Emotion
2017, Vol. 17, No. 3, 459–477

1528-3542/17/$12.00 http://dx.doi.org/10.1037/emo0000194

Emotions Are Understood From Biological Motion Across Remote Cultures

Carolyn Parkinson
University of California, Los Angeles

Trent T. Walker
University of California, Berkeley

Sarah Memmi and Thalia Wheatley
Dartmouth College

Patterns of bodily movement can be used to signal a wide variety of information, including emotional states. Are these signals reliant on culturally learned cues or are they intelligible across individuals lacking exposure to a common culture? To find out, we traveled to a remote Kreung village in Ratanakiri, Cambodia. First, we recorded Kreung portrayals of 5 emotions through bodily movement. These videos were later shown to American participants, who matched the videos with appropriate emotional labels with above chance accuracy (Study 1). The Kreung also viewed Western point-light displays of emotions. After each display, they were asked to either freely describe what was being expressed (Study 2) or choose from 5 predetermined response options (Study 3). Across these studies, Kreung participants recognized Western point-light displays of anger, fear, happiness, sadness, and pride with above chance accuracy. Kreung raters were not above chance in deciphering an American point-light display depicting love, suggesting that recognizing love may rely, at least in part, on culturally specific cues or modalities other than bodily movement. In addition, multidimensional scaling of the patterns of nonverbal behavior associated with each emotion in each culture suggested that similar patterns of nonverbal behavior are used to convey the same emotions across cultures. The considerable cross-cultural intelligibility observed across these studies suggests that the communication of emotion through movement is largely shaped by aspects of physiology and the environment shared by all humans, irrespective of differences in cultural context.

Keywords: biological motion, cross-cultural, emotion, communication, point-light

Supplemental materials: http://dx.doi.org/10.1037/emo0000194.supp

Even without speaking, humans can convey and decipher a remarkable diversity of information. For instance, just by reading and modulating bodily movements (i.e., biological motion), we can communicate with people too far away to hear our voices or discern our facial expressions. Previous research has demonstrated that certain biological motion characteristics are suggestive of particular emotional states and has investigated the movement features that are symptomatic of specific emotions within cultures (Dael, Mortillaro, & Scherer, 2012; de Meijer, 1989; Montepare, Koff, Zaitchik, & Albert, 1999; Van Dyck, Maes, Hargreaves, Lesaffre, & Leman, 2013). This body of research has demonstrated that emotions are effectively communicated through bodily postures (Atkinson, Dittrich, Gemmell, & Young, 2004; Coulson, 2004) and can also be reliably inferred from movement characteristics even when static form information is minimized through the use of point-light (PL) displays (Atkinson et al., 2004; Montepare et al., 1999), which depict bodily movement with minimal visual form information using bright points to represent an individual's major joints amid an otherwise dark environment (Johansson, 1973). Thus, biological motion-based signals allow us to convey our emotional states, as well as other information, such as action goals, to others (Atkinson, Tunstall, & Dittrich, 2007; Fridlund, 1994; Heberlein, Adolphs, Tranel, & Damasio, 2004; Manera, Schouten, Becchio, Bara, & Verfaillie, 2010; Runeson & Frykholm, 1983). How much of this arsenal of communicative signals is common to all humans and how much is shaped by culture?

This article was published Online First November 7, 2016.

Carolyn Parkinson, Department of Psychology, University of California, Los Angeles; Trent T. Walker, Center for Southeast Asia Studies, University of California, Berkeley; Sarah Memmi and Thalia Wheatley, Department of Psychological and Brain Sciences, Dartmouth College.

We thank the Department of Culture, Ratanakiri province, as well as Ockenden Cambodia and Cambodia Living Arts for facilitating visits to L'ak and for assistance with Khmer-Kreung translation. This research was supported in part by a McNulty Grant from the Nelson A. Rockefeller Center (Thalia Wheatley), a Foreign Travel Award form the John Sloan Dickey Center for International Understanding (Thalia Wheatley), and an NSERC PGS-D award (Carolyn Parkinson).

Correspondence concerning this article should be addressed to Thalia Wheatley, Department of Psychological and Brain Sciences, Dartmouth College, 6207 Moore Hall, Hanover NH 03755. E-mail: thalia.p.wheatley@dartmouth.edu

Cross-Cultural Consistency and Intelligibility of Emotional Signals

Faces

The majority of cross-cultural research on emotion recognition has focused on facial expressions of emotion. Certain emotional facial expressions have been argued to comprise human universals

(Ekman, 1994, but see Russell, 1994). The existence of a set of seemingly innately predisposed and universally recognizable emotional facial expressions has been attributed primarily to two adaptive benefits: sensorimotor regulation (Chapman, Kim, Susskind, & Anderson, 2009; Darwin, 1872; Farb, Chapman, & Anderson, 2013; Susskind et al., 2008) and social communication (Darwin, 1872; Fridlund, 1994).

With respect to sensorimotor regulation, the particular configurations of facial features that characterize specific expressions of emotion often beneficially alter the expresser's own capacity to act and perceive in response to emotion-inducing environmental contexts. For example, facial expressions of fear increase the expresser's nasal volume and visual field, and accelerate eye movements and air velocity during inhalation, enhancing his or her ability to detect potential threats in the environment (Susskind et al., 2008).

Through *exaptation*, the process by which preexisting structures are coopted to serve novel uses over the course of evolution (Gould & Vrba, 1982; Parkinson & Wheatley, 2015), emotional expressions that initially evolved to serve physiological regulation functions may have been repurposed to serve a secondary function: social communication (Chapman et al., 2009; Shariff & Tracy, 2011). Emotional facial expressions can effectively signal beliefs, desires, and ecologically relevant situational information, such as the presence of danger or of valuable resources, to conspecifics (Fridlund, 1994). We exploit the information contained in others' emotional expressions from an early age: Infants use their mothers' fearful facial expressions to decide whether or not to cross a visual cliff (Sorce, Emde, Campos, & Klinnert, 1985). In addition to their benefits to those perceiving them, emotional facial expressions can also benefit the expresser during social interactions (e.g., preventing a threatening individual's attack by making a fearful expression, which conveys vulnerability; Marsh, Ambady, & Kleck, 2005).

Beyond Faces: Voices and Bodily Movements

Suggestions that certain facial expressions of emotion are universal have been largely based on evidence that members of remote cultures can recognize Western-derived emotional facial expressions at above-chance accuracy levels in fixed response tasks (Ekman, Sorenson, & Friesen, 1969; Elfenbein & Ambady, 2002b; Tracy & Randles, 2011). This approach has recently been extended to vocal emotional signals (Sauter, Eisner, Ekman, & Scott, 2010). It remains to be seen whether bodily movements comprise an analogous cross-culturally decipherable communicative toolkit that does not depend entirely on cultural learning. Importantly, the rationale underlying theories regarding the purpose of cross-culturally recognizable emotional facial expressions logically extends to emotional signals conveyed through bodily movement.

Social Communication Through Emotional Bodily Movement. Similar to facial expressions, any posture or pattern of bodily movement could signal the expresser's internal state and relevant situational information and could be used to regulate interpersonal relationships. Moreover, because bodily postures and movements occur at a coarser spatial scale than facial expressions, these cues may be discerned from longer distances, when facial features may be difficult or impossible to distinguish. For instance, observing the fearful bodily movement of a conspecific could alert the perceiver to the possibility of impending danger, even from a distance or viewing angle at which the expresser's face is not clearly visible. In addition to environmental information, humans also use bodily movements to convey information about their own internal states during social interactions. For example, when experiencing rage, the human body "is stimulated by violent, almost frantic action" to produce actions that "represent more or less plainly the act of striking or fighting with an enemy" (Darwin, 1872, p. 74), conveying the expresser's dominance and impending threat to others (Shariff & Tracy, 2011). Similarly, the characteristic pride posture (i.e., chest expanded, head tilted back, torso pointed out, arms raised; Tracy & Matsumoto, 2008) following success or victory conveys heightened social status to observers (Shariff & Tracy, 2009), whereas the characteristic shame posture (i.e., chest narrowed, shoulders slumped, head tilted downward), often observed following failure, renders the expresser smaller, potentially to signal acceptance of another's power and avoid conflict (Tracy & Matsumoto, 2008). These postures mirror those associated with submission and dominance displays in other animals, suggesting a potential biological basis as communicative signals (Darwin, 1872; de Waal, 1989).

Sensorimotor Regulation Through Emotional Bodily Movement. Like facial expressions of emotion, the particular configurations and temporal dynamics of our bodily responses to environmental contexts can beneficially impact our capacity for sensation and subsequent action. For instance, when experiencing fear, humans may respond not only by configuring the face to increase sensory exposure, but also by "freezing" the body to further enhance vigilance to cues that may inform subsequent responses (e.g., fight or flight behavior; Roelofs, Hagenaars, & Stins, 2010), and, for proximal threats, by crouching to avoid observation (and possibly to appear smaller and nonthreatening to avoid becoming the target of others' aggression; Marsh, Adams, & Kleck, 2005; Shariff & Tracy, 2011) or quickly withdrawing to avoid the threat (Darwin, 1872, p. 280; Wallbott, 1998).

Can Emotions be Inferred From Bodily Movements Across Remote Cultures?

Although emotional postures and bodily movements appear to beneficially impact the expresser's potential to perceive and act appropriately in the current context, and comprise a rich source of social information for perceivers, empirical evidence for their universal decipherability is lacking. Ekman (1965) suggested that unlike faces, bodily expressions may be primarily indicative of emotional intensity or arousal, but not of more nuanced information. Since then, the overwhelming majority of studies examining emotional processing in humans have used faces as stimuli, and most others have used auditory stimuli (de Gelder, 2009). Thus, although much progress has been made in understanding faces as canvases for communicative signals, considerably less is known about the role of bodies as vehicles for emotional expression.

