper are, first, whether emotion can be perceived in point-light displays of two actors engaged in a dialogue and how the percept is disrupted through image inversion. Second, we explore whether the emotion perceived is an emergent property of the social interaction between the observed actors. We developed point-light displays which depicted two actors engaged in dialogue. The actors spoke alternate lines and delivered them in one of six emotional states: sadness, anger, joy, disgust, fear (see Ekman 1984), and romantic love—an important emotion that is often ignored, which was added as it has a strong interpersonal element. Subjects were required to watch the displays and rate the degree to which each of the six emotions was present. The images were presented in both their correct orientation and when the two figures were inverted, since the recognition of some biological-motion stimuli is diminished by image inversion (eg in walking: Bertenthal and Pinto 1994; Pavlova and Sokolov 2000; and affect in dance movements: Dittrich et al 1996). In a second experiment, we compared the ability of subjects to identify the emotion where two actors were present: first, with a situation when only one actor was present (ie the other was occluded) and, second, with a condition without the rhythmic timing of interlocution, ie by showing a single actor on one side of the midline with his or her point lights reflected about the midline (ie the mirror image of the same actor making the same movements at the same time).

## 2 Experiment 1

### 2.1 Method

2.1.1 *Subjects.* Ten subjects, three women and seven men (mean age 29.6 years), volunteered to serve as subjects. They were naive as to the purpose of the experiment and had never previously encountered the experimental stimuli. All had normal or corrected-to-normal vision.

2.1.2 *Stimulus materials and apparatus.* Five male and five female actors from The Guildford School of Acting were employed to create the stimuli. Each stimulus comprised a pair of actors engaged in dialogue, portrayed in one of six emotional states: anger, fear, disgust, sadness, joy, and love. The actors were asked to perform the same emotion as each other. The actors were given an eight-lined script (see Appendix) to learn a week before recording. The script was designed in order to facilitate a symmetrical behavioural pattern between the actors (ie turn-taking behaviour). It also ensured that the stimuli were of a similar length. The pair of actors always comprised

one male and one female. Every male actor worked with every female actor. At least three clips of each emotion per actor were produced. This made a corpus of  $\sim 100$  recordings (five female actors  $\times$  five male actors  $\times$  four emotions), with at least 16 recordings of each emotional category. On each recording, the actors were requested not to rush, and to give an indication when they 'felt' the emotion. They were then immediately asked to act that emotion. The actors were free in their expressions of the emotions except that they were instructed not to touch their acting partner or express themselves by using overt symbolic gestures such as shaking the fist for anger or reaching towards each other with open arms for love.

Each pair of actors was allowed to repeat a recording if they thought that the first was not good enough; if this occurred, then the first recording was discarded. No more than two recordings of the same stimulus were required. Recordings were made with a MaxReflex IR motion capture analysis system (60 Hz) in a dimly lit room. The camera was placed at a distance of 4.5 m from the target where the actors' heights filled approximately 70%–80% of a monitor screen. To keep the actors in view at all times, they were instructed to work within a fixed area (1.3 m wide and 0.8 m deep) which was marked on the floor. During the recording, each actor wore thirteen 50-mm diameter spherical reflective markers over his/her clothes. The markers were attached to the ankles, the knees, the hips, the shoulders, the elbows, the wrists, and the centre of the forehead. Each actor stood facing at approximately  $90^\circ$  to the other and at approximately  $45^\circ$  to the camera. No sound recording was made. Examples have been presented at conferences (eg Clarke et al 2003) and are available on the *Perception* website at <http://www.perceptionweb.com/misc/p5203/>.

During the experiments, the point-light displays were shown on a 33 cm  $\times$  25.5 cm Apple monitor set at a refresh rate of 60 Hz. The point-lights were shown in green on a black background. A head-rest was used, which was set at a viewing distance of 80 cm from the screen. The stimuli were presented within a boxed area of the monitor screen that subtended approximately 13 deg vertically and 9.75 deg horizontally. Figure 1 shows a typical static frame from one of the displays.



**Figure 1.** Static frame of a point-light display showing the two actors where each actor is represented by thirteen points of light. In this frame, the actor on the left has his left arm occluded by the rest of his body.

