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2012

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How to cite

DAEL, Nele, MORTILLARO, Marcello, SCHERER, Klaus R. Emotion expression in body action and posture. In: Emotion, 2012, vol. 12, n° 5, p. 1085–1101. doi: 10.1037/a0025737

This publication URL: <https://archive-ouverte.unige.ch/unige:97844>

Publication DOI: [10.1037/a0025737](https://doi.org/10.1037/a0025737)

Emotion Expression in Body Action and Posture

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Emotion communication research strongly focuses on the face and voice as expressive modalities, leaving the rest of the body relatively understudied. Contrary to the early assumption that body movement only indicates emotional intensity, recent studies have shown that body movement and posture also conveys emotion specific information. However, a deeper understanding of the underlying mechanisms is hampered by a lack of production studies informed by a theoretical framework. In this research we adopted the Body Action and Posture (BAP) coding system to examine the types and patterns of body movement that are employed by 10 professional actors to portray a set of 12 emotions. We investigated to what extent these expression patterns support explicit or implicit predictions from basic emotion theory, bidimensional theory, and componential appraisal theory. The overall results showed partial support for the different theoretical approaches. They revealed that several patterns of body movement systematically occur in portrayals of specific emotions, allowing emotion differentiation. Although a few emotions were prototypically expressed by one particular pattern, most emotions were variably expressed by multiple patterns, many of which can be explained as reflecting functional components of emotion such as modes of appraisal and action readiness. It is concluded that further work in this largely underdeveloped area should be guided by an appropriate theoretical framework to allow a more systematic design of experiments and clear hypothesis testing.

Keywords: emotion, expression, gesture, posture, appraisal

Supplemental materials: <http://dx.doi.org/10.1037/a0025737.supp>

The skeletal motor system is one of the most versatile and complex communicative modalities of the human body. The fact that it serves so many functions is illustrated by the sheer number of disciplines in which it is the object of study, from literary and performance arts to neuroscience and human–computer interaction. Affective psychologists have focused on its particular role in emotion communication. In the following section we show that bodily emotion communication is an old but long neglected topic in emotion research, but also that it is gaining increasing research attention. We then distinguish encoding and decoding approaches in terms of how they differently contribute to the understanding of the emotion communication process. In the following section, we give a brief overview of three competing theoretical models of emotion and their implications for bodily emotion expression. Finally, we account for the use of a systematically controlled

corpus of acted emotional expressions as a practical consequence of a research focus on emotion expression within a broad theoretical framework.

The Role of Body Movement in Emotion Communication

In *The Expression of Emotion in Man and Animals*, Darwin (1872) illustrated the continuity of emotion expression between humans and animals by comparing distinctive body postures and movements in response to emotion eliciting situations. The essential argument that the body serves an adaptive function to deal with events that compromise or foster the organism's well-being, survival, or reproductive value, has inspired many contemporary theories of emotion.

Despite Darwin's (1872) seminal work on body posture and movement, emotion expression and perception has been investigated predominantly in the facial and vocal domain. It has long been assumed that whereas a number of facial muscle configurations are reliable indicators of specific emotions, body movements or postures provide information of only gross affect state (e.g., liking) or emotion intensity (original studies by Ekman, 1965;¹ Ekman & Friesen, 1967; see Harrigan, 2005). This view is no

This article was published Online First November 7, 2011.

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This research is part of the dissertation project of Nele Dael and was supported by the Swiss National Science Foundation (FNRS 51A240–104897), by the National Center of Competence in Research (NCCR) Affective Sciences (51NF40–104897), and by the Faculty of Psychology and Educational Sciences, University of Geneva.

The supplemental materials for this article can be downloaded from www.affective-sciences.org/gemep/Bodily_expression

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¹ Ekman and Friesen (1967) slightly reformulated their claim, suggesting that “hand cues might be an exception to the general findings about body cues; instead of providing information only about intensity, hand cues, much like facial cues, might permit perception of the nature of the emotion . . . the nature of an emotion is not conveyed simply by a particular body part, such as hands, but by body acts as distinguished from body positions, regardless of body part”. (p. 713)

longer supported by recent studies showing that variations in body movement and posture convey specific information about a person's emotional state, more specifically in dynamic whole body movement and arm action or gesture (Atkinson, Dittrich, Gemmell, & Young, 2004; Atkinson, Tunstall, & Dittrich, 2007; Montepare, Koff, Zaitchik, & Albert, 1999; Pollick, Paterson, Bruderlin, & Sanford, 2001; Wallbott, 1998), static whole body configurations (Atkinson et al., 2004; Coulson, 2004; Tracy & Robins, 2004), gait (e.g., Roether, Omlor, Christensen, & Giese, 2009), dance (Boone & Cunningham, 2001; de Meijer, 1989; Dittrich, Troscianko, Lea, & Morgan, 1996; Sawada, Suda, & Ishii, 2003), and even sign language (Hietanen, Leppänen, & Lehtonen, 2004; Reilly, McIntire, & Seago, 1992). In addition to body specific contributions to emotion expression or perception, results from multimodal studies highlight the importance of the body in conjunction with the face or voice. In an extensive empirical examination of multimodal emotion expression, Scherer and Ellgring (2007b) showed cross-modal patterning of face, voice, and gesture. Spillover effects between modalities on emotion recognition also have been documented (Aviezer et al., 2008; Van den Stock, Grèzes, & de Gelder, 2008; Van den Stock, Righart, & de Gelder, 2007).

The Use of Emotion Encoding Studies

This growing body of studies clearly demonstrates that body movement plays a crucial role in emotion communication. Information conveyed from this channel is additional to and even modulates information conveyed by the face or the voice (e.g., Aviezer et al., 2008). However, most of the above mentioned studies focus on emotion attribution by judges based on the perception of a small sample of movements or configurations. This decoding approach has produced interesting findings related to emotion perception but does not provide insight into the process of emotion encoding, that is, the way in which an emotional state affects bodily expression. The selection of body stimuli is often based on theoretical criteria of relevant cues or on previously collected recognition rates under the assumption that perceived emotion is an ecologically valid criterion for expressed emotion. Also, judgments of movement cues are subjective representations of physical changes in movement behavior and do not necessarily reflect reliable indicators of emotion. Which objective features of the behavioral spectrum of emotion influence movement and emotion perception? What are the psychological mechanisms that are responsible for producing emotions in the body? Answers to these questions can best be obtained by investigating the production process (Scherer, 2003; Scherer & Wallbott, 1985).

Regarding the first question, only a limited number of emotion encoding studies have measured physical cues used to express emotion in the body, including specific types and dynamic qualities of arm, head, and trunk movement (Boone & Cunningham, 2001; Gross, Crane, & Fredrickson, 2010; Sawada et al., 2003; Wallbott, 1998; Wallbott & Scherer, 1986). One obvious reason for the relative dearth of production studies is the methodological difficulties in describing behavior. The establishment of refined measurement techniques for the face (e.g., the Facial Action Coding System; Ekman & Friesen, 1978) and voice (Scherer, 1986) has allowed systematic research on emotion expression in the respective modalities. Currently there is no consensus on how to

code body movement (Harrigan, 2005), and although several systems have been developed throughout the years, few of them have been used to investigate emotional expression (Friesen, Ekman, & Wallbott, 1979; Wallbott, 1998). In an effort to integrate several coding approaches and foster their usage in emotion research, Dael, Mortillaro, and Scherer (in press) proposed a multilevel coding system for the microanalytic segmentation and description of body action and posture.

Production studies also are needed to answer the second question mentioned above. Systematic research on emotion encoding can inform perception research in the choice of perceptual stimuli, and help to develop empirically informed hypotheses. We argue that research on the expression and perception of emotion in the body should be embedded in an emotion theoretical framework as is the case for facial and vocal emotion research. In the next section, we review three main emotion theoretical models from which different predictions on the patterning of bodily expression issue.

Emotion Theories and Predictions on Bodily Expression

Theories of emotion expression are mainly shaped by facial expression research. It has not been tested whether these theories provide valid explanations for (vocal or) bodily emotion expression. Even though major emotion models often do not provide explicit predictions on body movement, they imply different expectations regarding response patterning.