Previous research using stimuli that include cues conveyed through both facial expression and body posture information has found evidence for the cross-cultural decipherability of these nonverbal emotional signals across remote cultures. For example, the manner in which pride is expressed in Western (e.g., North American) cultures—that is, head tilted slightly back; arms akimbo or on the hips, low intensity smile (Tracy & Robins, 2007)—has been demonstrated to be recognizable based on photographs of posers taken from the waist up among members of multiple remote, non-Western, small-scale societies. The prototypical Western pride expression is reliably recognized from photographs including postural and facial expression information by members of a highly isolated tribe in Burkina Faso, West Africa (Tracy & Robins, 2008). In addition, among Fijian villages who live in a traditional, small-scale society, the prototypical pride expression is not only reliably recognized as a display of pride, but also serves as an automatic signal of status (Tracy, Shariff, Zhao, & Henrich, 2013). Furthermore, college-educated American and Indian participants are able to discern the emotions portrayed in dynamic expressions involving the face and body based on descriptions of how each emotion should be expressed from a centuries-old text (Hejmadi, Davidson, & Rozin, 2000). The results of these studies indicate that emotions can be communicated across members of remote cultures using a combination of facial and bodily cues. However, to our knowledge, no study to date has tested whether or not emotional signals conveyed through bodily movement cues alone are accurately conveyed across cultures without previous exposure to one another. Thus, it remains to be seen if bodily movement dynamics are sufficient to communicate emotion across members of disparate cultures.

There appears to be cross-cultural agreement in the recognition of emotion from bodily cues alone among formally educated individuals who have been exposed to other cultures. Recently, considerable cross-cultural agreement was observed between Japanese, Sri Lankan, and American raters in the recognition of four emotions (anger, fear, happiness, sadness) from static body postures produced by Japanese posers (Kleinsmith, De Silva, & Bianchi-Berthouze, 2006). Japanese observers performed significantly better than Americans or Sri Lankans in recognizing Japanese posers' body postures signifying anger and fear. Similarly, Rosenthal, Hall, DiMatteo, Rogers, and Archer (1979) demonstrated a positive correlation between emotion recognition accuracy and cultural similarity to the expresser among raters from 10 countries using the Profile of Nonverbal Sensitivity (PONS) test, in which participants are shown video recordings of an American researcher portraying 20 attitudes (e.g., "admiring nature," "expressing jealous anger") and choose one of two possible attitudes to describe each video. In addition, using data from a series of questionnaires administered to individuals in 37 countries, Scherer and Wallbott (1994) found substantial universality, as well as some cross-cultural variation, in the reported experience of various emotions, including physiological symptoms (e.g., muscles tensing) and expressive behaviors involving the body (e.g., approach/withdrawal behaviors). Thus, currently available evidence suggests that like facial expressions, bodily signals of emotion may comprise a nonverbal "language" that is largely cross-culturally consistent, but that is colored by nonverbal "accents" that vary across cultures (Elfenbein & Ambady, 2002a; Marsh, Elfenbein, & Ambady, 2003). If this is the case, then cross-cultural recognition of emotion from bodily movement cues should be possible across cultures lacking sustained exposure to one another through media or social contact, albeit with in-group advantages.

Overview of the Present Research

Here, we tested for successful emotional communication through bodily movement between individuals from cultures without previous contact through media or personal interaction. To test for the recognition of emotions from biological motion, we probed the recognition of previously validated sets of PL displays among members of a remote Kreung hill tribe in Ratanakiri, Cambodia using both free (Study 2) and fixed (Study 3) response paradigms. We tested the intelligibility of Western emotional PL displays among the Kreung using a fixed response paradigm (Study 3) to enhance the interpretability of the free response results (Study 2) were they to suggest that the Kreung could not discern emotions from Western bodily movement displays. More specifically, if negative results were obtained in Study 2, it would be difficult to ascertain whether such results stemmed from the difficulty and ambiguity inherent in free response paradigms (especially in a culture whose members have no experience with participating in psychological experiments), or true cross-cultural unintelligibility of emotional signals conveyed in bodily movements, and it would also be difficult to integrate such results into the broader literature on cross-cultural emotion recognition, which has tended to use fixed response paradigms. On the other hand, if the Kreung were able accurately discern emotion from Western-produced bodily movement signals in both Studies 2 and 3, such results would provide convergent evidence from the cross-cultural intelligibility of emotional movement signals. In addition, prior to conducting Studies 2 and 3, Kreung bodily movement signals for the same five emotions used in Study 3 were recorded. These recordings were made prior to showing any stimuli to Kreung participants in order to ensure that the Kreung emotional signals that were recorded would be as unbiased as possible. We later tested American participants' accuracy in recognizing Kreung emotional signals based on bodily movement cues alone (Study 1).

Kreung participants were inhabitants of L'ak, a village of approximately 300 Kreung tribe members in the sparsely populated province of Ratanakiri, northeastern Cambodia (see Figure 1). It is not possible to travel to L'ak for the majority of the year; access by outsiders is only feasible via unmaintained dirt roads during the brief dry season. The tribe is further isolated by virtue of its tribal language, Kreung, which is not mutually intelligible with Khmer (the national language), or with other regional tribal languages. In addition, the geographical and cultural isolation of L'ak is preserved by the Kreung's continued maintenance of traditional, autonomous dispute-resolution practices, animist religious customs, and self-sufficient subsistence-shifting agriculture (for further discussion of the Kreung, see Parkinson, Kohler, Sievers, & Wheatley, 2012; Sievers, Polansky, Casey, & Wheatley, 2013). Thus, the following studies provide a stringent test of whether or not movement kinematics are sufficient to convey emotional information between individuals in the absence of exposure to a common language or culture.

Study 1: American Recognition of Emotion From Kreung Movement (Fixed Response Task)

Methods

Participants. Twenty-eight individuals (13 female) from the Dartmouth College community (ages ranged from 18 to 31; $M =$

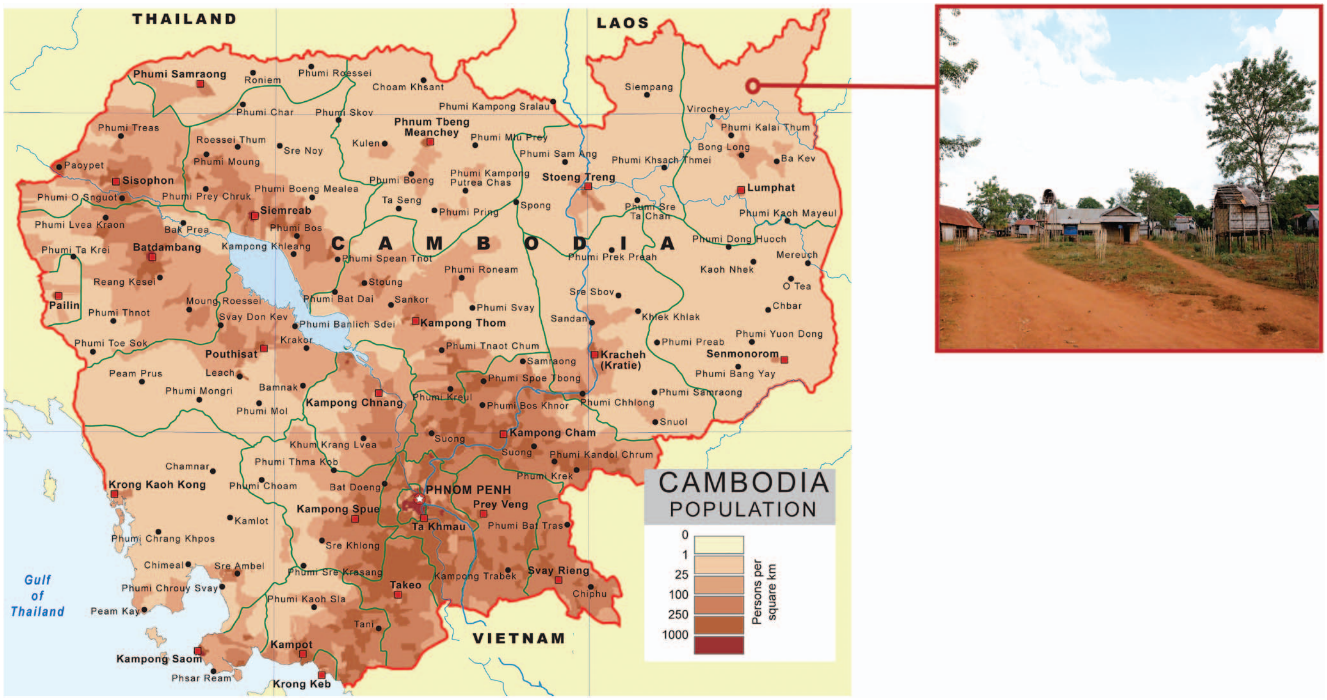

Figure 1. Studies were conducted in the geographically, culturally, and linguistically isolated village of L'ak in Ratanakiri, Cambodia. Left: Population density map of Cambodia. L'ak is indicated by the open circle. Right: Photograph of the village of L'ak. See the online article for the color version of this figure.

21.89, SD = 3.59) in Hanover, New Hampshire participated in Study 1.