**2.1.3 Design and procedure.** Six different examples of each of the six emotions were used. The criteria for choosing the clips for experiment 1 were to use as many combinations of different light actors as possible, and to use the clips that had the least number of occluded light points (caused by actors turning their bodies too far side-on to the

camera). They were presented either upright or upside down (inverted) which gave a total of 72 trials (six emotions  $\times$  six samples  $\times$  two orientations). Each stimulus was shown for its full duration (17–30 s).

The subjects were tested in a dimly lit room. They were told that they would see some points of light on the screen that represented two people in a social context, both acting out one of six possible emotions. The subjects were not informed that some displays would be presented upside down.

The subjects were asked to attend to the monitor carefully during each trial and to judge how much of each emotion they thought they perceived in the stimulus. After the presentation of each experimental stimulus, six horizontal scales appeared (arranged one above another) on the screen—one marked with each emotion, with the limits labelled from ‘very little’ (on the left) to ‘a lot’ (on the right). Subjects used the computer mouse to move a slider along each scale to provide the rating. They were asked to use the full range of the scale. For each subject, the order in which the emotions appeared on the scale for rating was altered so that the emotion that appeared at the top for one subject was moved to the bottom for the next subject, and so on. The subjects were obliged to work from the top scale to the bottom one on each trial. After the last scale had been rated on one trial, the next trial was automatically played. The upright and inverted stimuli were presented in one randomised block for each subject and the experiment lasted for approximately 50 min.

## 2.2 Results

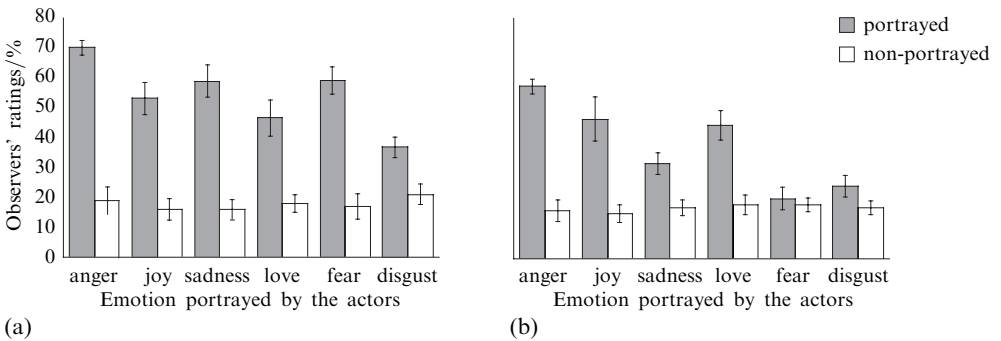
The ratings were recorded by the computer as scores between 0 (‘a little’) and 100 (‘a lot’). Subjects usually perceived more than one emotion and so most displays received non-zero ratings on all scales. No instruction was given in this regard. Often, observers would recount some fairly complex anecdote to account for what they thought unfolded in a display.

*2.2.1 Upright displays.* For each portrayed emotion, we pooled the means of the five non-portrayed emotion ratings so that comparisons could be made between just one ‘incorrect’ (non-portrayed) score and one correct (portrayed) rating. Figure 2a shows that the portrayed emotion received the highest rating in every case. For example, when anger was portrayed in the display, it received mean ratings in excess of 70%, whereas the other five non-portrayed emotions received an overall mean of 19%.

The complete set of ratings is shown in table 1. For each portrayed emotion, a one-way analysis of variance (ANOVA) was conducted between the ratings for that emotion and for the five non-portrayed emotions (ie along each row in table 1).<sup>(1)</sup> All ANOVAs showed significant main effects (portrayed anger:  $F_{5,45} = 24.9$ ,  $p < 0.001$ ; joy:  $F_{1.87,16.8^*} = 14.7$ ,  $p < 0.001$ ; sadness:  $F_{5,45} = 22.2$ ,  $p < 0.001$ ; love:  $F_{5,45} = 12.03$ ,  $p < 0.01$ ; fear:  $F_{2.6,23.7^*} = 18.8$ ,  $p < 0.001$ ; disgust:  $F_{1.9,17.9^*} = 10.12$ ,  $p = 0.001$ ). Tukey’s a posteriori tests confirmed that for each stimulus the portrayed emotion was rated higher ( $p < 0.001$ ) than each of the five non-portrayed emotions considered individually, with the exception of portrayed disgust. Ratings for this portrayed emotion did not differ from those for (non-portrayed) sadness, anger, and fear, although they were significantly larger than the ratings for (non-portrayed) joy and love ( $p < 0.001$ ).

