Attributing Emotion to Static Body Postures: Recognition Accuracy, Confusions, and Viewpoint Dependence

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ATTRIBUTING EMOTION TO STATIC BODY POSTURES: RECOGNITION ACCURACY, CONFUSIONS, AND VIEWPOINT DEPENDENCE

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ABSTRACT: A total of 176 computer-generated mannequin figures were produced from descriptions of postural expressions of emotion in order to investigate the attribution of emotion to static body postures. Each posture was rendered from 3 viewing angles and presented to participants in a forced-decision task. Concordance rates for attributions of 6 emotions (anger, disgust, fear, happiness, sadness, and surprise) ranged from zero for many disgust postures to over 90 percent for some anger and sadness postures. Anatomical variables and viewing angle were shown to predict participants' responses. Analysis of the confusion matrix suggested a circumplex solution with happiness and surprise sharing a similar position, and few confusions between the other four emotions. The means by which emotions may be attributed to static body postures are discussed, as are avenues for further research.

KEY WORDS: emotion; expression; posture.

The role of body posture in the expression and communication of emotion remains the poor relation of research into facial and vocal expression. Since publication of Darwin's *The Expression of the Emotions in Man and Animals* (Darwin, 1872/1965), a great deal of attention has focused on how emotions are communicated through facial expression, and much has been learned ranging from knowledge of the ways in which individual muscles contribute to each expression (e.g. Ekman & Friesen, 1984; Izard, 1979; Rinn, 1984) to the similarities and differences between cultures in emotional perception (e.g. Boucher & Carlson, 1980; Ekman et. al., 1987; Haidt & Keltner, 1999; Mesquita & Frijda, 1992; Russell, 1991). A similar although smaller literature exists on the perception of emotion from the voice (e.g. Banse & Scherer, 1996; Murray & Arnott, 1993; Scherer, 1986, 1995; van Bezooijen & Boves, 1986; Wallbott & Scherer, 1986). The general con-

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clusion is that emotion, insofar as the term refers to the six 'basic' emotions (anger, disgust, fear, happiness, sadness, and surprise) is accurately perceived through the face and voice, and furthermore that this process is similar across cultures.

Although much has been written about body posture and emotion, little systematic research has been carried out, and that which exists has tended to focus on emotional expression through movement rather than static posture. This lack of research is surprising when one considers that bodily expression is widely recognized as an important diagnostic tool in therapeutic practice (e.g. Berger, 1994; Dosamontes-Beaudry, 1997; Flack, Laird, & Cavallaro, 1999; Fuchs, 1996; Hirsch, 1994), and is a crucial feature of artistic forms such as acting and dance. Furthermore, human bodies are large objects possessing multiple degrees of freedom which would appear to be ideal channels for emotional communication (Montepare, Koff, Zaitchik, & Albert, 1999), especially at distances where the recognition of emotion from facial expression is difficult (Walk & Walters, 1988). However, the relationship between posture and emotion may be weaker than for other channels of nonverbal communication, and as such presents special challenges. The research reported here investigated the relationship between precisely defined static postures and attributions of emotion in an attempt to begin specifying how emotion may be communicated through the body.

How Well Do Bodies Communicate Emotion?

There is some evidence that viewers can read emotions from static body postures with reasonable levels of accuracy, and that certain cues play an important role in this process. Using a variety of methodologies including photographs, and dynamic and static point-light displays, Walk and colleagues have demonstrated that emotion can be recognized from static posture with varying levels of accuracy. Walters and Walk (1986) claim that recognition of emotion from photographs of posed expressions with face and hands obscured is comparable in accuracy to recognition of facial expressions. For point-light static displays, although recognition rates were significantly above chance for five of the six basic emotions (the exception being disgust), recognition rates only exceeded 30% for happiness (Walters & Walk, 1988). With dynamic displays and using a six alternative forced choice methodology, agreement rates increased to between 71% for fear to 96% for happiness (Walk & Homan, 1984). A consistent finding in these studies is that anger, happiness and sadness are most accurately recognized, with surprise and fear somewhat lower, and disgust frequently failing to reach statistically significant levels.

Despite demonstrating that posture is capable of communicating emotion, few studies have specified the anatomical features responsible for attribution of particular emotions. Aronoff, Woike, and Hyman (1992) analyzed expressive postures in ballet dancers and found that angular postures tended to be adopted when playing the role of a threatening character, and rounded postures were more common when playing a warm or friendly character. These results suggest that abstract geometrical properties of postures are important cues to underlying emotion. Schouwstra and Hoogstraten (1995) used stick drawings of armless figures, and varied head and spine positions. Upright postures were judged more positively, and forwards-leaning postures more negatively. An unpublished study which required participants to pose a wooden artist's doll suggested that the six basic emotions could be partially represented in terms of sagittal movement, spinal flexion, open/closed and forwards/backwards reaching, and facial orientation towards or away from the eliciting stimulus (Inouye, 1998).