Stimuli. Stimuli were produced by one male Kreung participant who performed an interpretation of each of five emotions (anger, disgust, fear, happiness, sadness). Limited access to the Kreung population necessitated including a single poser for all emotions. A poser was selected who stated that he was an active performer (i.e., of traditional instrumental music and dance) within the Kreung community. This individual was selected as a poser in hopes that his experience as a performer would cause him to be relatively comfortable with enacting emotional movements in front of strangers with whom he had had limited interactions, and who belonged to a culture that he had not previously encountered. Following Sauter et al. (2010), the poser was presented with a brief scenario corresponding to each emotion, and was asked to move his body as if he felt like the character in the story. The poser was free to use whatever movement he felt best emphasized the relevant emotion. These scenarios were adapted from Sauter et al. 2010, in which nonverbal emotional vocalizations were reliably matched with the correct scenarios both within cultures and across members of remote cultures, and translated into Khmer with the assistance of an individual who was knowledgeable about the culture of hill tribe villages in Ratanakiri. Scenarios were then translated into Kreung in collaboration with a Khmer-Kreung translator, who provided further advice regarding what would be easily understandable and culturally appropriate. English translations of the final versions of these scenarios are presented in Table 1. The poser's movements were recorded using a high-definition video camera. All recordings were completed at the beginning of our visit, prior to any other data collection. The poser was recorded performing emotional movement for each scenario only once.

Movie clips were converted to Audio Video Interleaved movie files (30 frames per s) with a resolution of 720 × 480 pixels. The poser's facial features were occluded by a uniform brown oval using Adobe Premiere Pro 5.5 to create a duplicate video layer. The circle video effect was used to create a circle of the same color as the poser's skin that covered the entire face. The radius and center of the circle were adjusted to reflect the poser's movements at three-frame intervals. Stimuli can be downloaded from http://www.wheatlab.com/emotion-videos, and a still frame of the fear video is presented in Figure 2A. Brief descriptions of the nonverbal behaviors contained in each video are also provided in Table 2

Table 1
Scenarios and Emotions Used for the Production of Kreung Emotional Movement in Study 1

Emotion	Scenario
Anger	I am very mad that I lost the stuff in my home.
Disgust	I want to vomit. This soup is spoiled.
Fear	I am so scared. Why are there so many tigers in this forest?
Happiness	I am very happy to be sharing these stories with other people.
Sadness	I feel so miserable when my child has gone far away.

Note. Scenarios adapted from Sauter et al. (2010).

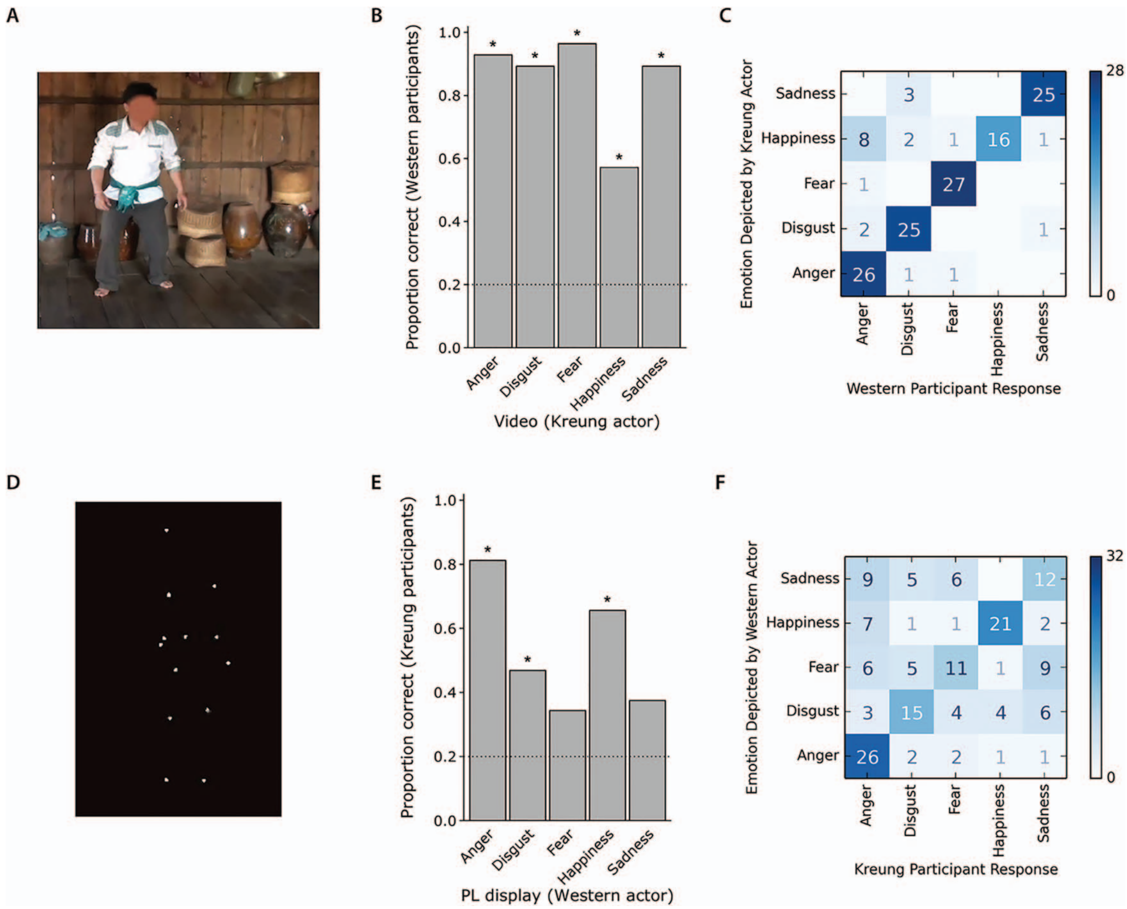

Figure 2. Cross-cultural recognition of emotion from bodily movement in fixed-response paradigms (Studies 1 and 3). A: Stimuli in Study 1 consisted of videos of Kreung portrayals of five emotional signals in which the poser's face was obscured with an opaque oval. B: Proportion of correct responses given by American participants when identifying the emotions depicted in each video in Study 1. Dotted line indicates chance accuracy (0.20 correct). C: Confusion matrix detailing all responses made in Study 1. Each row corresponds to a video; each column corresponds a response choice. Numbers and cell colors indicate the frequency of each response for each video. For ease of visualization, response frequency is also reflected in the contrast between font and background colors within each cell, and cells corresponding to responses that were never chosen for a given video are left blank (i.e., zeros are omitted). D: Still frame of an emotional point-light (PL) display from Study 3. E: Proportion of correct responses given by Kreung participants when identifying the emotions depicted in Western PL displays Study 3. Dotted line indicates chance accuracy (0.20 correct). F: Confusion matrix detailing all responses made in Study 3. Each row corresponds to a video; each column corresponds a response choice. Numbers and cell colors indicate the frequency of each response for each video, which is also reflected in the contrast between font and background colors within each cell for ease of visualization. * $p < .05$ (corrected). See the online article for the color version of this figure.

(see the Meta-Study section for details of the nonverbal coding procedures used).

Procedure. Stimuli were displayed in a random order without sound on a 13″ Macbook Pro laptop running PsychoPy 1.77 (Peirce, 2007). Each video was automatically repeated consecutively at least three times. Beginning with the third repetition, the response choices (anger, disgust, fear, happiness, sadness) appeared at the bottom of the screen. Participants clicked on the emotion label that they thought the poser was demonstrating, which became italicized and bolded to reflect their selection, then pressed "enter" to confirm their response selection and proceed to the next trial. If the participant did not respond during the third repetition, the video continued playing repeatedly until the participant responded. Before participating, participants were instructed that during each trial, they were to watch each clip carefully for its entire duration before responding, and to allow the video to repeat until they were sure of their response.

Results and Discussion

For each emotional signal tested, exact binomial tests were used to compare proportions of correct responses to chance level (.20 correct), and a Bonferonni-adjusted significance threshold was used to correct for testing five emotional displays ($p < .01$).

Table 2
Nonverbal Behaviors Documented in the Emotional Movement Stimuli Used in Studies 1, 2, and 3

Emotion	Study 1 stimuli (Kreung)	Study 2 stimuli (American)	Study 3 stimuli (British)
Anger	• Rapid pace • Irregular, erratic movement • Arms thrust forcefully downward • Forceful movement • Shoulders tense and raise upward • Moving head and body from side to side to scan the environment • Looking around and searching pockets for something	• Moderately fast pace • Irregular, erratic movement • Arms thrust forcefully downward • Forceful movement • Shaking fists • Bending forward, hinging at the hips • Stomping feet	• Moderately fast pace • Regular, steady movement • Arms thrust forcefully downward • Forceful movement • Walking forward, toward the viewer • Shoulders slump forward and down
Disgust	• Moderate pace • Regular, steady movement • Hand covers face/mouth area • Arms thrust forcefully downward • Shoulders slump forward and down • Head tilted/slumped downward • Moving head and body from side to side to scan the environment • Bending forward, hinging at the hips	N/A	• Moderate pace • Regular, steady movement • Hand covers face/mouth area • Shaking head from side to side • One hand waves in front of face • Alternately walking forward, toward the viewer and walking backward, away from the viewer
Fear	• Moderately fast pace • Irregular, erratic movement • Crouching downward • Shoulders tense and raise upward • Shaking head from side to side • Moving head and body from side to side to scan the environment • Looking around and searching pockets for something • Trembling	• Moderately fast pace • Irregular, erratic movement • Crouching downward • Shoulders tense and raise upward • Moving head and body from side to side to scan the environment • Forceful movement	• Moderate pace on average (included rapid movement and freezing) • Crouching downward • Bringing hands inward to cover the body • Shoulders slump forward and down • Walking backward, away from the viewer
Happiness	• Moderate pace • Regular, steady movement • Arms and hands are relaxed, and hang loosely to the sides of the body, swinging from side-to-side • Hands are placed on hips • Shoulders relax downward • Moving head and body from side to side to scan the environment • Swinging or twirling in smooth, circular movements	• Rapid pace • Regular, steady movement • Jumping up and down • Expansive posture • Swinging or twirling in smooth, circular movements	• Moderately fast pace • Regular, steady movement • Jumping up and down • Expansive posture
Sadness	• Slow pace • Regular, steady movement • Hands cradle the head and/or face • Head tilted/slumped downward • Shoulders relax downward • Shaking head form side to side	• Slow pace • Regular, steady movement • Hands cradle the head and/or face • Head tilted/slumped downward • Hand covers face/mouth area • Arms and hands are relaxed, and hang loosely to the sides of the body, swinging from side-to-side • Shoulders slump forward and down • Torso folds/collapses forward and down	• Moderately fast pace • Regular, steady movement • Hands cradle the head and/or face • Head tilted/slumped downward • Hand covers face/mouth area • Shoulders slump forward and down • Torso folds/collapses forward and down • Striking the floor with one arm
Pride	N/A	• Moderate pace • Regular, steady movement • Arms and hands are relaxed, and hang loosely to the sides of the body, swinging from side-to-side • Shoulders relax downward • Chin tilted slightly back and upward	N/A