*2.2.2 Inverted displays.* Figure 2b shows the mean ratings of the portrayed emotions as well as the combined mean scores for the non-portrayed emotions when the displays were presented upside down, and table 1 presents the complete set of ratings.

<sup>(1)</sup> An important assumption for within-subjects ANOVAs is that sphericity should not be violated as, if it is, the possibility of a type-I error may be greatly inflated (for a discussion see Howell 1997; chapter 14). Where the data have failed the sphericity test in the present experiments (as indicated by an asterisk) the more conservative Greenhouse–Geisser epsilon test has been used, which reduces the degrees of freedom of the numerator and denominator.



**Figure 2.** Observers' mean response ratings for (a) upright and (b) inverted presentations of the emotion categories of the portrayed and non-portrayed emotions. The mean ratings for the non-portrayed emotions were derived from the mean of the combined scores from the five non-portrayals in each case. Error bars show standard errors.

**Table 1.** Observers' mean response ratings for each emotion category when upright and inverted point-light stimuli were presented. Figures in bold type denote the mean ratings for the portrayed emotions. Standard deviations are shown in parentheses.

Stimulus	Response					
	anger	joy	sadness	love	fear	disgust
<i>Upright presentation</i>						
Anger	<b>70 (7.5)</b>	7 (7.3)	23 (20.7)	12 (11.1)	24 (18.8)	31 (16.2)
Joy	26 (13.8)	<b>53 (17)</b>	8 (6.1)	19 (13.8)	15 (11.1)	14 (12.1)
Sadness	16 (12.5)	6 (4.1)	<b>59 (17.2)</b>	20 (16.1)	17 (11.2)	20 (9.3)
Love	21 (11.8)	10 (5.9)	24 (11.2)	<b>47 (19.2)</b>	20 (9.9)	15 (10)
Fear	18 (18.2)	15 (12.2)	18 (13.6)	16 (11.4)	<b>59 (14.7)</b>	19 (9.9)
Disgust	24 (11.7)	9 (7)	37 (14.2)	14 (10)	22 (11.4)	<b>37 (11.1)</b>
<i>Inverted presentation</i>						
Anger	<b>57 (7.9)</b>	11 (5.1)	15 (8.9)	14 (14)	17 (11.9)	23 (16)
Joy	25 (16.7)	<b>46 (23.2)</b>	6 (4.7)	20 (11.6)	11 (6.8)	13 (7.5)
Sadness	17 (8.3)	11 (6.1)	<b>32 (11.3)</b>	24 (9.5)	16 (9.9)	19 (7.7)
Love	17 (12.9)	13 (6.6)	26 (15.9)	<b>44 (15.8)</b>	19 (8.7)	17 (9.2)
Fear	17 (11.3)	24 (8.7)	16 (4.5)	20 (8.1)	<b>20 (11.7)</b>	15 (5.8)
Disgust	19 (6.6)	12 (7.3)	21 (5.4)	17 (7.8)	19 (8.4)	<b>24 (11.6)</b>

A two-way ANOVA between display type and emotion, with two levels of display type (the bold figures in table 1) confirmed that ratings for inversion were significantly reduced ( $F_{1,9} = 32.2$ ,  $p < 0.001$ ) relative to the upright stimuli. A significant interaction between emotion and orientation ( $F_{2,3,20.6} = 5.5$ ,  $p < 0.01$ ) showed that inversion affected the ratings of some portrayed emotions more than others. A posteriori Tukey's tests following the ANOVA revealed that the ratings for anger ( $p < 0.005$ ), sadness ( $p < 0.005$ ), fear ( $p < 0.001$ ), and disgust ( $p < 0.05$ ) were significantly reduced by inversion, while joy and love were unaffected.