In addition to the empirical findings on static posture outlined above, a number of descriptive schemes for body posture and emotion have been produced dating from William James' original study (James, 1932). Although these descriptions present a useful framework, they tend to focus on general, frequently dynamic properties of bodies, and fail to make clear predictions regarding the specific postures which may be associated with different emotional states. Dimensions such as approach/withdraw are too coarse-grained when the intention is to determine likely configurations of head, trunk, arms and legs. Notwithstanding this, there exist a variety of sources which offer more or less detailed descriptions of emotional postures (e.g. Birdwhistell, 1975; Boone & Cunningham, 2001; Darwin, 1872/1965; de Meijer, 1989; Furnham, 1999; Mehrabian, 1981; Montepare et. al., 1999; Wallbott, 1998). For instance, in the descriptions put forward by these authors, anger is variously described as involving a jutting chin, angular body shape, forward weight transfer, chest out and angled forwards, and a bowed head. By translating these descriptions into joint rotations, descriptive schemes for selected emotions can be generated.

Although emotion can be inferred from body posture, the mechanisms by which this occurs are unclear. Postures may represent emotions, intentions, or requests, a distinction which is theoretically important but difficult to disentangle and demonstrate empirically. Also, emotional expression can be considered emblematic and propositional, or involuntary and extemporaneous (Buck, 1991). In terms of body postures, the former include behaviors such as raised fists (emblematic of anger), whereas the latter emphasize functional actions associated with the behavioral significance of the emotion (in the case of anger these might include general tenseness and a forward transfer of weight). Despite the obvious importance of emblems in the communication of emotion, the research reported here focused on the contribution of anatomical variables to expression, and consequently limited itself to the investigation of non-emblematic postures.

Further difficulties in studying posture relate to expressive idiosyncracies (de Meijer, 1989; Wallbott, 1998), controversies surrounding the nature of posed versus spontaneous expressions (Ekman, Hager, & Friesen, 1981; Skinner & Mullin, 1991), and the problems inherent in generating three-dimensional data from two-dimensional images. In combination, these factors make the use of video or photographic representations of natural or performed behavior problematic, and consequently the study reported here relied on computer-generated stimuli. As the aim was to examine the anatomical variables which communicate different emotions, complete control over the experimental stimuli was required. Computer-generated figures, unlike people, can be precisely manipulated, and once defined can be displayed from any angle.

Finally, in contrast with other channels of nonverbal communication, body posture involves an important three-dimensional presence which offers different percepts depending on the observer's location, and changes in viewing angle may result in occlusion of one body part by another. Indeed, there is some evidence which suggests the same posture viewed from different angles does not give rise to the same percept, as prior presentation of a posture does not prime its later recognition from a different viewpoint (Daems & Verfaillie, 1999). Consequently the inclusion of viewpoint as an additional variable was deemed important.

With the above in mind a number of research questions can be formulated. First, the nature of the postures associated with specific emotions need to be described and defined in terms of anatomical features. Second, the degree to which human participants agree on which emotion each posture expresses, and how this changes as a result of the angle from which the posture is viewed can be investigated. Finally, questions about which anatomical features contribute to attributions, and which emotions are confused with each other can be addressed.

Method

Participants

A total of 61 undergraduate students (36 women, 25 men) took part in the experiment for course credit. The mean age was 27 years (range 18–50).

Stimuli

The study limited itself to examining postures associated with anger, disgust, fear, happiness, sadness and surprise. Although the theoretical status of Ekman's six basic emotions, and the notion of categorical emotions itself, has been challenged from a number of directions (Carroll & Russell, 1996; Ortony & Turner, 1990; Russell & Barrett, 1999; Watson & Tellegen, 1985, 1999; Watson, Wiese, Vaidya, & Tellegen, 1999), there exists a wealth of data regarding their absolute and relative recognition accuracy within and across cultures.

In order to translate general descriptions of spontaneous features of bodily expression of emotion into specific postures, a framework for describing a body is required. The body is treated as a system of interconnected rigid segments, roughly corresponding to the bones connecting the major joints, and the relationships between these segments described in terms of rotations about one or more axes of the joints connecting them.

Ignoring fingers and toes, and treating the spinal column as three separate joints at the neck, chest and abdomen, there are fifteen major joints in the human skeleton with a total of twenty-nine degrees of freedom (ankles, knees, elbows and the chest are monaxial, wrists are biaxial, and shoulders, hips and the head/neck and abdomen 'joints' are triaxial). Certain simplifying assumptions are therefore required if the number of postures is not to become unmanageably large. Consequently, a model consisting of thirteen segments and nine degrees of freedom was chosen. The upper body consisted of seven segments (head/neck, chest, abdomen, two shoulders/upper arms and two forearms), the lower of six (two thighs, two shins and two feet). The degrees of freedom relate to axes of joint rotation, and are discussed further below. This model represents a compromise designed to maximize flexibility and minimize complexity.