Table 2 (*continued*)

Emotion	Study 1 stimuli (Kreung)	Study 2 stimuli (American)	Study 3 stimuli (British)
Love	N/A	• Moderate pace • Regular, steady movement • Arms and hands are relaxed, and hang loosely to the sides of the body, swinging from side-to-side • Shoulders relax downward • Chin tilted slightly back and upward • Hands folded over the heart • Swinging or twirling in smooth, circular movements	N/A

Note. Raters blind to the sources of stimuli and the purpose and hypotheses of these studies completed a questionnaire in which they indicated the nonverbal behaviors present in each stimulus video and rated each video in terms of the speed and regularity of movement (see supplemental material). Only those behaviors endorsed at least 50% of the time are included in this table. Pace of movement was rated on 5-point scale raging from 1 (*freezing or extremely slow*) to 5 (*rapid*).

Overall, participants correctly identified 85% of the emotions conveyed in the Kreung emotional movement clips; a rate that exceeded chance (95% CI: [.78, .90], $p = 2.20 \times 10^{-16}$). Response accuracies for each emotion are summarized in Figure 2B. The highest accuracy rate was associated with the fear video (.96, 95% CI: [.82, 1.00], $p = 2.20 \times 10^{-16}$), followed by anger (.93, 95% CI: [.76, .99], $p = 2.20 \times 10^{-16}$), disgust (.89, 95% CI: [.72, .98], $p = 5.79 \times 10^{-15}$), and sadness (.89, 95% CI: [.72, .98], $p = 5.79 \times 10^{-15}$). Happiness was associated with the lowest accuracy rate, but recognition accuracy for this video still significantly exceeded chance (.57, 95% CI: [.37, .76], $p = 1.65 \times 10^{-5}$). Figure 2C details the distribution of responses for each video.

Study 2: Kreung Recognition of Emotion From American Movement (Free Response Task)

Methods

Participants. Twenty-six Kreung individuals (11 female) participated in Study 2. The Kreung do not formally document age. Participants for Studies 2 and 3 ranged from late adolescents to older adults. Parental consent was obtained for participants believed to be potentially younger than 18. Participants were compensated with the local currency equivalent of a full day of farm labor, and the village was further compensated by a donation through the NGO Ockenden Cambodia to fund the construction of a water well. In addition, U.S. recognition accuracy data was obtained for the stimuli used in Study 2 from 34 individuals using Amazon.com's Mechanical Turk website.

Stimuli. Stimuli were created by one female American poser who performed a 15-s interpretation of each of three positive emotions (happiness, love, pride) and three negative emotions (anger, fear, sadness) through bodily movement (Figure 3A). This set of emotions was chosen to sample each quadrant in the circumplex model of affect (Russell, 1980), and thus, to test for the cross-cultural decipherability of both high and low arousal positive emotions and both high and low arousal negative emotions. The poser interpreted each emotion by walking in a manner that she felt best emphasized that emotion within a rectangle that marked the range of the motion capture equipment. Stimuli were recorded

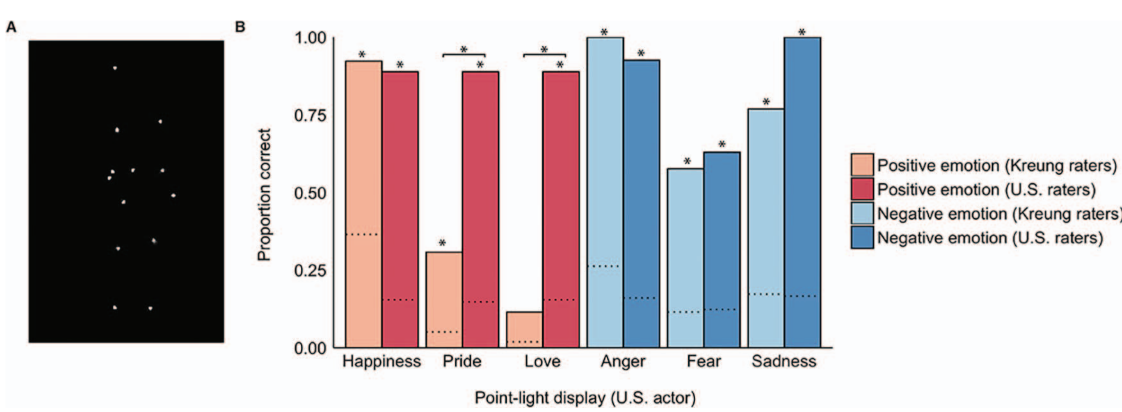

Figure 3. A: Still frame of a point-light (PL) display used in Study 2. Stimuli in Study 2 consisted of PL displays of emotional bodily movement. B: Proportions of correct responses given by Kreung and American raters for each American emotional PL display used in Study 2 in a free response paradigm. The culture of raters is indicated by the darkness of the corresponding bars (Kreung raters = light; American raters = dark). Pink bars (left half of graph) correspond to positive emotions; blue bars (right half of graph) correspond to negative emotions). Dotted lines indicate the base rate for each response across all PL displays within each sample. * $p <$ .05 (corrected). See the online article for the color version of this figure.

using a Vicon MX40 Mocap system running Vicon Blade and Vicon IQ.2 software in the Digital Imaging Laboratory in the Dartmouth College Department of Computer Science. The final PL displays contained 14 points, corresponding to the center of the poser's major joints (shoulders, elbows, wrists, hips, knees, and ankles), torso, and head. These movie clips were converted to QuickTime movie files (120 frames per s) with a resolution of 996 × 414 pixels. These stimuli can be downloaded from http://www.wheatlab.com/emotion-videos and brief descriptions of the nonverbal behaviors contained in each video are provided in Table 2 (see the Meta-Study section for details of the nonverbal coding procedures used). Because of time limitations with the motion capture system, it was only possible to record the movements of a single individual. As such, to create the clearest possible stimuli, an individual was chosen who had received extensive formal training in expressive dance and acting, and thus, we reasoned, would be both expressive and comfortable with performing expressive emotional bodily movements in this setting. In addition, pilot testing was performed to verify that the emotions conveyed in these PL displays were clearly discernable to U.S. participants, as described below.

Stimulus validation (U.S. participants). Thirty-four individuals in the United States watched these clips on Amazon.com's Mechanical Turk website and typed in the emotion that they thought was being conveyed in each clip. Seven participants whose responses indicated they did not understand or follow instructions (e.g., participants that did not follow the instructions to type in the emotion that they thought was being conveyed in each clip) were omitted from analyses. Two independent raters evaluated the accuracy of participants' responses to each clip in terms of whether or not descriptions of the actor's emotional state accurately reflected the target word. Cohen's κ (function kappa2 in the R package irr–Gamer, Lemon, Fellows, & Singh, 2010; R Core Team, 2013), a measure of interrater agreement that corrects for agreement due to chance alone (Cohen, 1960), was used to measure interrater reliability. Interrater reliability was high ($\kappa = 0.69$, $p < .0001$), indicating a substantial level of agreement between the two raters. Raters also assessed whether or not the emotional description matched the target emotion in terms of its valence (i.e., positive or negative) and arousal (i.e., high or low).

The correct emotion was identified by the majority of U.S. participants for each clip in this free response paradigm (see Table 3), with overall accuracies ranging from 63% correct (fear) to 100% correct (sadness). For each video, the proportion of the time that the correct response was given in response to that video (e.g., "fear" or synonymous descriptions, such as "scared" or "afraid" comprised 17 of the 27 U.S. raters' responses to the fear PL display) was compared to the base rate for that response throughout the entire experiment (e.g., "fear" or synonymous descriptions comprised 20 of the 162 total responses given by U.S. raters) using exact binomial tests. U.S. participants spontaneously used the correct emotional labels to describe the appropriate PL displays more often than they used those emotional labels overall, all ps < .0001 (please refer to Table 3 for exact statistics and further details). This suggests that instances where the correct emotional label was spontaneously applied to a PL display were not simply due to that emotional label comprising a popular guess that would have been indiscriminately applied across all PL displays.

Although limited access to Kreung participants precluded our ability to perform analogous stimulus validation in Study 1 (i.e., to test the recognition accuracy of emotional movement clips by perceivers of the same culture as the poser), such validity testing can inform interpretations of cross-cultural emotion recognition accuracy data. First, such data allows us to validate that the emotional signals in the stimulus set are in fact intelligible signals of the corresponding emotions to members of the same culture as the perceiver. This is particularly central to interpreting the significance of cases in which emotional signals are not successfully recognized across cultures; without such data, it is impossible to ascertain whether inaccurate cross-cultural recognition results from the use of unclear or poor stimuli that would not be intelligible even to members of the poser's own culture, or from signals of a given emotion that would be intelligible to members of the same culture as the poser being unintelligible across cultures. Thus, this validity data is particularly helpful in informing the interpretation of cases of unsuccessful cross-cultural emotional communication. Second, this validity data allows us to test for cross-cultural differences in recognition accuracy of the same stimuli, and thus to test if recognition of the bodily movement signature of a given emotion is characterized by an in-group advantage. Therefore, although collection of in-group recognition data was not possible in the Kreung sample, such data were collected in the American sample given that we had significantly more time with the American participants and a substantially larger pool of potential participants.