With the inverted stimuli, one-way ANOVAs that compared the ratings for the portrayed and all of the five non-portrayed emotions showed that there was a significant main effect for portrayed anger, sadness, love, and joy but not for fear or disgust (portrayed anger:  $F_{5,45} = 27.74$ ,  $p < 0.001$ ; joy:  $F_{1,6,14.7} = 11.13$ ,  $p = 0.002$ ; sadness:  $F_{5,45} = 6.49$ ,  $p < 0.05$ ; love:  $F_{2,1,19.1} = 8.87$ ,  $p = 0.002$ ; fear:  $F_{5,45} = 1.71$ , ns; and disgust:  $F_{2,4,22} = 3.02$ , ns). A posteriori Tukey's tests confirmed that for portrayals of anger, joy, or love, the portrayed emotion was rated significantly higher than each of the five non-portrayed emotions individually ( $p < 0.01$ ). This was also true for ratings of portrayed

sadness, except that the rated degree of sadness did not differ significantly from that of (non-portrayed) love. Ratings for disgust were confused with each of the five non-portrayed emotions, except for joy. Fear was indistinguishable from all other (non-portrayed) emotions when inverted.

### 3 Experiment 2

#### 3.1 Method

**3.1.1 Subjects.** Eighteen subjects, eleven women and seven men (mean age 21.5 years), volunteered to serve as subjects in the experiment. Most of the subjects were undergraduate psychology students from the University of Surrey who received course credits for their participation. All were naive to the types of displays presented and had normal or corrected-to-normal vision.

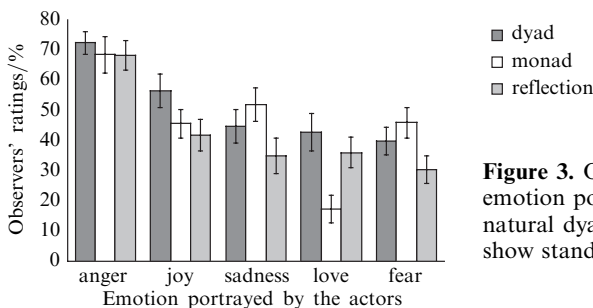
**3.1.2 Design and procedure.** There were three experimental conditions (i) the original stimuli with two actors (dyads) from experiment 1, (ii) a single actor (monad)—each actor from each original dyad was shown in a separate trial, and (iii) a dyad comprising a single actor and his/her mirror image reflected about the midline (reflected dyad). Owing to the findings in experiment 1, the stimuli which portrayed disgust were not included. Therefore, the second experiment used only five emotions. Four examples of each emotion were used for all three conditions. These were chosen from the original corpus used in experiment 1; the discarded clips were the ones that received the two lowest mean ratings for each emotion in the previous experiment (for anger and sadness these were stimuli with means  $< 50$ , for joy and fear  $< 30$ , and love  $< 40$ ). There were twice as many trials in the monad condition, as each actor was shown in a separate trial. This gave a total of 80 trials. To keep the experiment within a manageable time scale only the first 10 s of each clip was shown. The subjects were told that either one or two people would be seen, both acting out one of five emotions. The ratings procedure was the same as in experiment 1, except here there were only five emotions shown on the rating scale. The stimuli were shown in one block, in random order for each subject. The experiment lasted approximately 40 min.

#### 3.2 Results

Comparing the upright natural dyad conditions in experiments 1 and 2, a mixed design ANOVA with five levels of emotion as the repeated-measures factor and experiments 1 and 2 as the between-subjects factor did not reveal any significant main effect between the experiments ( $F_{1,26} = 1.82, p > 0.05$ ), and there was no significant interaction between experiment and the portrayed emotion ( $F_{4,104} = 1.95, p > 0.05$ ).

Figure 3 shows the mean ratings for each portrayed emotion in each viewing condition and table 2 shows the complete matrix of means from experiment 2.

A two-way ANOVA between display type and emotion, with three levels of display type (dyad versus monad versus reflection) and five levels of emotion, was conducted on the ratings given to the portrayed emotions (the bold figures in table 2).



**Figure 3.** Observers' mean response ratings for the emotion portrayed by the actors when displayed as natural dyads, monads, and reflections. Error bars show standard errors.

**Table 2.** Observers' mean response ratings for each emotion category when dyads, monads, and reflected stimuli were presented. Figures in bold type denote the mean ratings for the portrayed emotions. Standard deviations are shown in parentheses.