Basic emotion models (Ekman, 1992, Ekman, 2003; Izard, 1971, Izard, 1992; Tomkins, 1962) posit that there are a limited number of universal, so-called basic emotions. All other nonbasic emotions are hypothesized as combinations or "blends" of basic emotions. Basic emotions are said to be characterized by distinct, hard-wired neuro-mental processes. These fixed "affect programs" automatically produce a prototypical response configuration that is emotion specific. Culturally defined display rules are responsible for modifying or inhibiting full-blown expressions. This theory is almost exclusively based on empirical research on the face, where prototypical facial expressions for basic emotions have been extensively documented and differentiated (Ekman, 1972; Ekman & Friesen, 1971). According to this perspective, one should look for prototypical, emotion specific response patterns in bodily expressions for these basic emotions. In line with the basic emotion perspective, Tracy and Robins (2004) showed that pride, a self-conscious emotion, did show a particular set of body configurations, which were much more specific than the facial expression. Furthermore, these expressions were highly recognizable across cultures (Tracy & Robins, 2008). Hence, they argued that pride should be included in the set of distinct, universal emotions.

Dimensional models (Osgood, 1966; Russell, 1983; Schlosberg, 1952, Schlosberg, 1954) imply that emotions can be defined by their locations on a small number of emotion dimensions (usually two or three). The circumplex model (Russell, 1980, Russell, 2003), for example, states that all possible affective experiences can be represented along a circular structure that is anchored by two independent and bipolar axes, valence or pleasantness, and arousal or activation. Several variations of the circumplex model have been suggested in the literature (for a review, see Feldman Barrett & Russell, 1999). From such models it follows that the

bidimensional structure of affect underlies and explains response patterning. Again, this has mainly been reported in judgment studies of facial expressions (e.g., Russell, Weiss, & Mendelsohn, 1989). However, in a study on everyday arm movement, Pollick and colleagues (Pollick et al., 2001) mapped affective ratings on a two-dimensional structure, which was similar to a circumplex with activation and pleasantness as constituting factors.

Componential emotion models (Ellsworth & Scherer, 2003; Frijda, 1986, Frijda, 2007; Roseman & Smith, 2001; Scherer, 2001; Smith, 1989) define *emotion* as a process of interrelated changes in several components of psychobiological functioning: the appraisal or evaluation of objects or events with respect to the organism's goals or needs and the ensuing changes in autonomic physiology, behavior preparation and action tendency, motor expression, and subjective feeling. Contrary to the aforementioned models, the componential approach does not describe or reduce the affective spectrum in terms of a number of basic emotions or few emotion dimensions, but is aimed at explaining the full complexity of emotional experiences and expressions. Contrary to the fixed programs notion (in which an expression is a molar entity caused by activation of the affect program), componential models hypothesize that the individual elements of motor expression are direct effluent effects of appraisal outcomes on a series of criteria such as novelty, intrinsic pleasantness, goal conduciveness, coping potential, and normative significance of the eliciting event. Appraisal is thus considered the central mechanism in the elicitation and differentiation of emotion. It decouples the emotion eliciting stimulus from a reflex-like reaction and enables a flexible and adaptive response to the environment. Emotions characterized by different appraisal profiles are expected to have different expression patterns. Predicted motor effects of appraisal outcomes mostly concern facial and vocal expression. However, in the component process model (CPM), Scherer (Table 5.3 in Scherer, 2001) listed a number of predictions concerning body posture, movement, and gesture (e.g., agonistic arm movements, erect posture, body lean forward, and approach locomotion as an effluent result of an appraisal of control and high power). For example, Coulson's (2009) computational animation simulation model implemented some of the predicted functional appraisal effects on whole body configurations and how these configurations may change as the appraisal sequence unfolds. The empirical investigation of Scherer's componential view on response patterning is not restricted to facial expression (Scherer & Ellgring, 2007a), but also has included multimodal integration of face, voice and body movement (Scherer & Ellgring, 2007b).

The action tendency component of emotion is closely related to appraisal (Frijda, Kuipers, & ter Schure, 1989). In his componential theory, Frijda (1986, 2007) conjectured that emotions are changes in action readiness and lead to motivated action. Action tendency or change in action readiness is thus a central component in emotional experience and closely ties experience to motor expression. Facial expressions correspond to states of readiness to establish, maintain, or change a particular kind of relationship with an object in the environment (Frijda, 1986). The behavioral context in terms of gross body movements, postures, orientations, and object-related actions is assumed to equally express relational activity and modes of action readiness, though empirical and theoretical development is scarce (Frijda & Tcherkassof, 1997). In one empirical study, de Meijer (1989) found that perceptions of

gross body movements were indeed related to factors of action readiness. Further, expanded or slumped postures following a positive (success) or negative (defeat) emotional experience, were found to be related to adaptive appraisals or tendencies that guide self-regulation and information processing (Riskind, 1984).

A New Corpus of Bodily Emotion Expressions

The sets of emotional expressions used in most of the above cited studies are tailored to specific research questions, making it difficult to replicate and evaluate results from different theoretical perspectives. For example, to maximize experimental control on the behavior variable of interest, several researchers have used visually abstracted stimulus sets of dynamic point-light displays (e.g., Atkinson et al., 2004; Pollick et al., 2001; Roether et al., 2009).

A possibility to increase replicability and broaden theoretical application is to develop and exploit a database that consists of a large number of systematically obtained expressions and measurements that are made available for researchers. Most corpora of emotional expressions consist of recordings of facial or vocal expressions. Because the body modality has yet received little research attention by scholars in the field, relatively few corpora have been developed that include body posture, movement, or gesture. One exception is the Munich corpus, a collection of multimodal dynamic expressions of 14 emotions (Banse & Scherer, 1996), which has been used to investigate emotion expression through body posture and movements of the arms and head (Wallbott, 1998). Also, the Diagnostic Analysis of Nonverbal Accuracy (DANVA2-POS; Pitterman & Nowicki, 2004) is a test for emotion recognition based on a collection of static sitting and standing postures that was based on Argyle's (1988) major postures dimensions; head, arms, legs, and body lean. Over the last few years, two new corpora of emotional expressions have been developed. First, the UC Davis Set of Emotion Expressions (UCDSEE; Tracy, Robins, & Schriber, 2009) includes some static whole body postures and arm configurations of the three self-conscious emotions embarrassment, shame, and pride. Second, the Geneva Multimodal Emotion Portrayals corpus (GEMEP; Bänziger, Mortillaro, & Scherer, in press; Bänziger & Scherer, 2010) provides a large number of dynamic bodily expressions including postures, movements, and gestures of 18 emotions. Contrary to the UCDSEE, the bodily expressions in GEMEP are not systematically manipulated. On the other hand, GEMEP provides a large sample of the repertoire that can be used to express emotion in the body without a priori limiting to a few theoretical assumptions. Also, high emotional diversity sets the GEMEP corpus apart from others as it includes not only modal or basic emotions such as fear and anger, but also less frequently examined emotional states such as irritation or interest. In further contrast to other collections, the GEMEP corpus includes many positive states such as relief, pleasure, and pride. The choice of emotions was further motivated by theoretical considerations of their positions on two major emotional dimensions; valence and arousal (see Table 1). Emotions belonging to the same emotion family, for example, hot anger and irritation (cold anger), are theoretically differentiated by the level of arousal. This corpus thus likely represents a large range of emotions that occur in a daily interaction. A final contribution of the GEMEP

Table 1
Selection of Emotional States

Arousal	Valence	
	Positive	Negative
High	Elated joy Amusement Pride	Hot anger (rage) Panic fear Despair
Low	Pleasure Relief Interest	Cold anger (irritation) Anxiety (worry) Sadness (depression)

corpus to bodily expression research is, as the Munich corpus, the presence of emotional gesture accompanying nonlinguistic speech.

The Present Research

This production study is aimed at identifying common behavior patterns of body movement used by actors to express emotion, and, second, investigating emotion differentiation. We chose the GEMEP corpus as most adequate for our research purpose because it provides a very rich and diverse dataset both in terms of the number of emotions and in terms of the behavioral repertoire, integrating body posture, movement, and gesture. Given that these are rarely studied elements of emotion expression that are not yet well established in emotion theory, there is little basis for the formulation of specific hypotheses. Nevertheless, we interpret the results in the light of the three dominant emotion theoretical models described above. Basic emotion theories imply that we should find patterns that are specific for fundamental emotions. According to the bidimensional theory, emerging behavior patterns should be indicative of arousal and valence and thus would not lead to a clear categorical emotion differentiation. Componential or appraisal theories would predict that patterns of body movement reflect major appraisal profiles and action tendencies. From this notion it follows that emotions that share a particular configuration of appraisal outcomes are expected to be characterized by the same behavior pattern. Equally, emotions with different or opposite appraisal profiles should be represented by different behavior patterns.