Procedure. All stimuli were presented in the center of the screen of a 13-inch MacBook or MacBook Air laptop running SuperLab 4.0. The order of trials in each experiment was randomized. All participants were asked not to discuss the experiment with others until a village-wide debriefing session after all experiments had been completed.

In each experiment, participants sat directly in front of a laptop computer. A translator explained to participants that they would see a moving depiction of a person with white spots on his or her body against a black background, and that for each video that they saw, they were to describe the emotion that they thought best suited what the person seemed to be feeling. Participants were not given any response limitations or suggestions beforehand. Participants could choose any words in the Kreung language to respond and could respond at any point during the video. Regardless of whether a participant responded before the end of a given PL display, the entire video was always played, and the participant's final answer was always the answer that was transcribed.

Prior to participating in each experiment, participants were shown an emotionally neutral PL display of a communicative interaction from the Communicative Interactions Database (Manera et al., 2010) that was not being used in any of our studies. After viewing this PL display, participants were asked if they were able to see that the PL display was depicting human movement. The purpose of this step was to ensure that participants had sufficiently good vision to make out the small white dots in the PL displays, and to ensure that the PL displays could be interpreted as depicting biological motion, as PL displays contain minimal biological form information (Johansson, 1973), and our Kreung participants lacked experience with animations and computer screens. Only one participant declined to participate at this stage, an older woman who said that her

Table 3
Kreung and American Participants' Free Response Accuracies for American PL Displays of Emotion (Study 2)

PL display	Proportion correct	Base rate for correct response	Proportion of responses using correct label > label base rate?[a]	Most common incorrect response(s)[b]	Cross-cultural accuracy difference?[c]
Anger					p = .49, OR = inf., 95% CI: [.18, inf.]
Kreung raters*	1.00 (26/26)	.27 (41/156)	$p = 8.15 \times 10^{-16}$ 95% CI: [.87, 1.00]	—	
U.S. raters*	.93 (25/27)	.16 (26/162)	$p = 2.20 \times 10^{-16}$ 95% CI: [.76, .99]	—	
Happiness					p = 1, OR = 1.49, 95% CI: [.16, 19.32]
Kreung raters*	.92 (24/26)	.37 (57/156)	$p = 4.39 \times 10^{-9}$ 95% CI: [.75, .99]	—	
U.S. raters*	.89 (24/27)	.15 (25/162)	$p = 2.20 \times 10^{-16}$ 95% CI: [.71, .98]	Excitement (3)	
Sadness					p = .01, OR = 0, 95% CI: [0, .72]
Kreung raters*	.77 (20/26)	.17 (27/156)	$p = 4.55 \times 10^{-11}$ 95% CI: [.56, .91]	Happiness (2) Drunkenness (2)	
U.S. raters*	1.00 (27/27)	.17 (27/162)	$p = 2.20 \times 10^{-16}$ 95% CI: [.87, 1.00]	—	
Fear					p = .78, OR = .81, 95% CI: [.23, 2.77]
Kreung raters*	.58 (15/26)	.12 (18/156)	$p = 1.88 \times 10^{-8}$ 95% CI: [.37, .77]	Happiness (6) Anger (5)	
U.S. raters*	.63 (17/27)	.12 (20/162)	$p = 8.80 \times 10^{-10}$ 95% CI: [.42, .81]	Excitement (4) Agitation (2)	
Pride+					$p = 1.75 \times 10^{-5}$, OR = .06, 95% CI: [.01, .28]
Kreung raters*	.31 (8/26)	.05 (8/156)	$p = .3.24 \times 10^{-5}$ 95% CI: [.14, .52]	Happiness (8) Anger (4)	
U.S. raters*	.89 (24/27)	.15 (24/162)	$p = 2.20 \times 10^{-16}$ 95% CI: [.71, .98]	—	
Love+					$p = 8.92 \times 10^{-9}$, OR = .02, 95% CI: [.002, .11]
Kreung raters	.12 (3/26)	.02 (3/156)	p = .01 95% CI: [.02, .30]	Happiness (12) Anger (5) Sadness (3)	
U.S. raters*	.89 (24/27)	.15 (25/162)	$p = 2.20 \times 10^{-16}$ 95% CI: [.71, .98]	—	

Note. CI = confidence interval; inf. = infinity; OR = odds ratio; PL = point-light. Because 12 statistical tests were applied to each dataset, a Bonferonni-adjusted threshold of $p < .004$ was used to evaluate the significance of each statistical test, for an overall threshold of $p < .05$, corrected, across all tests. Exact p-values are provided for all statistical tests. Rows containing results that survived the Bonferonni-adjusted significance threshold are also demarcated for convenience as described below.
[a] Exact binomial tests were used to compare the proportion of times that each emotion label comprising a correct response was given for the appropriate PL display to the base rate for that label throughout the entire experiment within each sample. [b] The most common incorrect responses are provided in cases where that response was provided more than once for a given PL display. Response frequencies indicated in parentheses. [c] Fisher's exact test of independence was used to compare proportions of correct and incorrect responses between U.S. and Kreung samples for each emotional PL display. ORs range between 0 and infinity, and equal 1 when accuracy and culture (of raters) are independent. OR values between 0 and 1 reflect higher accuracies for U.S. raters; OR values between 1 and infinity reflect higher accuracies for Kreung raters.
+ $p < .05$ (corrected), cross-cultural accuracy difference. * $p < .05$ (corrected), correct label frequency for appropriate PL display differs from label's base rate.

vision was too poor to clearly make out the dots on the screen. During each experiment, the participant faced the laptop screen, while three individuals (the Kreung-Khmer translator, the Khmer-English translator, and an English-speaking experimenter) sat on the other side of the laptop, facing the participant. These three individuals were blind to which trial the participant was viewing during the study. After each trial, the participant responded verbally in Kreung with the emotion word(s) that he or she thought best matched the emotion that the poser on the screen was feeling, and this response was translated into Khmer by a Kreung-Khmer translator, then immediately into English by a Khmer-English translator, at which point the verbal response and trial number were transcribed by the English-speaking experimenter. After transcribing the participant's response for a given trial, a translator reached over the laptop screen to press the space bar to advance to the next trial. After returning to the United States, a rater who was blind to the goal of the experiment and to the source of the descriptions compared these response translations to the target emotion word (e.g., "anger") in order to determine response accuracy. The English-speaking rater scored each response in terms of whether or not the description of the actor's emotional state accurately reflected the target word. The rater also assessed whether or not the emotional description matched the target emotion in terms of its valence (i.e., positive or negative) and arousal (i.e., high or low).

To evaluate interrater reliability in assessing participants' accuracy, a second independent judge was asked to score all participants' answers. As with the stimulus validation data, Cohen's κ was highly significant (κ = .93, $p < .0001$), indicating a substantial level of agreement between raters.

Results and Discussion

Even without a predetermined set of response choices, the Kreung were very often accurate in identifying emotional signals conveyed through movement alone: The overall accuracy score for Kreung participants was 62% in this free response task. Proportions of correct responses given for each clip by both Kreung participants and U.S. pilot study participants are displayed in Figure 3B. Detailed statistical results, as well as common incorrect responses in cases where multiple individuals offered the same incorrect response, are summarized in Table 3.

In contrast to the extremely low likelihood of guessing the correct emotion from all possible words in the Kreung language, 100% of Kreung participants correctly described the anger PL display in this free response task. All but one participant gave a single word response ("angry"); the remaining participant described the individual in the PL display as "angry and drunk." Nearly all (92%) of participants correctly identified the happiness PL display, with the remaining responses divided across fear ("scared") and anger ("angry, playing sports"). Kreung participants' descriptions of the happiness PL display often included situational details, such as "happy that no one is hurt or sick in the family and that there are no problems happening," "happy to be able to make food out of wild animals," "happy because we have vigor and energy and no illness," "happy to come together as a family," and "happy and dancing." The majority of participants also correctly identified the PL displays of sadness (77%) and fear (58%); responses for these PL displays tended to be single words ("sad" and "scared," respectively). Figure 4 contains word clouds illustrating the frequency with which each word that was used to describe a given PL display appeared in all participants' descriptions of that PL display.

The majority of Kreung participants did not correctly describe the love and pride PL displays. As shown in Figure 4, the word that appeared most often in Kreung participants' descriptions of both the love and pride PL displays was "happy," which could be considered a more general term for these emotions. However, descriptions of the positive emotion PL displays tended to be more elaborate than those of the negative emotion PL displays (as reflected in the larger word clouds for these emotions in Figure 4), and these elaborations were only sometimes consistent with the emotion portrayed in the relevant PL display. For instance, for the pride PL display, some relatively elaborate descriptions containing the word "happy" were consistent with the emotion of pride (e.g., "happy because they are beautiful"), whereas others were not clearly consistent with pride (e.g., "happy to see their friends come back to the village;" "happy, walking leisurely in the village"). Similarly, for the love PL display, some descriptions containing the word "happy" were consistent with the emotion of love (e.g., "happy and content, calling for their lover to come"), whereas others were not (e.g., "happy that there is no suffering and they just have lots of money").

As with the U.S. pilot data, to evaluate the significance of Kreung participants' recognition accuracies in this free-response task, the relative frequency with which each emotional label comprising a correct response was used correctly was compared to that label's base rate using exact binomial tests. Using the base rate for each correct response as a statistical point of comparison provided a conservative method of ensuring that instances of correct responses did not merely reflect popular guesses or high frequency words being applied indiscriminately across PL displays, and of quantifying the significance of accuracy rates that were relatively lower (e.g., 58% for fear), but still impressive given that participants were not provided with a predetermined set of response choices. In addition, to test for cross-cultural differences in recognition accuracy for each emotional PL display, proportions of correct and incorrect responses given by Kreung participants were compared to those given by U.S. participants using Fisher's exact test of independence. Fisher's exact test of independence was used because it is more accurate than the chi-square test of independence for small sample sizes (McDonald, 2013). Because 12 statistical tests in total were applied to the Kreung recognition accuracy data, a Bonferonni-corrected threshold of $p < .004$ was used as a significance threshold for each of these 12 tests.