Stimulus	Response				
	anger	joy	sadness	love	fear
<i>Dyads</i>					
Anger	<b>72 (16.1)</b>	5 (3.6)	18 (17.2)	11 (13.9)	15 (7.9)
Joy	22 (18.9)	<b>56 (23.5)</b>	7 (5.6)	18 (20.4)	7 (5.2)
Sadness	8 (5.4)	7 (5.6)	<b>45 (23.9)</b>	28 (21.5)	14 (13.5)
Love	15 (13.9)	13 (11.1)	12 (8.8)	<b>43 (26.7)</b>	9 (8.6)
Fear	23 (19.6)	16 (13.4)	14 (12.6)	16 (13.7)	<b>40 (19)</b>
<i>Monads</i>					
Anger	<b>69 (25.4)</b>	5 (7.3)	14 (12.3)	7 (6.2)	14 (17.7)
Joy	24 (15)	<b>46 (19.7)</b>	7 (4.5)	11 (9)	11 (6)
Sadness	8 (6.4)	5 (3.7)	<b>52 (23.5)</b>	9 (7.8)	17 (11.9)
Love	14 (19.5)	8 (4.9)	26 (16.5)	<b>17 (19.3)</b>	19 (23.3)
Fear	15 (13.8)	12 (9.3)	16 (11.6)	8 (5)	<b>46 (21.6)</b>
<i>Reflections</i>					
Anger	<b>68 (20.8)</b>	6 (6.5)	22 (23.2)	10 (12.6)	10 (9.4)
Joy	27 (18.7)	<b>42 (22.2)</b>	8 (7.1)	13 (15.6)	8 (8)
Sadness	5 (3.2)	8 (9.1)	<b>35 (25)</b>	27 (27)	19 (18)
Love	19 (22.16)	13 (11)	10 (7)	<b>36 (21.4)</b>	16 (18.6)
Fear	16 (14.9)	13 (10.4)	19 (17)	21 (21.8)	<b>30 (18.9)</b>

Significant main effects were found for display type ( $F_{2,34} = 8.2$ ,  $p = 0.001$ ) and for emotion ( $F_{4,68} = 16.6$ ,  $p < 0.001$ ). There was also a significant interaction between display type and emotion ( $F_{4,4,75,4} = 5.65$ ,  $p < 0.001$ ). A posteriori Tukey's tests revealed that portrayed joy received higher ratings when displayed as natural dyads ( $p < 0.02$ ) than as monads or reflections. Portrayed love received significantly higher ratings when seen as natural or reflected dyads relative to monads ( $p < 0.001$ ). Interestingly, Tukey's tests also showed that the monad presentations of sadness and fear portrayals received higher ratings than the reflected dyad ones ( $p < 0.05$ ). No other significant differences were found.

One-way ANOVAs and a posteriori Tukey's tests were carried out on all of the results across each row in table 2 and all of the portrayed ratings were found to be statistically higher than the corresponding non-portrayals ( $p < 0.05$ ), except for three cases. First, after the one-way ANOVA for the five ratings of monad portrayals of love ( $F_{2,2,37,4} = 3.5$ ,  $p < 0.05$ ), Tukey's tests revealed that love was confused with all of the non-portrayed emotions ( $p > 0.05$ ). Second, following the one-way ANOVA for the five ratings of reflection portrayals of sadness ( $F_{1,7,33,2} = 9.54$ ,  $p = 0.001$ ), Tukey's tests showed that ratings for portrayed sadness were no different to ratings of non-portrayed love and non-portrayed fear. Third, for the reflected images of fear ( $F_{2,61,44,45} = 3.07$ ,  $p < 0.05$ ), fear ratings were not significantly different from those for any of the non-portrayed emotions except joy.

#### 4 Discussion

This study was designed to investigate whether we can recognise emotions from the non-verbal cues displayed in point-light displays produced by pairs of actors engaged in dialogue. The first experiment showed clearly that the emotions of anger, fear, joy, sadness, and love can be identified in such displays, which suggests that the spatio-temporal information inherent in human movement is sufficient to specify certain emotions. The exception in our results was for the display of disgust, which was often