Method

Recording and Selection of Emotion Portrayals

The GEMEP corpus was developed and recorded at the University of Geneva (Bänziger, Mortillaro, & Scherer, in press; Bänziger & Scherer, 2010). Professional actors portrayed a comprehensive set of emotions in a scenario-based interaction setting coached by a professional theater director. To ensure content validity and avoid ad hoc labeling, each emotion was defined and described in three scenarios. Recordings were made in a controlled environment under high technical standards in terms of frame speed (25 Hz) and multiple camera angles (frontal and side view of the body from knee upward). The actors did not receive instructions to use particular facial or bodily expressions, apart from the restriction not to move away from the central point of the two cameras. A complete description of the GEMEP material and procedure can be

found in Bänziger and Scherer (2010) and in Bänziger, Mortillaro, and Scherer (in press).

The material used for this study is a subset of the GEMEP corpus that was based on extensive ratings to ensure high technical quality, believability, and recognizability of the encoded emotion (Bänziger, Mortillaro, & Scherer, in press; Bänziger & Scherer, 2010). This subset consists of 120 portrayals in which 10 actors (five female, five male) expressed 12 emotions, uttering a standard nonlinguistic sentence (“ne kali bam soud molen” or “koun se mina loud belam”). The selected emotions include both “basic” and subtle emotions, comprising several families and equally representing the two poles of the valence/pleasantness dimension (positive, negative) and the arousal/activation dimension (high arousal or active, low arousal or passive, see Table 1).

Coding of Body Movement

We adopted a recently developed observational coding system to perform microcoding of our set of emotion portrayals (Dael et al., in press). In that paper we presented the development and reliability of the Body Action and Posture (BAP) system, which is primarily designed for application in nonverbal uni- and multi-modal emotion expression research. It provides time-aligned microdescriptions of body postures and actions integrating different levels of expressive manifestation, that is, on an anatomical level (different articulations of body parts), a form level (direction and orientation of movement), and a functional level (based on Ekman & Friesen, 1972).

For the current study we analyzed a set of 49 behavioral categories (listed in Table 2). These variables were obtained by pooling the elementary variables corresponding to the basic movement unit coded with the BAP coding system (listed in the supplemental material), and removing those variables for which intercoder agreement was insufficient or could not be calculated due to infrequent coding (Dael et al., in press). To preserve a maximum of information we used the proportion of duration within each portrayal as the measurement unit of the behavior variables. The use of duration data of this set of variables is justified by very high intercoder agreement (kappa using a time window of 440 ms, $M = 0.80$, $SD = 0.12$). Further detail on the coding procedure and reliability analyses can be found in Dael et al. (in press).

Results

Data Reduction: Principal Component Analysis

To reduce dimensionality in the data we first performed a principal component analysis (PCA) on the 49 behavior variables describing the dataset ($N = 120$). Sixteen factors were retained that have an eigenvalue greater than 1 and explained 73.40% of the total variance. The first and largest factor accounts for 15.06% variance and group variables related to all arm action articulations and directions, indicating general arm activity. Variables loading high on the second factor, which captures 8.30% of the variance, relate to functionally illustrative and repetitive arm actions. The third factor explains 6.64% and is characterized by an averted lateral head posture and absence of body oriented movements. The fourth factor explains 5.43% and is characterized by repetitive head action and touching movements. The other 10 factors add

Table 2

Component Matrix of the 49 Behavior Variables Included in a Principal Component Analysis (16 Components Extracted)

Behavior variable	Component															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Shoulder action	.86															
Elbow action	.83															
Double arm action	.75						.41									
Lateral arm action	.74															
Arm action towards body	.71															
Arm action away from body	.71															
Backward arm action	.69															
Upward arm action	.69															
Downward arm action	.66															
Forward arm action	.65															
Finger action	.58															
Asymmetrical arm action	.54									.51						
Both arms at side	-.47			-.42												
Wrist action	.45															
Beat		.80														
Repetitive up-down arm action		.64					.42									
Emblem		.62														
Illustrator		.62														
Repetitive forward-backward arm action		.56														
Facing trunk orientation	-.42						.41									
Touch			-.63	.43												
Manipulator			-.59	.37												
Action hold			-.57	.38												
Averted head orientation			.56		.43											
Head posture tilted lateral			.42													
Gaze averted to the side			.39					-.35								
Head action			.38	.56	-.46											
Head shake				.52	-.51											
Trunk lean posture to the front		.43		-.49												
Arm(s) at waist																
Head posture tilted up					.44											
Gaze upward						-.71										
Gaze straight forward					-.43	.53										
Lateral trunk lean posture		.37				-.48										
Symmetrical arm action	.49						.59			-.36						
Single arm action		.40		.38			-.50									
Whole body posture to the front								-.49	.39						-.35	
Eyes closed					.43			.46								
Lower limb movement								-.45	.37				.43			
Head posture turned lateral									-.40							
Trunk lean posture to the back																
Arm action retraction										.53						
Trunk action											-.50					
Both arms held in front											-.46				.45	
Frontal neck posture						-.40					.46					
Whole body posture to the back												.56		.47		
Both arms in the pockets												-.37			-.52	
Knee movement										.35						.45
Downward gaze																-.45

between 2% and 5% of explained variance each and thus represent a small but nonredundant part of the behavioral complexity implicated in the dataset.² These behavior dimensions are often based on a small number of behavior categories, for example, backward whole body movement (high loadings of lower limb movement, backward body posture). This set of 16 factors³ relates to both action and posture behavior and to different descriptive levels included in the coding scheme: anatomical articulation (e.g., double arm action), form (e.g., symmetry), and function (e.g., illustrative action).

² Despite the fact that several factors had a relatively low added variance, they remained included in the factor solution because all of them had an eigenvalue of more than 1 and they were meaningful for interpreting the results. In addition, this PCA was intended to reduce dimensionality but nevertheless keep the explained variance high to render subsequent analyses representative for our dataset.

³ This set of factors best characterized the current dataset, and should thus not be considered as descriptive primitives as the interrelations between the 49 descriptive categories can vary in different datasets.

Taken together these results, both general movement dimensions and particular behavior types characterized our dataset. The varied set of emotional body movements cannot be reduced to a handful of behavioral dimensions without significant loss of information (frequent occurrence, significant eigenvalues > 1). The component matrix gives an overview of the variables loading higher than .35 on each factor (see Table 2). We adopted the regression method to calculate the factor scores and used the resulting set of 16 behavior factors as variables for all subsequent analyses.

Identification of Behavior Patterns of Emotion: Two-Step Cluster Analysis

In the next step we applied a two-step cluster algorithm to reveal natural groupings (clusters) of emotion portrayals based on common behavior patterns (available in SPSS 11.5 and later, based on Chiu, Fang, Chen, Wang, & Jeris, 2001; Zhang, Ramakrishnan, & Livny, 1996). Compared to other clustering techniques, this procedure is useful for handling large datasets with both categorical and continuous variables. We included the 16 factors as continuous variables and emotion as a categorical variable.⁴ We fixed the number of clusters to the 12 emotion categories that comprise our dataset so we can assess how well each emotion category is represented by the behavior factors.

Each cluster groups a number of portrayals and represents a homogeneous behavior pattern. The cluster distribution (see % of total in Table 4) shows that one cluster grouped only 2.5% of all portrayals and was subsequently discarded as an outlier cluster (No. 6). Cluster sizes varied between 5% and 13.3%. The centroid matrix represents the behavior pattern of each cluster indicated by the mean factor loadings for each cluster (see Table 3). Factors with a higher positive or negative value have a stronger impact on cluster formation. To identify the behavior factors that defined the clusters in our dataset, we selected the components that have a centroid value of more than plus or minus 1 for each cluster that corresponds to 1 standard deviation above the mean loading for that factor. When this criterion is applied, all but one cluster was differentially linked to one or more components. To explore the association of clusters with individual emotions or groups of emotions, we calculated the distribution of emotion portrayals over the clusters (see Table 4). We refrained from interpreting the Pearson chi-square independence test because the low number of expected counts is known to yield unreliable coefficients. The within cluster distribution of portrayals gives information about the emotional specificity of that behavior pattern, but not about the behavior frequency. In contrast, the within emotion distribution of portrayals gives information about the behavioral homogeneity of that emotion, that is, the frequency with which the behavior pattern is used to encode this emotion. On the basis of these distributions we distinguish three cluster types: an emotion specific cluster type, a multi-emotion cluster type, and a nonemotion-specific cluster type. In the next section we describe the behavior composition of the clusters and how they are associated to the emotion categories. In Figure 1 we present a summary description of the behavioral composition of each cluster illustrated with some still video frames and its associated emotion(s). Exemplar videos that illustrate some of the behaviors used in these clusters can be found as supplemental material.