As illustrated in Figure 3B, descriptions of anger, happiness, sadness, fear, and pride were each more likely to be spontaneously applied to the appropriate PL display by Kreung participants than they were to be applied overall (all ps $< .001$; for further details, please refer to Table 3). This suggests that high Kreung response accuracies for the anger, happiness, sadness, fear and pride PL displays did not merely result from these emotions comprising popular guesses applied indiscriminately across video clips. Only the response "love" was not more likely to be given for the love PL display than overall, $p = .01$ (this result did not survive the corrected significance threshold of $p < .004$). This description was not given for any PL display other than love, but was only given by three of 26 participants.

As shown in Table 3, there were no significant differences between Kreung and U.S. raters' accuracies in describing the anger, happiness, sadness, or fear PL displays. However, U.S. participants were significantly more accurate in identifying the emotions conveyed in the pride (odds ratio [OR] = 0.06, 95% confidence interval [CI]: [0.01, 0.28], $p = 1.75 \times 10^{-5}$) and love (OR = 0.02, 95% CI: [0.002, 0.11], $p = 8.92 \times 10^{-9}$) PL displays (Figure 3B). This finding is consistent with the general idea of an in-group advantage for emotion recognition, whereby emotional signals tend to lose some, but not all, of their meaning when transmitted across cultures, especially when those cultures lack significant previous exposure to one another (Elfenbein & Ambady, 2002a, 2002b). In addition, despite cross-cultural differences and relatively low Kreung recognition accuracy rates for American pride and love PL displays, descriptions of pride were used by Kreung participants to describe the pride PL display significantly more often than chance (i.e., this description's base rate), consistent with previous suggestions that pride is associated with a universally recognizable signal involving facial and bodily form information (Tracy & Robins, 2008). Comparatively low recognition accuracy for bodily movements associated with pride (relative to other emotions in the current study) could result from PL displays lacking facial expression information, which has been demonstrated to be integral to the accurate recognition of pride (Tracy & Robins, 2004) and to be useful in distinguishing pride from other positive emotions (Mortillaro, Mehu, & Scherer, 2011).

There were no significant differences between American and Kreung raters' accuracies in perceiving the majority of emotional displays (i.e., PL displays depicting happiness, anger, fear, and sadness). This lack of an in-group advantage was unexpected. However, we take caution in interpreting the lack of a significant

Figure 4. Word clouds depicting the terms used to freely describe the American point-light (PL) displays of emotional movement used in Study 2. Font size corresponds to relative frequency. Stop words (high frequency function words—e.g., "to," "the," "of"—that are typically filtered out prior to natural language processing) were removed prior to plotting using the R packages tm (Feinerer et al., 2008) and wordcloud (Fellows, 2012).

difference between groups for these emotions. Future studies with increased statistical power (e.g., studies with larger sample sizes) may find significant group differences in recognition accuracies of emotional bodily movement by raters of the poser's own culture and raters of a disparate culture, given that in-group advantage in emotion recognition is a phenomenon that has been widely documented across diverse emotions, cultures, and modalities (Elfenbein & Ambady, 2002b). We also note that situational differences in testing across cultures may have influenced response accuracies within the American and Kreung rater groups. For example, American participants were tested online, possibly in variable environments (e.g., in the presence of ambient noise or in a silent room, alone or in the presence of other people), and without any direct interaction with the experimenter, whereas Kreung participants were tested in the presence of three experimenters. It is possible that higher accuracies would have been observed in the American participants (and thus, significant in-group advantages for more emotions) if the stimulus validation procedure involving emotion recognition by American raters had been completed in the lab in the presence of experimenters; participants who complete the experiment in the presence of experimenters may be more motivated to attend to experimental stimuli and follow instructions.

The results of Study 2 strongly suggest that communication of anger, happiness, sadness, fear, and pride from bodily movement cues does not depend entirely on exposure to a shared culture. Depictions of these emotions through the bodily movement of an American poser were correctly identified at above-chance rates by Kreung participants, even without a fixed set of response options. In addition, there were no cross-cultural differences in recognition accuracy rates for anger, happiness, sadness, and fear. In contrast, although a few Kreung participants were able to correctly infer what the PL poser was portraying in the pride and love video clips, these PL displays were often described using other positive emotion words (e.g., "happy," see Table 3 and Figure 4), and were associated with significant cross-cultural differences in recognition accuracies. Next, to test for the cross-cultural decipherability of emotional information from kinematic cues in a more constrained manner, we used a fixed response paradigm using a different stimulus set.

Study 3: Kreung Participants' Recognition of Emotion From Movement Cues (Fixed Response Task)

Methods

Participants. Sixteen Kreung participants (10 female) who had previously completed Study 2 participated in Study 3. In all cases, participants completed Study 2 prior to Study 3.

Stimuli. Stimuli were 2-s digital video clips of 13-sensor PL displays (25 frames per second) presented at a resolution of 714 × 510 pixels; these stimuli were taken from a previously validated set of PL displays depicting bodily signals of emotion. Details of the stimulus set construction, modification, and validation have been published previously (Atkinson et al., 2004, 2007, 2012). Actors freely interpreted and expressed five emotions (i.e., anger, disgust, fear, happiness, sadness) through bodily movement while small patches of white tape were affixed to their major joints and head. The resultant patch-light displays (i.e., small white rectangular patches depicting movement of the head and major joints against a black background) were later converted to PL displays (i.e., small white circular dots depicting movement of the head and major joints against a black background) using MATLAB as described in Atkinson et al. (2012). These stimuli had previously been validated in a forced-choice experiment in which 16 Durham University students viewed the videos individually in a quiet room and indicated whether the video depicted anger, disgust, fear, happiness or sadness, or whether the video was emotionally neutral (Atkinson et al., 2007). For the current study, the best recognized male and female PL videos for each emotion were used (based on the data from the experiment described in Atkinson et al., 2007). Average emotion recognition accuracies for these particular clips were high within the culture in which they were developed (i.e., anger: 100%; disgust: 90.63%; fear: 93.75%; happiness: 96.88%; sadness: 96.88%). Atkinson et al. (2004, 2007, 2012) provide further details regarding the creation and discernibility of these stimuli in a Western (U.K.) sample. Brief descriptions of the nonverbal behaviors contained in each video are provided in Table 2.

Procedure. Study 3 followed nearly the same procedure as Study 2, but participants were given a list of five possible emotion words in Kreung (the Kreung words for: anger, disgust, fear, happiness, sadness) to choose from to describe each PL display. Participants watched one male and one female depiction of each of five emotions presented in a random order and were asked to indicate verbally which emotion they thought was being portrayed, given five choices (anger, disgust, fear, happiness, or sadness), which were repeated by a Kreung speaker (who was blind to which stimulus the participant was seeing) following the presentation of each video.

Results and Discussion

Exact binomial tests were used to compare the proportions of correct responses to chance accuracy level (.20 correct) in this fixed response task. A Bonferonni-adjusted significance threshold was applied to each test to correct for having conducted multiple (five) statistical comparisons ($p < .01$). The proportions of correct responses for each emotion are illustrated in Figure 2E. Overall, Kreung participants matched the PL displays of emotion to the Kreung translations of the intended emotion words at frequencies significantly above chance (total accuracy = .53, 95%, CI: [.45, .61], $p = 2.20 \times 10^{-16}$). More specifically, the Kreung performed this task at above-chance levels for anger (proportion correct = .82, 95% CI: [.64, .93], $p = 1.69 \times 10^{-13}$), disgust (proportion correct = .47, 95% CI: [.29, .65], $p = .0006$) and happiness (proportion correct = .66, 95% CI: [.47, .81], $p = 2.65 \times 10^{-8}$) PL displays. Correct response rates for sadness (proportion correct = .38, 95% CI: [.21, .56], $p = .024$) and fear (proportion correct = .34, 95% CI: [.19, .53], $p = .048$) exceeded .20 but did not survive the Bonferonni-adjusted significance threshold. However, notably, fear PL displays were correctly identified as portraying a negative emotion ("fear," "anger," or "disgust") 97% of the time (i.e., in all but one case, when it was called, "happy"), and sadness was identified as a negatively valenced emotion 100% of the time. The distribution of responses collapsed across videos for each emotion used in Study 3 is provided in a confusion matrix in Figure 2F.

The relatively high response accuracies observed in Study 2 in comparison to Study 3 were surprising given that Study 3 used a fixed response paradigm, whereas Study 2 used a free response paradigm. We hesitate to directly compare the results of these two studies, given substantial differences in the stimuli and paradigms used. However, we suspect that the most likely source of decreased performance in Study 3 relative to Study 2 is the difference in stimuli length between these studies. PL displays used in Study 2 were 15 s in duration, whereas those used in Study 3 were 2 s in duration. Thus, the stimuli used in Study 2 contained more movement information than those used in Study 3. Relatively high recognition accuracies in Study 2 compared to Study 3 are consistent with previous evidence that additional movement information improves emotion recognition accuracy from biological motion displays (Atkinson et al., 2004), and underscore the utility of movement information for effective emotion perception.