confused with sadness, anger, and fear. Inversion reduced the salience of the displayed emotions to varying extents, although overall performance was still good for most emotions. In the second experiment, we investigated the importance of the second actor's behaviour during interlocation in the specification of emotion. We found that performance was markedly altered by the presence of the second actor in either veridical or non-veridical (mirror image) formats, or both, for all the emotions except anger. Our finding that a range of emotions can be recognised in biological displays of actors engaged in a dialogue is in line with previous research, in which more stylised movements such as dance were generally used (eg Dittrich et al 1996). The fact that fear was well identified here is consistent with Walk and Homan's (1984) results in point-light displays of an actor engaged in mime, but contrasts with the poor identification of fear with other types of movement (eg musicians' movements presented in full light: Dahl and Friberg 2004; dancers' movements presented in point light: Dittrich et al 1996). Interestingly, Bassili (1978) found that fear and anger were not easily discriminated in point-light displays of facial emotion, but disgust was. However, in the present study, disgust was poorly perceived in agreement with Dittrich et al's (1996) finding that disgust was not only discriminated below chance in point-light presentations of dancers' movements but was also the least well identified in the corresponding full-light presentations of the same. This suggests that the body is not a good channel to communicate this emotion regardless of whether the representations of it are presented in full-light conditions or abstracted ones. Overall, it would appear that the face is a better channel for veridical perception of some emotions, and the body for others.

Evidence suggesting that the recognition of biological motion from point-light displays is impaired when inverted (Bertenthal and Pinto 1994; Dittrich et al 1996; Pavlova and Sokolov 2000; Shipley 2003) was supported by our findings as, in general, lower ratings were given for the inverted stimuli than for the upright ones. This effect was particularly pronounced for fear; as yet we have no explanation why this might be so.

In experiment 2, recognition of the emotions displayed by natural dyads was in some cases better than with only one actor (the monad condition) or without rhythmic synchronisation between two actors engaged in conversation (as in the reflected dyads). In particular, the removal of one actor seemed to affect the perception of joy and romantic love, as successful identification of these emotions was significantly impaired when the second actor was not present. These emotions are particularly expressive socially and this is consistent with our finding that they are conveyed better when displayed in a two-actor context. For example, joy is typically expressed by laughing, smiling, and talking to another person enthusiastically (Schaver et al 2001), and Fridlund (1992) found that people show more amusement when watching a funny video in the presence of others than they do alone.

It is also noteworthy that fear, joy, and sadness are not easily perceived in non-veridical contexts (as in the reflected dyads). This suggests that observers take into account information from the entire scene when judging the emotional content of a situation. Context cues are seldom considered in research on point-light displays (for an exception see Pavlova and Sokolov 2003), and clearly more research will be required to investigate these contextual cues further.

In summary, we have shown that humans can use information about the emotional content of human verbal exchanges when displayed in abstract point-light displays, which only preserve the spatiotemporal patterns of thirteen points of light attached to each of two actors. Performance is compromised when the displays are inverted, and altered for some emotions when only one actor is displayed or when non-veridical contexts are used.



**Acknowledgments.** This research was funded by the Economic and Social Research Council. We are grateful to the actors from The Guildford School of Acting for their performances in the generation of the stimuli. We thank Frank Pollick for conversations about this research and the anonymous reviewers for their comments on a previous version of the paper.