The overall movement of the body's center of mass can be described in a number of more or less complex ways. Descriptions of emotion, however, are rarely more precise than indicating whether a body experiencing a specific emotion is likely to move towards or away from the eliciting stimulus. Because of this, movement of the mass center was coded as one of three levels—forwards, backwards, or neutral. Parameters specifying joint rotations for the hips, knees and ankles were generated accordingly and presented to ten participants (who did not take part in the main study) who unanimously identified the direction of weight transfer in each case.

By introducing a final simplifying criterion, that of symmetrical arms, it is possible to describe a body posture in terms of one parameter specifying movement of the mass center, and six joint rotations (head bend, chest bend, abdomen twist, shoulder adduct/abduct, shoulder swing, and elbow bend), for a total of seven degrees of freedom.

The final stage of the process involves identifying the degree to which each joint can rotate. There are no guidelines as to how this might be achieved, and consequently three or four levels of each rotation were selected, a number which permits a range of realistic and perceptually distinct positions to be produced while keeping the total number of stimuli manageable. By permuting the quantitative joint rotation values with the qualitative descriptions, a family of distinct configurations for each emotion can be generated. A full description of the joint rotations defining each emotion, and the number of distinct postures generated by this process, can be seen in Table 1.

Each of the 176 descriptions was used to generate a mannequin figure within Curious Labs' Poser4 figure animation package. The mannequin figure was chosen because it represents an easily recognized human body stripped of age, sex, ethnicity and facial features. Each posture was produced at a resolution of 400x400 pixels in 24-bit colour, and was depth shaded. A ground plane was introduced to prevent the figure from appearing to float in space. Each image was further rendered from three distinct viewing angles, from the front, the left hand side, and above and behind the left shoulder. This resulted in a total stimulus set of 528 images (176 postures each rendered from three angles). To give an example of the range of postures included in the stimuli, the results of the parameters for anger are illustrated in Figure 1 where the 32 generated postures are shown from the three different viewing angles.

Procedure

In order to gain parity with studies of facial and vocal expression, a six-alternative forced-choice methodology was adopted. Direct comparisons between forced choice and more open-ended methods suggest that 'there is not much wrong . . . with the forced choice format' (Izard, 1994, p. 291; see also Frank & Stennett, 2001).

The 528 images were split into three equal sets, with each set containing one view of each posture, and a third of postures seen from each viewpoint. The order of presentations was pseudo-randomly ordered such that postures designed to represent the same emotion were never presented more than three times in sequence, and the same viewing angle was presented no more than twice in succession. Four separate pseudo-random orders were generated for each of the three presentation sets (the third and fourth being reversals of the first and second).

TABLE 1

Joint Rotations for Six Emotions

	Abdomen twist*	Chest bend**	Head bend**	Shoulder ad/abduct***	Shoulder swing**	Elbow bend**	Weight transfer	No. of postures
Anger	0	20, 40	–20, 25	–60, –80	45, 90	50, 110	Forwards	32
Disgust	–25, –50	–20, 0	–20	–60, –80	–25, 45	0, 50	Backwards	32
Fear	0	20, 40	25, 50, –20	–60	45, 90	50, 110	Backwards Neutral	24
Happiness	0	0, –20	0, –20	50	0, 45	0, 50	Forwards Neutral	32
Sadness	0, –25	0, 20	25, 50	–60, –80	0	0	Backwards Neutral	32
Surprise	0	–20	25, 50	50	–25, 0, 45	0, 50	Backwards	24

Note: Number of postures for each emotion category is the product of the number of distinct values for each joint rotation and weight transfer values for that category.

*The abdomen was specified as twisting to one side only or not at all.

**Positive and negative values relate to a coordinate system with its origin at the joint centre. In this case a right-hand coordinate system is used and positive rotations are forward.

***Rotation is relative to a neutral position which is the arm raised out to the side, level with the shoulder. Negative values relate to arms above shoulder level (abduction), positive values to arms towards the side of the trunk (adduction).