Although Kreung participants' accuracies in recognizing fear and sadness PL displays were not significantly above chance after correcting for multiple comparisons in Study 3, in Study 2, the majority of Kreung participants correctly identified fear and sadness PL displays, even without a fixed set of response options. This suggests that at least some aspects of bodily movement signals for these emotions are cross-culturally decipherable. In addition to the relatively long duration of the PL displays used in Study 1 (15 s) compared to those used in Study 3 (2 s), qualitative differences between the PL displays used (e.g., the posers' movement choices; the inclusion of an extra point on the poser's torso in Study 2; potential differences in the expressiveness of the targets—Zaki, Bolger, & Ochsner, 2008) may have contributed to higher accuracies in identifying emotions from movement in kinematics in Study 2 compared to Study 3.

Meta-Study: Nonverbal Coding of Emotional Movement Displays

Nonverbal coding of the videos contained in all stimulus sets was performed to document the behaviors contained in each emotional movement display and to assess the degree to which similar patterns of nonverbal behaviors were consistently used to convey particular emotions across cultures (rather than, for instance, being consistently associated with a given culture, irrespective of the emotion being signaled).

Methods

Nonverbal coding procedure. Two authors (Carolyn Parkinson and Thalia Wheatley) documented the nonverbal behaviors contained in each video. These observations were combined into a list of all of the nonverbal behaviors present in the stimuli. Next, three raters who were blind to the emotions meant to be conveyed in each video, as well as to the purpose of the experiment and to the culture of the posers, independently watched each video and coded it for the presence of each nonverbal behavior from the list (see Table 2). Raters first indicated the rate of movement (i.e., rapid, moderately fast, moderate, slow, freezing/extremely slow) and if it was characterized by a regular or erratic pace. Raters were then provided with lists of movements/postures involving the hands and arms (e.g., placing hands on hips), shoulders (e.g., shoulders slump forward and down), head (e.g., chin tilted slightly back and upward), and body position (e.g., crouching downward), as well as other nonverbal behaviors (e.g., trembling), and were asked to indicate which movements/postures were present in the video. Raters were also asked to indicate if the subject walked backward/away from the viewer and/or forward/toward the viewer during the video. Altogether, each video was coded by each rater with respect to 33 items: 31 nonverbal behaviors that were indicated as present or absent in the video, the pace of the movement, and whether the pace of movement was regular or irregular. The appendix (see supplemental material) contains the nonverbal coding questionnaire used by each rater for each video. Raters could watch each video as many times as they wished, and rated each video in full before moving onto the next video.

Interrater reliability. Light's κ (Light, 1971) was used to assess the interrater reliability of the three raters. Light's κ is an extension of Cohen's κ (Cohen, 1960) to data sets with three or more raters and is calculated based on the arithmetic mean of all possible pairwise combinations of raters. Across all 21 videos and 33 questionnaire items, interrater reliability was high, $\kappa = .566$, $z = 4.67$, $p = 3.01 \times 10^{-6}$. Significantly above chance interrater reliability was also documented within ratings of the stimulus sets used in Study 1 ($\kappa = 0.578$, $z = 2.70$, $p = .00704$), Study 2 ($\kappa = .614$, $z = 2.77$, $p = .00568$), and Study 3 ($\kappa = .528$, $z = 2.73$, $p = .00629$).

Multidimensional scaling analysis. If similar patterns of nonverbal behavior are used to convey the same emotional states across cultures, then the patterns of nonverbal behavior contained in the video stimuli should be similar across different cultures' portrayals of the same or similar emotions. Alternatively, if patterns of nonverbal behavior are associated with particular cultures, irrespective of the emotion being conveyed, then patterns of nonverbal behaviors contained in the video stimuli should be similar across portrayals of different emotions within each culture. A third possibility is that nonverbal behaviors are neither systematically associated with particular emotions or particular cultures; if this were the case, then patterns of nonverbal behaviors should not be organized systematically according to culture or emotion.

Multidimensional scaling (MDS) provides a convenient way to visualize the similarities among items in a dataset and to detect meaningful dimensions underlying those similarities. MDS algorithms arrange objects into a representational space with a predetermined number of dimensions (here, two for ease of visualization) and position those objects within the representational space such that the visualized distance between each pair of objects best matches the actual dissimilarity of those objects (Cox & Cox, 1994). Thus, in the current study, emotional movement displays that appear closer together in the MDS solution (see Figure 5) are more similar to one another in terms of the patterns of nonverbal behavior that they contain, whereas emotional movement displays that appear farther apart are more different from one another in terms of the nonverbal behavior patterns that they contain.

The results of the nonverbal coding performed by the three blind raters were averaged across raters, resulting in a vector describing the pattern of nonverbal behavior associated with each emotion within each culture. Next, a distance matrix describing the dissimilarities among the patterns of nonverbal behavior in each of the 21 videos was computed based on the euclidean distances between the vectors described above. This distance matrix was used as the input for MDS, which was implemented using Kurskal's nonmet-

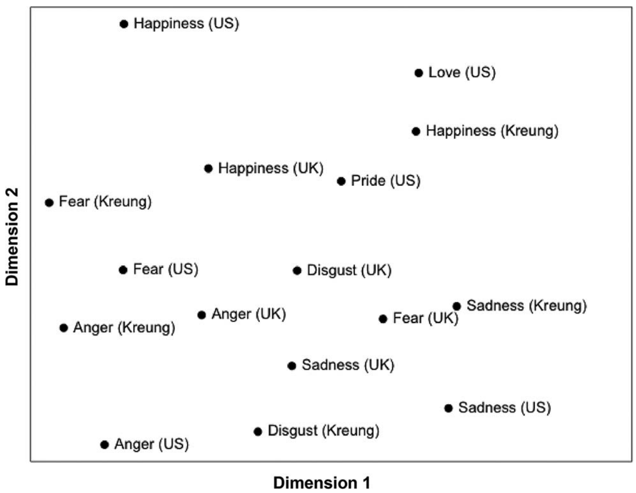

Figure 5. Multidimensional scaling (MDS) solution depicting similarities among the patterns of nonverbal behavior used by Kreung, U.S., and U.K. posers in emotional movement displays. Greater distances between points indicate more dissimilar patterns of nonverbal behavior; smaller distances between points indicate more similar patterns of nonverbal behavior.

ric MDS algorithm in the R package MASS (R Core Team, 2013; Venables & Ripley, 2002). This algorithm selects a two-dimensional configuration of the items in a dataset such that the stress (which is inversely related to the degree of correspondence between the distances between points in the MDS map and the distances between points in the input) is minimized.

Results

The results of MDS appeared to be more consistent with the nonverbal behavior patterns being organized according to the emotional information being signaled than with the nonverbal behavior patterns being organized according to the culture of the poser (see Figure 5). In particular, the Kreung, U.S. and U.K. depictions of sadness were relatively close to one another in the MDS solution, indicating that similar patterns of nonverbal behavior were used to convey sadness across cultures. Similarly, the Kreung, U.S., and U.K. depictions of anger were also relatively close to one another, indicating that similar patterns of nonverbal behavior were also used to signal anger across cultures.

The MDS plot did not appear to be organized according to culture. For example, data points corresponding to different Kreung movement displays appeared at the low and high ends of both dimensions, rather than being confined to a particular area of the MDS plot (see Figure 5), which one would expect if nonverbal behavior patterns signified the poser's culture rather than the emotion that he or she was displaying. Indeed, the first dimension (corresponding to the *x*-axis in Figure 5) appeared to roughly correspond to arousal, with displays of sadness and love at one extremity, and fear and anger at the other (we note, however, that the U.K. depiction of fear, which included freezing behavior, appeared to group with the low arousal emotions on dimension one, whereas the Kreung and U.S. fear displays, which contained more frantic, fast-paced movement, clustered at the other extremity of that dimension, closer to anger). The second dimension (i.e., the *y*-axis in Figure 5) appeared to approximate valence, with happiness, love, and pride located high on dimension two, and the other (all negatively valenced) emotions located at the low end of this dimension.

General Discussion

The current results suggest that movement kinematics alone can effectively convey emotions across disparate cultures. This research complements previous work suggesting that certain facial (Ekman et al., 1969) and vocal (Sauter et al., 2010) cues comprise universally decipherable affective signals, as do static depictions (i.e., photographs) of facial and postural information presented together (Tracy & Robins, 2008). This is the first evidence that emotions can be decoded from bodily movement cues alone between cultures that have been substantially isolated from each another. Emotions were accurately communicated across disparate cultures through PL displays, which lack some information that static photographs contain—such as fine-grained visual form information (e.g., facial expressions, finger and hand position, cues to muscle tension, such as skin tautness) and visual cues to skin pallor and redness—and contain information about movement dynamics (e.g., movement speed and temporal regularity) that static photographs lack. Information about bodily movement dynamics and posture appears to be sufficient to convey emotion across disparate cultures.

Accurate Communication of Specific Emotion Categories Across Remote Cultures

Recently, researchers have debated whether nonverbal emotional signals can communicate specific emotion category information or only more basic affective properties (e.g., valence) across remote cultures (Gendron, Roberson, van der Vyver, & Barrett, 2014; Sauter, Eisner, Ekman, & Scott, 2015). In a series of studies examining the communication of emotion in nonverbal vocalizations across disparate cultures (i.e., recognition of British emotional vocalizations among members of the Himba ethnic group of Namibia), Gendron et al. (2014) found that recognition was only above chance in fixed-response paradigms in trials in which participants were presented with foils (i.e., incorrect response choices) that differed from the target emotion word in terms of valence. The authors concluded that affective meaning (e.g., positive vs. negative valence), but not specific emotion category information, can be reliably conveyed in nonverbal vocal cues across disparate cultures. Conversely, Sauter et al. (2010, 2015) provided evidence that the Himba could in fact accurately recognize emotions in British vocalizations, even when foils were of the same valence as the target. These authors suggested that the discrepant findings of Gendron et al. (2014) could be attributable to differences in the experimental procedures used; Sauter et al. (2010, 2015) used a manipulation check to verify that Himba participants understood the task and their response choices, whereas Gendron et al. (2014) do not report using such a manipulation check.