Three out of 12 clusters define emotion specific behavior patterns. As can be seen from Table 4, one cluster (No. 4) is entirely made of hot anger portrayals, and no other portrayals of this emotion are found in any other cluster. Hence, hot anger is prototypically and homogeneously expressed by frontal body lean or movement in this dataset. Second, all amusement portrayals are grouped under one single cluster (No. 11), which is highly—but not completely (76.9% of that cluster)—specific for that particular emotion. Amusement, as expressed by these 10 actors, is homogeneously and almost prototypically expressed by touching or manipulation and discontinuous movements (filled with midaction breaks or holds) while the head is laterally straight and oriented toward the interlocutor (negative loading on third component, see Table 2). One other cluster appears to be fairly specific for pleasure as this emotion represents 57.1% of portrayals in this cluster (No. 9). However, the behavior pattern of this cluster (head tilted up and averted, asymmetrical arm action) is not used to encode all cases of pleasure (40% of all pleasure portrayals). In other words, although this behavior is not frequently present in the encoding of pleasure, it is nevertheless fairly prototypical of pleasure.

The second and most frequent type of cluster (six out of 12) is a multi-emotion cluster that represents two prominent emotions, that is, grouping at least 30% of the emotion portrayals. The cluster characterized by symmetrical up-down repetitive arm action (No. 8) is highly frequent for encoding elated joy (70%) and pride (40%). The cluster (No. 12) formed by symmetrical arm action (negative loading on the asymmetry component) and knee movement is frequent for panic fear (60%), but overlaps to some extent with elated joy (30%). Portrayals of sadness (60%) and relief (50%) are grouped under a cluster defined by both arms resting in the pockets (No. 10). Furthermore, 80% of all despair portrayals are classified within one cluster (No. 2), indicating that despair is homogeneously expressed by one behavior pattern. Unfortunately none of the 16 factors had a strong impact on this cluster formation, as no loading reached the threshold of -1 . This indistinct pattern is not specific for despair because it also includes 50% of anxiety portrayals. This cluster thus represents a frequent (13.3% of entire dataset) yet not despair specific behavior pattern. A second large portion of anxiety portrayals (40%) is grouped together with panic fear (30%) under the cluster characterized by backward body lean or movement combined with upward gaze and lateral trunk lean (No. 3). Thus these two clusters represent the expressive profile of anxiety. Finally, a small portion of our dataset (5%) was characterized by arms resting at side with trunk leaning frontal, combined with asymmetrical one arm action (negative loading on behavior factor 4, 7, and 13). This cluster (No. 1) grouped 30% of interest and irritation portrayals.

Two clusters grouped few portrayals from many different emotions. One cluster (No. 5) is defined by repetitive head action combined with touching arm actions. This behavior pattern is found in 10% of our dataset but is not specific for any particular emotion or set of emotions, although 75% of these portrayals are

⁴ Actor was not included as a variable in this analysis because the research focus of this paper is not on interindividual differences in emotion encoding. Because this is nevertheless an important factor to be accounted for, we report actor-cluster associations later in this section.

Table 3
Centroid Matrix

Behavior factor	Cluster no.											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Double arm action	-0.35	0.23	-0.14	0.47	-0.52	-0.21	-0.89	0.41	0.90	-0.83	0.40	0.25
2. Illustrative action	0.84	-0.20	-0.24	0.88	-0.47	0.86	-0.06	0.67	0.00	-0.73	-0.35	0.13
3. Head tilted lateral averted	-0.14	-0.10	-0.67	0.29	0.50	0.03	0.81	-0.14	0.09	0.81	-1.04	0.11
4. Head shake with touch	-1.32	-0.24	-0.32	-0.35	1.19	0.83	1.40	0.02	-0.07	-0.20	-0.25	-0.28
5. Head tilted up averted with closed eyes	-0.75	-0.31	-0.34	-0.36	0.30	1.68	-0.69	-0.25	2.07	0.28	0.17	-0.27
6. Straight body and gaze ahead	0.10	0.57	-1.71	0.50	0.52	-0.99	-0.40	0.56	0.19	-0.06	0.08	-0.03
7. Symmetrical up-down arm action	-1.67	0.14	0.14	0.01	0.02	-1.46	-0.72	1.17	0.15	0.13	-0.27	0.37
8. Lower body inactivity and closed eyes	0.84	0.35	0.24	-0.47	0.04	-2.56	-0.46	0.00	-0.77	0.47	0.20	-0.07
9. Forward whole body movement	-1.00	-0.10	0.21	1.96	-0.04	-0.25	-0.60	-0.27	-0.37	-0.01	-0.04	-0.24
10. Asymmetrical arm action	0.14	-0.12	0.26	-0.50	0.27	-2.01	0.43	0.06	1.11	0.22	0.34	-1.31
11. Arm retraction	0.17	-0.28	-0.26	-0.12	0.33	-0.54	-1.45	0.04	0.61	0.02	0.42	0.69
12. Neck extended to front	0.94	0.16	0.39	-0.08	0.15	0.40	-0.87	-0.52	0.62	0.04	-0.82	0.31
13. Backward whole body movement	-1.46	-0.01	1.46	-0.11	0.28	-0.39	-0.28	-0.20	-0.25	0.15	-0.38	-0.17
14. Backward whole body lean	-0.82	0.26	0.10	0.07	-1.44	-1.33	1.04	-0.15	0.83	0.37	0.06	0.26
15. Arms held in front	-0.42	0.19	0.12	0.14	-0.10	-2.28	0.85	0.23	0.51	-1.08	0.27	0.00
16. Knee movement	-0.95	-0.13	-0.30	-0.07	-0.32	0.76	0.72	0.09	-0.83	-0.53	0.08	1.77

from low aroused or passive emotions. The cluster marked by repetitive head action with touch combined with backward body lean (No. 7) is also a mix of few portrayals from mostly low aroused emotions (87.5% of all portrayals in this cluster).

To examine whether the individual way or style of encoding emotion confounded these cluster results, we calculated the distribution of actor portrayals (12 portrayals per actor) over the clusters. This factor (actor) did not seem to be related to the

Table 4
Within Cluster and Within Emotion Distributions of Emotion Portrayals (Proportions)

Cluster no.	% of total	Proportion type	Emotion											
			Amu	Ang	Des	Pri	Anx	Int	Irr	Joy	Fea	Ple	Rel	Sad
1	5.0	Prop clus Prop emo						.50 .30	.50 .30					
2	13.3	Prop clus Prop emo			.50 .80		.31 .50	.13 .20				.06 .10		
3	10.8	Prop clus Prop emo				.08 .10	.31 .40	.08 .10	.08 .10		.23 .30	.08 .10	.15 .20	
4	8.3	Prop clus Prop emo		1 1										
5	10.0	Prop clus Prop emo			.08 .10	.17 .20		.17 .20	.25 .30			.17 .20	.17 .20	
6	2.5	Prop clus Prop emo							.33 .10			.33 .10		.33 .10
7	6.7	Prop clus Prop emo			.13 .10		.13 .10	.25 .20	.13 .10			.13 .10		.25 .20
8	9.2	Prop clus Prop emo				.36 .40				.64 .70				
9	5.8	Prop clus Prop emo				.29 .20					.14 .10	.57 .40		
10	9.2	Prop clus Prop emo											.55 .60	.45 .50
11	10.8	Prop clus Prop emo	0.77 1			.08 .10								.15 .20
12	8.3	Prop clus Prop emo						.10 .10	.30 .30	.60 .60				

Note. $N = 120$. For easier readability, zero proportions are omitted. Amu = amusement; Ang = hot anger (rage); Des = despair; Pri = pride; Anx = anxiety (worry); Int = interest; Irr = irritation (cold anger); Joy = elated joy; Fea = panic fear; Ple = pleasure; Rel = relief; Sad = sadness (depression); Prop clus = proportion of portrayals relative to the cluster size; Prop emo = proportion of portrayals relative to the total number of portrayals per emotion ($n = 10$).