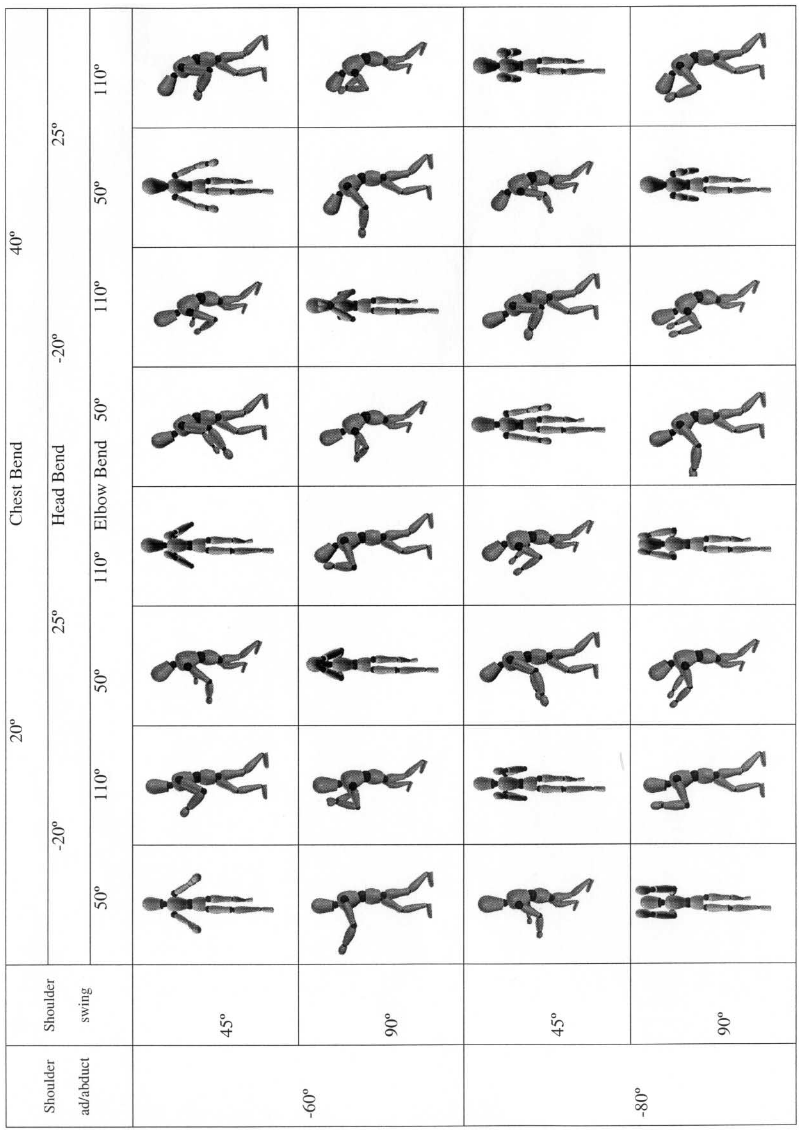


Figure 1. Thirty-two postures representing anger viewed from three angles.

Participants were presented with each posture in turn on a computer monitor, and were required to select which of the six basic emotion labels (anger, disgust, fear, happiness, sadness, surprise) best described a person adopting that particular posture. Clicking the computer mouse on a button relating to the chosen emotion label advanced the experiment to the next trial. The emotion labels appeared on the screen at all times throughout the experiment, and each posture was presented for as long as the participant wished. There was an inter-trial interval of 500 milliseconds, and participants were asked to take a short break after every 30 trials. The testing session lasted 40–50 minutes.

Results

To determine whether fatigue was affecting participants' responses, an items analysis was performed on the four presentation sets. For each stimulus, the modal response (i.e., that emotion label which was chosen by the greatest number of participants) was used as the criterion for accuracy, and the number of attributions for stimuli appearing in the first half of each set were compared with those for the same stimulus appearing in the second half of the complementary set. A repeated measures t-test failed to reach significance ($t(527) = 1.18$, $p =$ n.s.), suggesting participants' accuracy of identification was not deteriorating as the study progressed.

In order to examine the degree to which participants agreed on the emotion being expressed by each posture, binomial probabilities were used to calculate significance levels (chance is 16.7%). Standard levels of alpha were not used due to the potentially large number of Type I errors and the fact that the null hypothesis (that the distribution of responses to each stimulus is random) is almost always wrong, and rejecting it provides little useful information (Russell, 1995). Militating against these factors is the unknown number of stimuli for which the null hypothesis is in fact correct. No 'pruning' of the stimuli took place post-generation, with the result that some may have elicited random responses from participants (following the posture generation procedure outlined above, the only check performed on the stimulus set was to ensure no two postures were identical). Despite ensuring that all joint rotations were realistic in degree, the complexity of the stimuli meant that some postures looked rather unusual. Rather than remove these prior to the study, a process which may inadvertently introduce bias, all generated postures were included in the study.

With these constraints in mind, increasingly strict concordance requirements were adopted and the number of stimuli attributed to a single emotion at each level examined. Table 2 summarizes the findings for concordance levels of 50%, 60%, 70%, 80% and 90% agreement broken down by viewpoint (all concordance rates represent alpha levels several orders of magnitude below those generally adopted). The posture receiving the highest concordance for each emotion is shown, and its defining parameters listed, in Figure 2. In general, anger, happiness, and sadness are being attributed to large numbers of postures, with some identified by 90% or more of the sample. Fear and surprise are less frequently, and less consensually identified, and no posture was identified as disgust by 50% or more of the sample.