## References

- Argyle M, 1967 *The Psychology of Interpersonal Behaviour* (London: Pelican)
- Baron R M, Boudreau L, 1987 "An ecological perspective on integrating personality and social psychology" *Journal of Personality and Social Psychology* **53** 1222–1228
- Bassili J N, 1978 "Facial motion in the perception of faces and of emotional expression" *Journal of Experimental Psychology: Human Perception and Performance* **4** 373–379
- Bernieri F J, Reznick J S, Rosenthal R, 1988 "Synchrony, pseudosynchrony, and dissynchrony: measuring the entrainment process in mother–infant interactions" *Journal of Personality and Social Psychology* **54** 243–253
- Bertenthal B I, Pinto J, 1994 "Global processing of biological motions" *Psychological Science* **5** 221–225
- Birdwhistell R, 1970 *Kinesics and Context* (Philadelphia, PA: University of Pennsylvania Press)
- Blair R J R, 2003 "Facial expressions, their communicatory functions and neuro-cognitive substrates" *Philosophical Transactions of the Royal Society of London B* **358** 561–572
- Bull P, 1990 "What does gesture add to the spoken word", in *Images and Understanding* Eds H Barlow, C Blakemore (Cambridge: Cambridge University Press) pp 108–121
- Campos J J, Campos R G, Barrett K C, 1989 "Emergent themes in the study of emotional development and emotion regulation" *Developmental Psychology* **3** 394–402
- Clarke T J, Rose D, Bradshaw M F, Field D T, Hampson S E, 2003 "Perceiving emotion from point-light displays of interpersonal communication behaviours", paper presented at Applied Vision Association meeting *Vision in a 3D World, London, UK, 19 March*
- Dahl S, Friberg A, 2004 "Expressiveness of musician's body movements in performances on marimba", in *Gesture Based Communication in Human–Computer Interaction, Lecture Notes in Artificial Intelligence* Eds A Camurri, G Volpe (Berlin: Springer) **2915** 479–486
- Dittrich W H, 1993 "Action categories and the perception of biological motion" *Perception* **22** 15–22
- 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
- Ekman P, 1984 "Expression and the nature of emotion", in *Approaches to Emotion* Eds K R Scherer, P Ekman (Hillsdale, NJ: Lawrence Erlbaum Associates) pp 319–343
- Emde P, 1988 "Development terminable and interminable: I. Innate and motivational factors from infancy" *International Journal of Psychoanalysis* **69** 23–42
- Field T, Healy B, Goldstein S, Guthertz M, 1990 "Behavior-state matching and synchrony in mother–infant interactions of depressed and non-depressed dyads" *Developmental Psychology* **26** 7–14
- Fridlund A, 1992 "The behavioral ecology and sociality of human faces", in *Emotion* Ed. M S Clark (Newbury Park, CA: Sage) pp 90–121
- Howell D C, 1997 *Statistical Methods for Psychology* (Belmont, CA: Duxbury)
- Johansson G, 1973 "Visual perception of biological motion and a model for its analysis" *Perception & Psychophysics* **14** 201–211
- Klinnert M D, Emde R N, Butterfield P, Campos J J, 1987 "Social referencing: the infant's use of emotional signals from a friendly adult with mother present" *Annual Progress in Child Psychiatry and Child Development* **22** 427–432
- McClave E, 1994 "Gestural beats: the rhythm hypothesis" *Journal of Psycholinguistic Research* **23** 45–66
- McClave E, 2000 "Linguistic functions of head movements in the context of speech" *Journal of Pragmatics* **32** 855–878
- Pavlova M, Sokolov A, 2000 "Orientation specificity in biological motion perception" *Perception & Psychophysics* **62** 889–899
- Pavlova M, Sokolov A, 2003 "Prior knowledge about display inversion in biological motion perception" *Perception* **32** 937–946
- Pollick F E, Paterson H, Bruderlin A, Sanford A J, 2001 "Perceiving affect from arm movement" *Cognition* **82** B51–B62
- Schaver P, Schwartz J, Kirson D, O'Connor C, 2001 "Emotion knowledge: further exploration of a prototype approach", in *Emotions in Social Psychology: Essential Readings* Ed. W G Parrott (Philadelphia, PA: Psychology Press) pp 26–56

- 
- Shipley T F, 2003 "The effect of object and event orientation on perception of biological motion" *Psychological Science* **14** 377–380
- Trevarthen C, 1993 "The functions of emotions in early infant communication and development", in *New Perspectives in Early Communicative Development* Eds J Nadel, L Camaioni (London: Routledge) pp 48–51
- Walk R D, Homan C P, 1984 "Emotion and dance in dynamic light displays" *Bulletin of the Psychonomic Society* **22** 437–440
- Wallbott H G, 1998 "Bodily expression of emotion" *European Journal of Social Psychology* **28** 879–896

## Appendix

- Actor A: It's a long way from Mordovia.
- Actor B: I didn't expect it would be so far.
- Actor A: But there's a trip to Moscow thrown in.
- Actor B: No-one told me about the extra trip.
- Actor A: Well the embassy arranged it all.
- Actor B: I thought that our comrades arranged it.
- Actor A: If the train could stop especially here.
- Actor B: Such a thing could be arranged.

ISSN 0301-0066 (print)

ISSN 1468-4233 (electronic)

# PERCEPTION

VOLUME 34 2005

[www.perceptionweb.com](http://www.perceptionweb.com)

**Conditions of use.** This article may be downloaded from the Perception website for personal research by members of subscribing organisations. Authors are entitled to distribute their own article (in printed form or by e-mail) to up to 50 people. This PDF may not be placed on any website (or other online distribution system) without permission of the publisher.