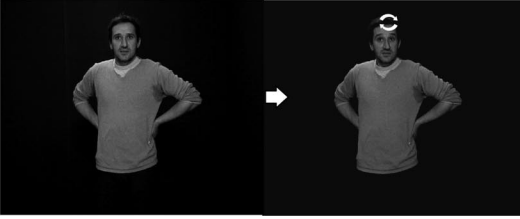
Cluster No	Cluster description	Associated emotion(s)	Visual illustration
1	Arms resting at side with trunk leaning to the front, asymmetrical one arm action	Interest, irritation	
2	No distinctive pattern	Despair, anxiety	
3	Backward body lean or movement with upward gaze and lateral trunk lean	Anxiety, panic fear	
4	Forward whole body movement	Hot anger	
5	Repetitive head action with touching arm actions	Passive emotion actions	

Figure 1. Summary description of the behavior patterns and the associated emotion(s) for each cluster, illustrated with still video frames. Emotions are considered associated to a cluster when at least 30% of the emotion portrayals are grouped in this cluster.

cluster formation (see Table 5). Unfortunately, also here the assumptions for testing independence were violated, preventing accurate calculation of the Pearson chi-square coefficient. In clear contrast to the emotion distribution, however, clusters never grouped more than one third of portrayals of a single actor. Thirty-three percent of portrayals of actor 10 were grouped under the cluster characterized by repetitive head action combined with touching arm actions (No. 5). Thirty-three percent portrayals of actor 2 were grouped under the cluster characterized by backward body lean or movement combined with upward gaze and lateral trunk lean (cluster No. 3). These behavior clusters were nevertheless used by four or five other

actors to express emotion. All other actor portrayals were widely spread over many clusters. This suggests that cluster formation was not dominated by idiosyncratic movement style.

Emotion Differentiation: Discriminant Analyses

To test the general assumption that emotion has an effect on body movement, we first performed a repeated measures multiple regression with emotion (12 levels) and body movement (16 levels) as within-subjects variables. Emotion did not have a main effect on all behavior factors together, $F(11, 99) = 2.06, ns$. In line

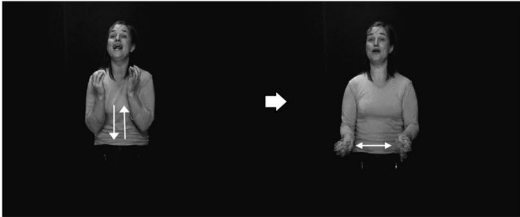
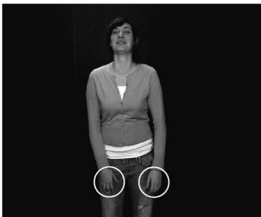
6	Outlier	/	
7	Repetitive head action with touch and backward body lean	Passive emotion	
8	Symmetrical up-down repetitive arm action	Elated joy, pride	
9	Head tilted up and averted, asymmetrical arm action	Pleasure	
10	Both arms at rest and in the pockets	Sadness, relief	
11	Touching or manipulation and discontinuous movement with straight head oriented towards interlocutor	Amusement	
12	Symmetrical arm action, knee movement	Panic fear, elated joy	

Figure 1. (continued)

with our expectation that emotions have differential effects on body movement, the general model showed a significant interaction effect between emotion and body movement, $F(165, 1485) = 2.14, p = .04$ (Greenhouse–Geisser corrected p value). The effect

of emotion on body movement is thus different for different behavior factors.

We followed up this main test by a discriminant analysis to investigate how the behavior factors discriminate emotions. Four

Table 5

Within Cluster and Within Actor Distributions of Actor Portrayals

Cluster no.	Proportion type	Actor									
		1	2	3	4	5	6	7	8	9	10
1	Prop clus			.17	.17	.17	.17	.17	.17		
	Prop act			.08	.08	.08	.08	.08	.08		
2	Prop clus	.06	.13	.06	.13	.13	.13	.19	.06		.13
	Prop act	.08	.17	.08	.17	.17	.17	.25	.08		.17
3	Prop clus		.31	.15			.08		.15	.23	.08
	Prop act		.33	.17			.08		.17	.25	.08
4	Prop clus	.10	.10	.10	.10	.10	.10	.10	.10	.10	.10
	Prop act	.08	.08	.08	.08	.08	.08	.08	.08	.08	.08
5	Prop clus	.08			.08	.25				.25	.33
	Prop act	.08			.08	.25				.25	.33
6	Prop clus	.33				.67					
	Prop act	.08				.17					
7	Prop clus	.38	.13	.38					.13		
	Prop act	.25	.08	.25					.08		
8	Prop clus	.18	.09	.18	.18	.09	.18			.09	
	Prop act	.17	.08	.17	.17	.08	.17			.08	
9	Prop clus	.14	.14		.14			.14	.29	.14	
	Prop act	.08	.08		.08			.08	.17	.08	
10	Prop clus	.09			.18		.09	.18	.18	.18	.09
	Prop act	.08			.17		.08	.17	.17	.17	.08
11	Prop clus	.08	.15	.08	.08	.08	.15	.15	.08	.08	.08
	Prop act	.08	.17	.08	.08	.08	.17	.17	.08	.08	.08
12	Prop clus			.10	.10	.10	.20	.20	.10		.20
	Prop act			.08	.08	.08	.17	.17	.08		.17

Note. $N = 120$. For easier readability, zero proportions are omitted. Prop clus = proportion of portrayals relative to the cluster size; Prop act = proportion of portrayals relative to the total number of portrayals per actor ($n = 12$).

discriminant functions or dimensions reached significance and explain 78.7% of the total variance, as shown in Table 6.

Table 7 presents the standardized canonical coefficients, which shows the relative contribution of each factor to the functions. High scores indicate that a factor is important for a function, and factors with positive and negative coefficients contribute to the functions in opposite ways. Here we report the factors with a coefficient higher or equal to .40 to understand the nature of each function or dimension. The first discriminant function is positively weighted by mainly illustrative action (.50), forward whole body movement (.55) and is negative on head tilted up averted (−.56) and asymmetrical arm action (−.44). The second discriminant function is positively contributed by symmetrical up-down arm action (.50) and knee movement (.50), and negatively by forward whole body movement (−.64). Important factors with a positive weight for the third function include head tilted up averted (.63),

double arm action (.48), arms held in front (.45); backward whole body lean (−.43) has a negative weight. Finally the fourth function is weighted positively by head tilted up averted (.45), symmetrical up-down arm action (.40), and backward whole body lean (.41).

Next, we examined the mean discriminant scores of emotions per function (see Figure 2) to identify the emotions that are best

Table 7

Standardized Canonical Discriminant Function Coefficients for the Four Functions

Behavior component	Function			
	1	2	3	4
1. Double arm action	.35	.15	.48	−.11
2. Illustrative action	.50	−.02	.22	−.21
3. Head tilted lateral averted	−.02	−.29	.01	.15
4. Head shake with touch	−.17	.06	.19	.15
5. Head tilted up averted with closed eyes	−.56	−.04	.63	.45
6. Straight body and gaze ahead	.31	−.14	.03	.34
7. Symmetrical up-down arm action	.34	.50	−.11	.40
8. Lower body inactivity and closed eyes	−.28	.10	−.07	−.01
9. Forward whole body movement	.55	−.64	.00	.33
10. Asymmetrical arm action	−.44	.01	.25	−.21
11. Arm retraction	.13	.41	.04	.23
12. Neck extended to front	−.29	−.31	−.29	−.21
13. Backward whole body movement	.03	.23	−.16	−.06
14. Backward whole body lean	−.12	.01	−.43	.41
15. Arms held in front	.19	.02	.45	−.37
16. Knee movement	.18	.50	−.04	.04

Table 6

Significant Functions From Discriminant Analysis

Function	Eigenvalue	% of variance	Wilks' Lambda	df	p
1	1.74	38.38	.04	176	.0000
2	0.73	17.49	.10	150	.0000
3	0.60	13.13	.18	126	.0011
4	0.44	9.76	.29	104	.0375