To assess the degree to which anatomical variables and viewpoint determine attribution of emotion, the eight variables defining each posture (six joint rotations, the weight transfer parameter, and viewpoint) were entered as predictor variables in a multinomial logistic regression (MLR) using response category as the dependent variable. MLR was chosen in preference to discriminant function analysis because the predictor variables were not normally distributed due to the small number of levels of each rotation.

The results of this analysis are presented in Tables 3 and 4. The final model was significantly better than the intercept-only model ($\chi^2 = 9346$, $p < 0.001$), and likelihood ratio tests revealed that all predictor variables made significant contributions to the model (all $p < 0.001$, Cox & Snell pseudo $R^2 = .581$). Across all six categories, the regression correctly predicted 48.5% of responses. There was considerable variation in accuracy for different response categories, with rates for happiness and sadness greater than 75%, and very few predictions for disgust. As all responses to all stimuli were entered into the regression, the results are somewhat confounded by the degree of consensus to each stimulus. However, a second analysis not reported here which removed all stimuli that failed to reach 40% consensus for at least one emotion attribution revealed a very similar pattern of results.

The beta coefficients indicate that all emotions are predicted by a variety of variables. In creating the regression model in MLR analysis, a 'reference class' for the dependent variable must be specified. The choice of reference class is arbitrary in that it does not affect the overall results, but it does affect the interpretation of the coefficients. Disgust was chosen as the reference class in order that the five emotions receiving the highest concordances were represented in the analysis. A significant coefficient thus means the particular level of the variable predicts category membership (emotion attribution) relative to the reference class. For joint rotations, the reference class was chosen as zero degrees of rotation (for shoulder adduct/abduct there is no zero rotation, and 50° was selected), for weight

TABLE 2

Number of Stimuli Reaching Consensus Levels of Between 50% and 90% for Six Emotions Across Three Different Viewpoints

	Anger			Disgust			Fear			Happiness			Sadness			Surprise		
	Front	Side	Rear	Front	Side	Rear	Front	Side	Rear	Front	Side	Rear	Front	Side	Rear	Front	Side	Rear
50%	18	12	10	0	0	0	0	4	2	49	28	24	25	43	36	4	4	1
60%	16	8	4	0	0	0	0	2	0	35	25	20	20	39	29	0	1	0
70%	10	3	1	0	0	0	0	0	0	24	16	12	12	26	18	0	1	0
80%	2	1	0	0	0	0	0	0	0	7	7	8	5	12	8	0	0	0
90%	1	0	0	0	0	0	0	0	0	1	2	2	0	3	1	0	0	0

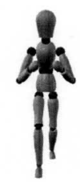
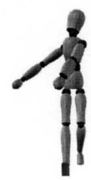
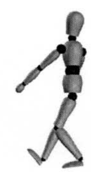
	Front	Side	Rear	Description
Anger	 90%	 50%	 36%	Head bend -20 Chest bend 40 Abdomen twist 0 Shoulder swing -60 Shoulder adduct/abduct -45 Elbow bend -110 Weight transfer forwards
Disgust	 6%	 5%	 43%	Head bend -20 Chest bend 0 Abdomen twist -50 Shoulder swing -60 Shoulder adduct/abduct -45 Elbow bend 0 Weight transfer backwards
Fear	 67%	 67%	 50%	Head bend -20 Chest bend 20 Abdomen twist 0 Shoulder swing -60 Shoulder adduct/abduct -45 Elbow bend -50 Weight transfer backwards

Figure 2. Posture receiving highest concordance for each emotion (posture shown from all three view-points—viewpoint receiving highest concordance was the highest for that emotion).

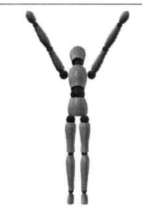
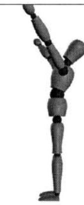
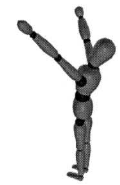
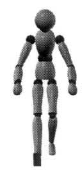
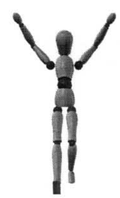
Happiness	 50%	 72%	 95%	Head bend -20 Chest bend -20 Abdomen twist 0 Shoulder swing 50 Shoulder adduct/abduct -45 Elbow bend 0 Weight transfer neutral
Sadness	 76%	 95%	 72%	Head bend 50 Chest bend 40 Abdomen twist 0 Shoulder swing -60 Shoulder adduct/abduct -45 Elbow bend -50 Weight transfer backwards
Surprise	 22%	 71%	 27%	Head bend 25 Chest bend 0 Abdomen twist -25 Shoulder swing -80 Shoulder adduct/abduct 0 Elbow bend 0 Weight transfer backwards

Figure 2. (*continued*)

TABLE 3

Results of Multinomial Logistic Regression—Classification Table

	Predicted						
Observed	Anger	Disgust	Fear	Happiness	Sadness	Surprise	% Correct
Anger	617	154	434	447	110	4	34.9%
Disgust	289	272	145	505	218	8	18.9%
Fear	102	115	1919	174	196	7	76.4%
Happiness	239	81	71	1966	138	6	78.6%
Sadness	31	115	777	209	429	6	27.4%
Surprise	80	82	236	338	207	9	.9%
Overall %	12.6%	7.6%	33.4%	33.9%	12.1%	.4%	48.5%

TABLE 4

Results of Multinomial Logistic Regression—Beta Coefficients

	Beta coefficients				
	Anger	Fear	Happiness	Sadness	Surprise
Head bend					
–20°	0.42*	0.62*	0.58**	–0.86*	0.65**
25°	0.13	0.34	–0.07	0.31	–0.15
50°	–0.01	0.32	–0.29	0.72*	–0.12
Chest bend					
–20°	–0.27*	–0.04	–0.02	–0.02	0.39**
20°	0.20	–0.14	–0.58**	0.08	–0.21
40°	0.37	0.10	–1.12**	0.85**	–0.88**
Abdomen twist					
–50°	–0.93**	–0.88**	–0.77**	–0.66**	0.07
–25°	–0.77**	–0.41*	–0.86**	–0.42**	0.35
Shoulder swing					
–90°	0.14	0.22	–0.20	0.21	–1.20**
–45°	–0.03	–0.26	–0.13	–0.42*	–0.47**
25°	–0.44*	–0.09	–0.32*	0.02	–0.20
Shoulder ad/abduct					
–80°	–0.88**	0.61*	–2.23**	2.51**	–1.69**
–60°	–1.01**	0.76**	–1.89**	2.40**	–1.36**
Elbow bend					
–110°	1.62**	0.71**	–0.83**	0.13	–0.19
–50°	0.71**	0.31*	–0.61**	–0.53**	–0.04
Weight transfer					
Backwards	0.29*	0.92**	0.13	0.15	0.25
Forwards	0.49**	0.82**	0.09	0.05	0.16
Viewpoint					
Front	0.42**	–0.37**	0.87**	–0.17	0.49**
Rear	–0.10	0.04	–0.16	–0.19*	–0.09

Note: Reference class is disgust. Reference class for joint rotations is zero rotation except for shoulder adduct/abduct, which is 50°.

*$p < 0.05$.

**$p < 0.01$.

transfer the neutral position was chosen, and for viewpoint the side view was selected.

Considering each emotion in turn, anger is predicted by backwards head bend and the absence of a backwards chest bend, no abdominal twist, and arms raised forwards and upwards. Weight transfer is either forwards or backwards, and attributions are more likely when postures are seen from the front. For fear, head backwards and no abdominal twist are predictive, and there is no effect of chest bend or upper arm position. Forearms are raised and weight transfer is either backwards or forwards, and attributions are less likely when viewed from the front. Happiness is characterised by head backwards and no forwards movement of the chest. Arms are raised above shoulder level and straight at the elbow, weight transfer is not predictive, and attributions are more likely when viewed from the front. Sadness is the only emotion characterised by a forwards head bend, and in addition includes forwards chest bend, no twisting, and arms at the side of the trunk. Weight transfer is not predictive and attributions are less likely when viewed from behind. Finally, surprise involves backwards head and chest bends, any degree of abdominal twisting, and arms raised with forearms straight. Weight transfer is not predictive, and attributions are again more likely when viewed from the front.

In addition to examining whether changes in viewpoint affect recognition accuracy, it is important to investigate consistency of attribution across viewpoints. In order to accomplish this, a series of non-parametric correlations was performed. For each posture seen from each viewpoint, the six emotions were ranked in terms of how often they were selected by participants. Correlations were then calculated across the three viewpoints for each emotion. To the extent that attributions are consistent across viewpoints, the correlations for same emotion pairs should be higher than for different emotion pairs.

The results are summarized in Table 5, and reveal a pattern of correlations where all emotions except disgust showed the highest correlations for same emotion pairings. That is, for five out of six emotions, a posture seen as representing a specific emotion from one viewpoint was most likely to be attributed to the same emotion when viewed from a different viewpoint. For disgust, although there was some evidence for consistency, postures seen as disgust were equally likely to be seen as disgust or fear when viewed from a different viewpoint.