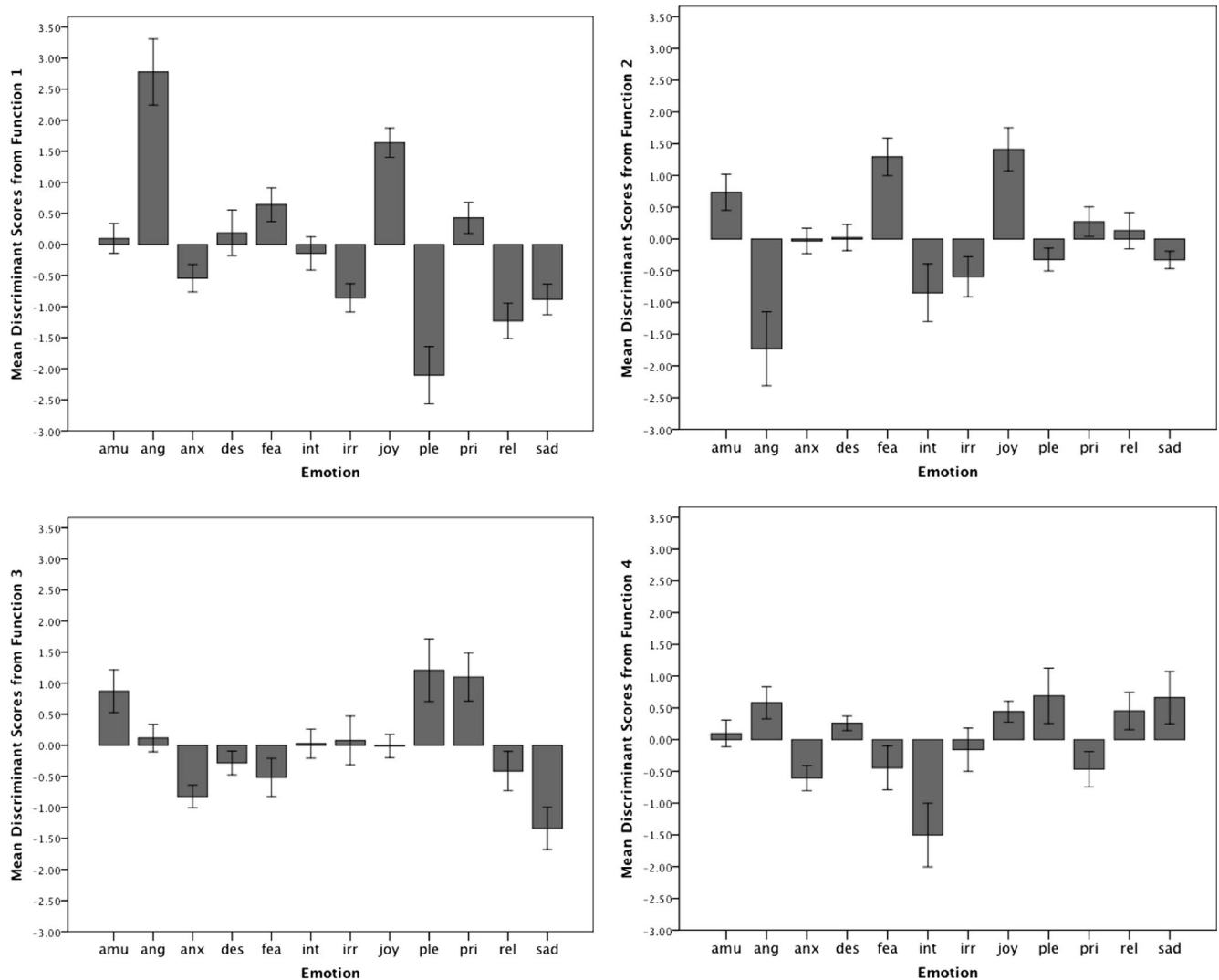


Figure 2. Mean discriminant scores for each emotion on the four functions (error bars ± 1 SE).

discriminated by specific functions. The first discriminant function clearly differentiates active emotions such as hot anger and elated joy, as well as panic fear and pride, from low aroused emotions such as pleasure and relief, but also sadness, irritation, and anxiety. This dimension closely corresponds to sympathetic arousal or activation, but could equally be labeled communicative engagement judging from the defining behavioral components. The second discriminant function separates panic fear, elated joy, but also amusement from hot anger, followed by interest and irritation. Taking into consideration the underlying behavior components, this function seems to differentiate emotions with opposing power/control appraisal outcomes and subsequent action tendencies. Emotions characterized by appraisals of high control or power and attack tendencies are discriminated from other emotions, notably low power or control and withdrawal. It is interesting to note that this dimension does not reflect approach tendency as might be expected. In fact, the approach emotion elated joy is not characterized by forward directed movement

but rather by vertical movement of the arms and knees, and this behavior had an opposite loading to forward body movement on the second discriminant function. The third discriminant function discriminates pride and pleasure but also amusement from sadness and anxiety. These two groups of emotions are located on opposite sides of the bipolar dimensions pleasantness and potency, combining positive with strong and negative with weak. The fourth and last function discriminates interest, and to a lesser extent, pride, anxiety, and panic fear from pleasure and sadness, followed by hot anger, elated joy, and relief. Given the high loading of interest in particular, it is not clear whether this function represents an underlying property of interest alone or if it represents a general emotion dimension where other emotions have meaningful mappings. This function can nevertheless be interpreted as attention orientation as represented in the action readiness mode *attending*, defined by Frijda as wanting to observe well, to understand, to pay attention (Frijda, 1986; Frijda et al., 1989). This function also corresponds to Osgood's

Table 8
Classification Matrix

Actual group membership	Predicted group membership (%)											
	Amu	Pri	Joy	Fea	Anx	Des	Sad	Ang	Irr	Int	Ple	Rel
Amusement	70		10	10	10							
Pride	10	50	20		10	10						
Elated joy			90			10						
Panic fear		10	30	60								
Anxiety				10	50	30	10					
Despair		10	20			40	20		10			
Sadness	10				10	30	30					20
Hot anger			10			10		70		10		
Irritation				10	10	10			30	20	10	10
Interest		20	10					10		60		
Pleasure					10	10				10	60	10
Relief	10		10		20		10					50

Note. For easier readability, zero percentages are omitted. Bold numbers indicate percentages of correct classification. Amu = amusement; Pri = pride; Joy = elated joy; Fea = panic fear; Anx = anxiety (worry); Des = despair; Sad = sadness (depression); Ang = hot anger (rage); Irr = irritation (cold anger); Int = interest; Ple = pleasure; Rel = relief.

Interest factor (Osgood, 1966), which has subsequently been reported in studies on facial expression and labeled as attentional activity (Smith & Ellsworth, 1985).

Last, we assessed how well the behavioral model based on our body movement coding is able to predict individual emotions. The classification matrix shows the relationship between the actual emotion encoded and the emotion predicted from the behavior components.⁵ Table 8 shows that the overall rate of correct classification is 55% compared to the chance level of 8.3%. Classification accuracy varies for the different emotions. Highest number of correct classifications was found for elated joy (90%) and lowest for sadness and irritation (both 30%). Amusement and hot anger also are well discriminated from all other emotions (both 70%). Interesting confusions occur with some emotions. For instance, sadness is classified as despair to the same degree as sadness. Thirty percent of all anxiety portrayals were also classified as despair. Finally, panic fear is sometimes confused with elated joy (30%). Although elated joy is almost perfectly classified, this large class is not specific to joy as it includes also many other emotions such as despair, pride, and panic fear.

Individual Encoding Styles: Regression Analyses

We tested for actor differences in a multiple regression analyses with actor as a between-subjects factor (sample sizes were too small to include emotion as a factor and test for actor-emotion interaction effects). The general model indicated a significant effect of actor, $F(144, 927) = 1.43, p = .001$, but the subsequent analysis of variance per behavior factor revealed that this effect was present for only two of the 16 factors, namely, head tilted lateral averted, $F(9, 110) = 4.07, p < .01$; and arm retraction, $F(9, 110) = 2.37, p = .02$.