To further investigate the patterns of confusion between emotions, a multidimensional scaling (MDS) procedure was applied to the matrix of stimulus categories and participants' responses. Confusion is not commutative; confusing expression A with expression B does not imply expression

TABLE 5

Summary of Viewpoint Showing Same Emotion Correlations, and Range of Other Emotion Correlations

	Front-side		Front-rear		Side-rear	
	r	(range)	r	(range)	r	(range)
Anger	.36	(–.35–.18)	.46	(–.34–.29)	.55	(–.29–.15)
Disgust	.15*	(–.20–.25)	.23**	(–.21–.23)	.08*	(–.21–.11)
Fear	.42	(–.43–.29)	.47	(–.40–.25)	.62	(–.43–.28)
Happiness	.60	(–.51–.38)	.63	(–.56–.41)	.71	(–.60–.53)
Sadness	.64	(–.64–.36)	.71	(–.60–.29)	.79	(–.70–.26)
Surprise	.60	(–.48–.48)	.58	(–.46–.50)	.62	(–.49–.51)

*Same emotion correlation was not the highest correlation observed.
**Same emotion correlation was joint highest correlation observed.

B will be confused with expression A, and the full matrix as opposed to averaged (upper or lower triangle) values was used.

A two-dimensional circumplex fits the confusion data well (Kruskal Stress-1 = 0.08, see Figure 3). Happiness and surprise occupy similar locations on the surface with the other four emotions well spread out around the circumplex.

Discussion

The results of this study shed light on a number of questions regarding the perception of emotion from body posture. These concern how different emotions are attributed to body postures, the effect of anatomical variables and viewpoint on attribution, and the nature of confusions across emotions. Each of these is addressed below.

The results paint a complex picture of how well body posture communicates emotion. Disgust was not attributed to any posture by more than 50% of the sample, and fear and surprise were consistently attributed to only a small number of postures. Anger, sadness, and happiness, by contrast, were attributed to large numbers of postures, and some stimuli were attributed to the same emotion by 90% or more of the sample. For these three emotions, agreement rates are comparable to those obtained from

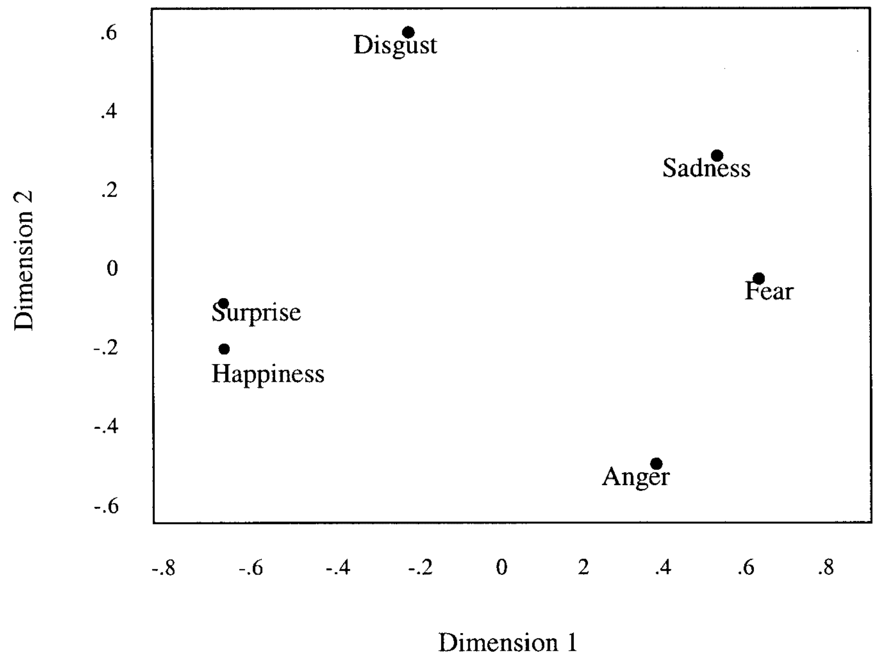


Figure 3. Multidimensional scaling analysis of confusion matrix.

static facial expressions, and replicate other findings suggesting they are accurately perceived from posture (Boone & Cunningham, 1998; Walk & Homan, 1984).

For the less well recognized emotions, a number of explanations can be put forward. For disgust, accuracy rates from other studies have been similarly low, and there may be no static body posture for disgust other than the act of retching. Disgust may therefore be primarily communicated through the face, although it remains to be seen whether certain dynamic features of the body also contribute.

Surprise and happiness generated perceptually similar postures, and the low figures for surprise may be due to participants opting for an attribution of happiness in the absence of situational cues for surprise. This observation is supported by the analysis of the confusion matrix, which identified surprise and happiness as the only systematically confused postures, and is developed further in the discussion of confusions below.

The results for fear are perhaps more surprising when one considers the ease with which postural expressions of fear can be brought to mind. The cowering aspect of fear is well represented in the stimulus set, yet participants were reluctant to attribute fear. One possible explanation for this concerns the relative contributions of posture and movement to the attribution of emotion. Although static images can imply movement, and have been shown to activate neural systems associated with motion detection, attributions of certain emotions may be especially sensitive to motion cues, and static images may not represent an appropriate medium within which dynamically expressed emotions can be communicated. In a dynamically unfolding response, snapshots may sometimes provide a great deal of useful information, but at other times be uninformative or even misleading. Fear and surprise (and perhaps to a lesser extent disgust) are emergency responses whose bodily expression may have more to do with velocity and form of movement than postural configuration. Clearly, future research should investigate how posture and movement contribute collectively or independently to the attribution of emotion.