Discussion

We explored the structure of bodily emotion expression and tested to what extent emotions can be differentiated on the basis of behavior components extracted from our coded set of body action and posture categories. Results from the principal component

analysis show that the expressive repertoire of emotional body postures, movements, and gestures is extremely diverse. From this rich dataset we extracted the most relevant aspects by grouping related individual behaviors along 16 behavior components. Even though the two-step cluster procedure does not allow strict hypothesis testing, the analysis produced interesting behavior patterns which were systematically related to emotion. Results from discriminant analysis generally supported and extended the exploratory cluster analysis. The results showed that all emotions could be significantly differentiated, including subtle emotions, which are often not included in standard emotion studies. In one comparable study, Wallbott (1998) reported an almost identical rate of overall correct classification (.54). Sadness, despair, and anxiety (labeled as "fear") were less confused with each other than in our study. Also, panic fear ("terror") was confused with happiness, not elated joy as in our study. These differences of confusion may be due to the fact that a different set of emotions was used. Another important reason may be that Wallbott included movement quality judgments in his set of predictors such as movement activity, expansiveness, and energy, which had a strong effect on emotion differentiation.

In the following section we discuss how the resulting behavior patterns and emotion differentiation results can be understood from three major emotion theoretical frameworks. We also discuss how the results from this study complement the empirical literature in the field. Finally, we account for some of the major drawbacks of our approach and propose solutions for future studies.

⁵ The reported results do not include cross-validation because (a) we want to compare the classification accuracies with those reported in a similar study by Wallbott (1998), and (b) our aim is to discriminate emotions on the basis of the entire behavior dataset that cannot be considered exhaustive enough to allow blind emotion prediction. As additional information, the cross-validated classification accuracies ranged between 10% and 60%.

Theoretical Evaluation of the Obtained Results

Three emotions, hot anger and to a large extent amusement and pleasure, were consistently clustered in one cluster each. These emotions are thus characterized by a prototypical response pattern. Consequently, they are very well discriminated from any other emotion. Apart from hot anger, these results may be surprising from a basic emotion view, as amusement and pleasure are usually not considered basic or fundamental emotions. Moreover, many so-called basic emotions such as elated joy, panic fear, and sadness were not represented by one specific behavior response pattern. One should bear in mind that basic emotion theories have not explicitly stated that prototypical configurations in the face should be accompanied by specific body postures or movements. Nevertheless, the general lack of emotion specific behavior profiles strongly suggests that emotional body movement is not driven by fixed affect programs.

Two behavior patterns fit within a bidimensional perspective in the sense that they did not represent any single or combination of emotions, but rather reflected a generally passive response profile. This result is rather weak because these two patterns jointly account for only 17% of all portrayals. Furthermore, no patterns emerged that grouped portrayals of many emotions of equal valence or of high arousal. Looking at the multi-emotion clusters, two out of six clusters represented combinations of equally valenced emotions; four out of six represented equally aroused emotions. Furthermore, the discriminant analysis showed that two dimensions of bodily expression were related to valence and arousal, but that potency and attentional activity also differentiated bodily expression. The four dimensions of bodily expression found in this study are in fact surprisingly similar to those consistently found for facial expression (e.g., Osgood, 1966; for an overview, see Smith & Ellsworth, 1985). In sum, valence and arousal are relevant yet not sufficient to adequately explain our results.

Componential appraisal theory would attempt to explain the results by linking motor expression to appraisal as an adaptive response to the emotion-eliciting situation. Within this framework one would argue that the behavior patterns found in this study reflect the efferent outcome of a particular appraisal profile. According to this view there is no a priori categorical distinction between basic and nonbasic emotions. Behavior patterns should be emotion specific only if the representative appraisal mode or profile shows no or little overlap with that of other emotions. Equally, emotions that share a particular appraisal profile should often be grouped together in a behavior cluster and show relatively more classification confusion.

Hot anger was encoded with a very specific response profile, characterized by high rates of communicative and emphasizing gestures combined with forward body inclination. This pattern closely resembles the expressive profile predicted by Scherer (2001) as a response to the appraisal of an event as an obstruction to reaching a goal or satisfying a need, in combination with the appraisal of high control and power to remove the obstruction. The action tendency to attack, also typically associated to hot anger, seems to be represented in the forward directed movement of the trunk or body. This particular behavior dimension strongly discriminated hot anger but also irritation from panic fear and anxiety, two emotions characterized by the opposite tendency, namely, to withdraw or avoid contact (Frijda, 1986, Frijda, 2007). These two

groups of emotions are both defined by high relevance and obstructiveness, but are dissociated by opposite outcomes on control and power. Forward approaching versus backward body movement away from the interaction partner thus seems to function to prepare the individual to act on the goal-obstructing environment by either withdrawing from or removing the obstacle, depending on the level of coping potential (Scherer, 2001). In this sense human behavior may still reflect universal traces of evolutionary adaptive fight and flight responses (Cannon, 1929; Darwin, 1872).

Besides the well-known response patterns of these basic emotion families, we also found two not previously reported expressive patterns specific to the enjoyable emotions of amusement and pleasure. Amusement produced a pattern of discontinuous and touching or manipulating movements, which most likely reflects a laughter response pattern involving the entire body. The fact that this behavior is prototypically related to amusement in our dataset is in line with the argument that laughter is a very specific, evolutionary continuous behavior (Ross, Owren, & Zimmermann, 2009). This study provides first yet tentative evidence that amused laughter produces not only a specific vocal pattern, but is accompanied by very specific changes in body movement. It also shows that touching or manipulating movements do not necessarily indicate discomfort or negative affect, as suggested by Ekman and Friesen (1972). In fact, two other clusters marked by this behavior were not specific to any particularly valenced emotion or set of emotions.

Ekman (2003) distinguished sensory pleasure as an emotion accompanied by movement or orientation toward the source of the stimulation. In this study, the source of imagined pleasure stimulation was tactile or gustatory, which was typically expressed by tilting the head upward away from the interaction partner while moving the arms in an asymmetrical fashion. Though the functional direction of this arm movement remains unclear, this behavioral tendency can be seen as functionally adaptive because it assists the individual to increase, prolong, and elaborate the impact of the pleasurable stimulation.

Even though some emotions were characterized in our dataset by a specific behavior pattern, most emotions were encoded by a combination of clusters that also grouped other emotions. Classification confusions generally confirmed these multi-emotion clusters and point to a large amount of expressive variability and overlapping response profiles. Emotions that were systematically paired are relief and sadness, panic fear and elated joy, pride and elated joy, and anxiety and panic fear. The latter two pairs represent the basic emotion families of joy and fear (Ekman, 2003), which, from a componential perspective, are elicited by distinct appraisal profiles (Scherer, 2001). Nevertheless, these two usually strongly dissociated modal emotions also share some appraisal outcomes with regard to relevance (high suddenness, low predictability and high goal/need relevance, see Table 5.4 in Scherer, 2001), which might explain their partial expressive overlap. Further response distinction is likely to be found in combination with other modalities, such as facial and/or vocal expression. The cluster formed by relief and sadness could be labeled as general disengagement or resignation, also found by Scherer and Ellgring (2007b), as there is complete absence of any particular action or postural movement apart from retiring the hands in the pockets. The major action readiness mode for sadness is apathy or hypoactivation, characterized by passive withdrawal from every form of

contact. The event is appraised as uncontrollable and the agent as low in command. Relief is similarly characterized by deactivation but presumably from a slightly different readiness mode, where the individual feels at rest, thinks everything is OK, feels no need to do anything (Frijda, 1986; Frijda et al., 1989). Indeed, in terms of overt behavior these emotions are both characterized by a loss of overall muscle tone and absence of action (Ekman, 2003).

Contrary to what might be expected from an action tendency approach, elated joy was not characterized by forward approach locomotion but instead by repetitive vertical movement of the arms and knees, reflecting the activation state "exuberant" rather than the action tendency "approach" (Frijda, 1986; Frijda et al., 1989). This pattern of symmetrical up-and down arm movement is also used to encode pride. This particular finding has not yet been reported because up-to-date the expression of pride is typically described by static configuration of arms, head, and trunk (Tracy & Robins, 2007). Our results suggest that the dynamic property of repetitiveness is an additional essential aspect of emotion expression. However, the association between joy-like emotions and upward arm movement has been repeatedly reported in emotion expression literature (Boone & Cunningham, 1998, 2001; Coulson, 2004; de Meijer, 1989; Wallbott, 1998).

However, interest, which is also considered as an approach emotion, could be discriminated from other emotions by forward trunk lean and facing head orientation even though large variations occurred. This pattern did support the notion that interest motivates the organism to physically approach to enhance contact or process information, combining action readiness modes approach and attending (Frijda et al., 1989). This response pattern further reflects two of its defining appraisal components, namely, the appraisal of an event or object as novel, complex, and appraisal of coping potential in the ability to understand (Silvia, 2005). Why some approach emotions are expressed by sagittal—body-movement and others by vertical—arm-movement remains to be investigated.