The joint rotations and weight transfer variables that defined the postures were shown to predict participants' attributions with varying degrees of accuracy. Each emotion was associated with a unique set of joint rotations and none of the anatomical variables was redundant. While these data point to a means by which structural and psychological descriptions of body posture may be integrated, they are far from definitive. The range of joint rotations included was small, and little can be said about the degree to which each rotation is able to affect the overall attribution of emotion. Future research should address these questions in more detail, and map out the complex relationships between patterns of rotation and resulting attributions. Unlike facial expression, where muscle actions are quantified in fairly gross ways, the study of postural expression should focus on the degree of change, with the aim of formally describing the relationships between anatomical variables and perceptual gestalts.

Turning to the effects of viewpoint, there was a general tendency for frontal views to lead to more consensual attributions, although this pattern did not apply to fear or sadness. It is possible that these differences arise from the occluding effects of particular viewpoints on some classes of stimulus. For instance, the more closed and downward looking postures for disgust, fear and sadness appear smaller from the front, and present less information to the viewer than side and rear views. An inspection of the stimuli themselves leads to a similar observation for anger and happiness postures seen from the side.

The overall preference for frontal views suggests that attributing emotion to a body posture is a great deal easier when the person adopting the posture is facing the perceiver. Such an orientation, while not necessarily ideal for perceiving the three dimensional relationships between body segments, may nonetheless enhance recognition due to its interpersonal significance. If a person is facing away, decoding their emotional state may be useful but not critical. When we are confronted, rapid and accurate decoding of emotional state offers important information that can be used to guide behavior.

An alternative explanation for the effects of viewpoint is that participants are not basing their decisions on the inferred three-dimensional properties of the stimulus, but on some other unknown perceptual variable or variables. While this explanation remains a possibility, it is rendered less plausible by the results of the correlational analyses of viewpoint, which showed that for all emotions bar disgust the attribution made to one viewpoint was the one most likely to be selected for the other two. This suggests participants are extracting three-dimensional information from the stimuli and using this as the basis for their decisions rather than viewpoint-dependent cues.

With regard to confusions between postures, the pattern obtained here was consistent with a two-dimensional circumplex of emotion. Four out of six emotions (anger, disgust, fear, and sadness) were not confused with one another, but the remaining two (happiness and surprise) demonstrated considerable overlap. This could be due to the physical similarity of the postures produced for happiness and surprise, but may also reflect conceptual similarities. Carroll and Russell (1996) argue that the attribution of emotion to displays occurs in a context that they label *limited situational dominance*. That is, knowledge of the eliciting context has a direct effect on perceptions of emotion. In the context-free stimuli used in this study, participants may use happiness as a default category for stimuli which are generally upright with the arms raised to the sides. In the absence of an explicit emotion-eliciting event, it may be more parsimonious to attribute an internal cause to the emotion, and select happiness over surprise. An analogous effect would not be predicted in attributions to facial expressions due to the large differences between happy and surprised faces.

Several questions remain unanswered. First, the relatively low agreement rates for fear suggest either that fear is poorly recognized from static posture (and that recognition may rely more on dynamic cues), or that the fear postures used in this study were unrepresentative. The latter account is difficult to reconcile with the levels of agreement found for the majority of the other emotions, but this requires further investigation. The more general issue of the relative roles of posture and movement, and how these may vary across different emotions, also requires further investigation, and may cast light on the generally small effects of weight transfer observed in this study. Researchers are becoming increasingly aware of the importance of the temporal signature of facial expressions (Wehrle, Kaiser, Schmidt, & Scherer, 2000), and it is likely that bodily movement will prove similarly important. Investigating physical variables describing dynamic as opposed to static features of the body (velocity and acceleration of segments, time course of onset and termination, etc.) should continue the integration of psychological and anatomical accounts attempted here.

Second, the range of emotions was limited to those six which have attracted the greatest attention in previous work on recognition. There is an entire emotional repertoire to be investigated, and it is likely that other emotions will be recognized from posture at levels comparable to those studied here. A similar exercise which considered some of the self-conscious emotions such as shame, guilt, and embarrassment which typically include hiding of the face and might therefore be effectively communicated through the body could enhance understanding of these emotions, and of the role of posture in communicating emotion generally.

These findings as a whole support the contention that static body posture offers a reliable source of information concerning emotion, and contribute to our understanding of how emotion is expressed through the body. Recognition of emotion from posture is comparable to recognition from the voice, and some postures are recognized as well as facial expressions. An account of bodily expression of emotion in the language of anatomical variables is tractable, and would represent a tool with considerable research and practical significance.

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