Limitations

The problem of the appraisal-based interpretations is that they are only indirectly supported by our results because emotion category and not appraisal profile is the independent variable. Emotions have an array of appraisal outcomes and it is not clear how each outcome affects body movement. However, our results clearly point out that the emotion encoding is organized along a number of emotional properties other than traditional emotion categories or two major emotion dimensions. Behavior prototypes and general response dimensions such as valence or arousal can nevertheless be informative because they were still partly supported by our results.

Some of our research choices produced a number of other methodological and conceptual limitations. First, as most corpora in this research domain, GEMEP consists of acted expressions. The choice of using actors has a number of important drawbacks and benefits for emotion expression research compared to naturally occurring expressions recorded in the field or expressions of laboratory induced emotions. Among the most cited problems in using actor-based corpora in emotion expression research is the lack of "naturalness" (authenticity) and stereotypicality (Bänziger & Scherer, 2007). In the GEMEP corpus these issues are addressed by using professional actors who apply the Stanislavski procedure,

that is, the actors generate an emotional state that closely resembles the intended emotion by retrieving personal experiences or through imagination (Bänziger & Scherer, 2010). Further, compared to field recordings, expressions obtained in a laboratory controlled setting typically reduce ecological validity, so it can be argued that the obtained results do not generalize to a real-life setting. Stable effects of emotion on expression obtained in such settings are in fact likely to be moderated or mediated by factors such as language and culture. Depending on the research goals however, the effect of personal or social display rules on emotional expression also can be considered an artifact, obscuring real or felt emotion. In this case, acted expressions suffer less from artifacts caused by display rules than naturally occurring expressions obtained in the lab or field. Thus, as argued by Scherer and Bänziger (2010), a simple dichotomy between naturally occurring expressions and actor portrayals in terms of naturalness or authenticity does not hold. The selected portrayals used in this study may be different from spontaneous expression on a number of aspects. However, a previous rating study has shown that they are judged believable and recognizable (Bänziger & Scherer, 2010). It is also worth mentioning here that the actors could use their bodies freely to portray the emotion, without particular instructions. Their attentional focus was directed toward the pronunciation of meaningless sentences and not on their body movement.

One important benefit of the actor approach is that investigators have control over the emotional content that is conveyed by providing the actors standard scenario's and illustrative descriptions of the intended states. By using this approach in our study we increase internal validity and comparability of the emotional expressions portrayed by different actors. Furthermore, standardized recordings of high technical quality can be made, which allow accurate and detailed measurements of the different parameters of expression. As a consequence of the systematic construction of the dataset, we were able to adopt powerful statistical analyses to perform in-depth exploration and significance testing. In terms of the emotions studied, using actors has the advantage that we can investigate a large, representative sample of both intense and subtle emotions. This would be difficult to obtain with both induction techniques and field recordings because emotion induction is restricted by ethical constraints and field samples are often restricted to relatively faint and frequent emotions that occur in public settings.

In sum, different types of constructing stimulus sets can be used for studying emotional expressions and the choice needs to be adapted to the specific research goals. The use of an actor-based corpus was especially useful for our research purpose, which was to produce a comparable and representative inventory of the expressive repertoire that can be employed when expressing emotions. To our knowledge there are currently no studies available that address these research questions using sets of spontaneous expression.

A second source of criticism concerns the existence of idiosyncratic behavior styles. It has been shown that this is an important factor to take into account (Wallbott, 1998). Given that we used a large number of different actors, it was possible to test the effect of actor on body movement. Interindividual differences played a minor role in cluster formation compared to emotional differences. Two actors portrayed emotion in a less differentiated fashion as indicated by the fact that a considerable portion of their portrayals

was characterized by the same behavior patterns. This may suggest that these actors produced stereotyped movements that are unrelated to the intended emotion. Alternatively, these actors may have encoded emotion using very subtle cues, which could not be coded with our system. It should be noted that these patterns were nevertheless used by several other actors to express emotion, so the behavioral expressions represented by these clusters are not idiosyncratic. Further analyses revealed that the effect of an actor on emotion expression was limited to few behaviors. Thus, although there were indeed some actor-specific expressions, none of the actors showed an overall idiosyncratic style. In sum, emotion components rather than idiosyncratic styles were the main driving force behind bodily response patterning.

Furthermore, our behavioral variables, as coded with the BAP system, are based on behavior durations and thus include detailed, temporal information. Unfortunately, we were unable to perform temporal sequential analyses because the duration of the portrayals was too short. Also, the temporal information may have underestimated actual durations because the onsets and offsets of the action and posture units regularly coincided with or exceeded the boundaries of the video segments.

A final drawback of this research is that it gives a unimodal and thus restricted view on emotion expression. We do not claim that emotions can be predicted from the body alone. However, we think that from a functional perspective, skeletal body movement has particular advantages over the other modalities for certain emotion components and situations, and may provide information about the emotion that is not available from facial or vocal expression. This should be the case for example when instrumental action is particularly adaptive in dealing with the emotion eliciting event (e.g., obstruction removal or withdrawal, stimulation enhancement). The body also is likely to provide additional emotion information in situations of visual interaction from a larger distance, making facial expressions less salient. Last, given that one of the major functions of gesture is to support verbal interaction (Kendon, 2004; McNeill, 2005), emotional gesturing should be expected to increase when the vocal channel is disrupted.

Further Research

One of the next tasks in this area of investigation is to extend and replicate the current findings to real-life situations. Once stable patterns of emotional body movement are established through replication and validation, one can develop and test hypotheses about the role of specific features of body action and posture in the encoding and decoding of emotion.

Second, future studies can test specific hypotheses on the exact relation between appraisal and its effect on bodily expression by means of experimental induction (e.g., van Reekum et al., 2004) or computational simulation of appraisal outcomes (e.g., Coulson, 2009).

Third, it would be interesting to see in future studies whether the pattern of confusion found here, which is based solely on objective cues of body movement used to encode emotions, is also reflected in human emotion recognition. Such a comparison of production and perception based categorization of emotion is important to assess how well our measurements capture the aspects of body movement that convey emotionally relevant meaning to the receiver. It will further allow us understand the nature of the emotion

inference process. Relevant indicators of emotion may possibly get lost in the course of perception and attribution, be transformed or misused (Scherer, 2003; Wallbott, 1985). Also, it is likely the case that humans, being skilled observers, will perceive relevant cues for which an objectively measurable counterpart has not yet been identified. Such a comparison would only be fair if we include the parameters obtained from the dynamic level of description, which we deliberately omitted here but describe in a separate study (Dael & Scherer, 2011).

A fourth interesting follow-up on the current study would be the implementation of our descriptive dataset in a multimodal clustering and discrimination analyses with the aim of replicating and refining the study of Scherer and Ellgring (2007b). Compared to that study, we provide a larger pool of well-delineated descriptive categories, which may lead to a better representation of the body modality along side the facial and vocal modality. We also provide important measurement improvements such as time-locked coding and duration instead of frequency variables, enabling the investigation of precise synchronization of behaviors within and across modalities.

General Conclusions

Taken together, the results from this study give an extensive account of the nonverbal behavior repertoire of a relatively neglected modality of emotion expression. We showed that emotion components systematically affect response patterning in body posture and action. The amount of information conveyed by the body modality that is relevant to a person's emotional state or intention is thus much larger than has long been assumed. This general finding supports earlier research (e.g., Wallbott, 1998) and shows that this systematic variability forms a measurable part of the emotion expression. Furthermore, we discussed the results from the point of view of three theoretical perspectives. The results suggest that there may be few emotion specific prototypical patterns of body posture, gesture, or movement. Instead, an emotion can be encoded by a variety of behavior patterns, suggesting that emotional components rather than specific affect programs or general valence and arousal dimensions drive bodily expression. Thus, our findings cannot be sufficiently explained by basic emotion theory or bidimensional emotion theory. Instead, componential theories provided several functional explanations of the expressive behavior as adaptive responses for internal regulation (e.g., information processing), preparation, and direction of action, communication of reaction and behavioral intention. To conclude, we hope that this study will generate more research on the underestimated role of the body in emotion communication and will provide an empirical basis for developing hypotheses of the adaptive functions of emotional body movement.

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Received December 7, 2010

Revision received June 3, 2011

Accepted June 27, 2011 ■