Our findings, particularly those of Study 2, in which no category distractors were provided to participants, are consistent with those of Sauter et al. (2010, 2015). Even without a set of response choices, Kreung participants spontaneously offered the correct emotion category to describe the emotional bodily movement of an

American poser with above-chance accuracy for five of the six emotions tested. This suggests that specific emotion categories, and not just affective dimensions (e.g., positive vs. negative affect), can be accurately communicated across disparate cultures. Interestingly, although we tested a different channel of nonverbal emotional communication (i.e., bodily movement) than the nonverbal vocalizations tested by Sauter et al. (2010, 2015) and Gendron et al. (2014), our results evinced a similar pattern of results to those of Sauter et al. (2010) such that the negative emotions tested were more accurately recognized across cultures than positive emotions.

Negative Emotions

In fixed-response paradigms, American participants identified Kreung bodily movement signals of anger, disgust, fear, and sadness, and Kreung participants correctly identified Western PL displays of anger and disgust with above-chance accuracy. Although brief (2 s) PL displays of fear and sadness were not recognized with above-chance accuracy by Kreung participants, when given longer (15 s) PL displays of the same two emotions, Kreung participants' accuracy rates were high and did not significantly differ from those of American participants (see Figure 3).

Indeed, using an open-ended task without a predetermined set of response choices, the majority of Kreung participants correctly identified American PL displays of fear, sadness, and anger (see Figure 3). In addition, nonverbal coding of emotional movements produced by Kreung, American, and British individuals revealed commonalities in the bodily movements used to signal these emotions across cultures (Table 2; Figure 5). For example, across all three stimulus sets, sadness was signaled by a downward head tilt and cradling one's head in one's hands. Similarly, anger consistently involved forceful movement and thrusting one's arms downward, fear consistently involved crouching downward, and disgust consistently involved using one's hand to cover one's face and mouth. This pattern of results is consistent with suggestions that these "basic emotions" (Ekman & Cordaro, 2011; Izard, 2011; Levenson, 2011) are communicated using biologically predisposed, cross-culturally decipherable signals through the face (Ekman et al., 1969), voice (Sauter et al., 2010), and, it appears, through bodily movement.

Positive Emotions

Similar to the negative emotions described above, bodily movement-based signals of happiness were reliably recognized across cultures using both fixed- and free-response paradigms. In addition, signals of happiness were consistently characterized by regular, steady movement (see Table 2). Importantly, cross-cultural studies of emotion recognition often test only a single positive emotion, and vary arousal level only within the negative emotion category. Our stimulus set in Study 2 contained an equal number of positive and negative emotions, allowing us to assess if specific positive emotions, like negative emotions, can be accurately communicated through movement cues alone across members of disparate cultures.

Although Kreung participants' free response accuracy rates for happiness and pride both significantly exceeded chance, this was not the case for love. Consistent with the general notion of an in-group advantage in recognizing emotional signals (Elfenbein & Ambady, 2002a, 2002b), American raters' accuracies were significantly higher than those of Kreung raters for love and pride. The below-chance Kreung recognition accuracy rate and cross-cultural accuracy difference for the love PL display suggest that the signals used in the love PL display may reflect culturally bound cues.

Incorrect answers for love and pride often included other positive emotion words (e.g., happy), consistent with previous suggestions that disentangling signals of positive emotions often involves culturally specific cues (Sauter et al., 2010). Alternatively, it is possible that some descriptions given by Kreung participants for the pride PL display that were classified by American raters as incorrect (e.g., "happy to be free of illness;" "happy to see their friends come back to the village") comprise scenarios that typically evoke pride in the Kreung culture, which could have led to an underestimation of accuracy rates for these emotions. A limitation of this stimulus set that could also have led to an underestimation of the cross-cultural intelligibility of emotional movement is that a single poser produced all PL displays. Using stimuli produced by a greater diversity of posers likely would have yielded a more diverse set of movement signals for each emotion, including, for instance, signals for love that may have been more cross-culturally intelligible.

Cross-cultural differences in recognition accuracy rates for love and pride might also be attenuated using other modalities of expression. For instance, prototypical expressions of pride are well-recognized using photographic stimuli that depict visual form details of both the face and bodily posture in North America (Tracy & Robins, 2007) and in remote, preliterate cultures (Tracy & Robins, 2008), and are displayed by congenitally blind athletes in moments of success (Tracy & Matsumoto, 2008), suggesting they do not depend on visual learning. Comparatively low accuracies in identifying pride here could reflect the importance of visual form details in both the face and body for recognizing this emotion (Tracy & Robins, 2004), and the utility of facial expression information for disentangling pride from other positive emotions (Mortillaro et al., 2011).

More generally, fine visual form details may be especially important for recognizing positive emotions: Biological motion characteristics (e.g., direction, velocity, intensity) could be perceived at a greater distance than the nuances of facial expressions and some aspects of bodily posture, and thus, may have more adaptive value in conveying negative emotions. For instance, when seeing others at a distance running in fear from threat or toward oneself in anger, understanding the emotional meaning inherent in their movement, rather than waiting for a closer view of their facial expressions, confers the ability to act immediately. Positive emotions may be less crucial to distinguish from one another at long distances and may be carried in signals typically conveyed to those who are within close proximity to the expresser. Correspondingly, love, along with other affiliative positive emotions, such as gratitude and sympathy, are relatively reliably discerned from touch (Hertenstein, Keltner, App, Bulleit, & Jaskolka, 2006; Löken, Wessberg, Morrison, McGlone, & Olausson, 2009; Morrison, Löken, & Olausson, 2010; Sauter, 2010). Thus, while accuracy rates for love were low compared to the other emotions studied here, future work using modalities of expression more closely associated with this emotion in everyday life (e.g., touch; Morrison et al., 2010) may find evidence for a universal signal of this emotion.

Notably, the pride PL display included some postural cues that characterize the prototypical pride expression, such as a slight backward head tilt, but not others, such as arms akimbo and a slight smile (Tracy & Robins, 2007). The relatively low Kreung accuracy rate for the pride PL display might have been ameliorated had the PL display depicted the arm position that is characteristic of the prototypical pride expression, which has been shown to be recognizable across disparate cultures (Tracy & Robins, 2008). In addition, the stimuli used here contained information about movement dynamics without fine-scale visual form information (i.e., without facial expression information). The slight smile characterizing the prototypical pride display (Tracy & Robins, 2007) may have been useful in differentiating pride from anger for our Kreung participants (four Kreung respondents identified the pride PL display as angry; see Table 3). American participants were extremely accurate in recognizing the pride PL display, even without some aspects of the prototypical pride expression. This may be due in part to a general in-group advantage for emotion recognition (Elfenbein & Ambady, 2002b), and in part to the inclusion of information about the poser's movement dynamics, such as a highly regular (rather than irregular, or "jittery"), moderate pace of movement, which may be at least partially culturally specific signals of pride. Previous characterizations of the prototypical pride expression (and previous tests of its cross-cultural intelligibility) have tended to use static stimuli; more research is needed to characterize how pride is signaled through biological motion dynamics, and if such signals are intelligible across members of cultures that are isolated from one another.

Use of Posed Emotional Signals Versus Evoked Emotional Expressions

The current results demonstrate that emotions can be successfully signaled between members of remote cultures through bodily movement cues. A distinct, but related, question is whether the ways in which people move their bodies when spontaneously experiencing a given emotion can be reliably decoded across members of remote cultures. Posed emotional signals could reflect both the miming of emotional expressions (e.g., the same kinds of movements that are observed when an individual spontaneously experiences an emotion) and of behaviors or situations associated with a given emotion. Future studies using emotionally evoked spontaneous bodily movements as stimuli could provide insight into whether spontaneously evoked emotional movements, like posed emotional bodily movement signals, can be accurately decoded across remote cultures.

Limitations

Fixed response paradigms. Limitations of the fixed response paradigms used in Studies 1 and 3 should be noted. In particular, forced choice paradigms can artificially inflate the level of agreement between raters (Russell, 1993). For example, even when the "correct" response (e.g., "anger") is removed from the set of response options, respondents will tend to select an alternative label (e.g., "frustration", "disgust") at rates exceeding chance; thus, forced choice paradigms can produce artificially inflated estimates of participant agreement (Russell, 1993). Future studies using forced choice paradigms to assess the cross-cultural intelligibility of emotional bodily movements should include response options beyond the set of emotion labels associated with items in the stimulus set (e.g., "none of these terms are correct"). Such modifications of forced choice emotion recognition paradigms have been shown to ameliorate the artificial inflation of apparent response agreement across participants (Frank & Stennett, 2001). We note that although the results of Study 3 may reflect artificially inflated estimates of participant agreement, the high accuracies observed in Study 2, in which Kreung participants identified the emotions being conveyed in Western PL videos in a free response paradigm, suggest that a similar pattern of results may have been obtained if a modified forced choice paradigm (e.g., one that included a "none" option) had been used in Study 3.

Use of a single poser in Studies 1 and 2. The use of a single poser in Studies 1 and 2 comprises an additional limitation of the current work. Because only a single power was used in each of the corresponding stimulus sets, those stimulus sets only included the emotional signals of a single gender of poser (i.e., a male poser in Study 1; a female poser in Study 2). Given possible gender differences in emotional expressivity (Kring & Gordon, 1998), future research on cross-cultural emotional recognition should employ multiple posers of both genders. More generally, using the emotional displays of multiple posers would allow future researchers to assess the reliability with which emotions can be decoded from bodily movement cues across remote cultures.

Further, an individual's idiosyncratic personality and movement style likely influence his or her emotional movements. Using stimulus sets consisting of the emotional movements of a single individual does not allow us to distinguish between aspects of emotional movement that reflect a particular individual's movement style or personality and those that are consistently used to convey a particular movement by members of his or her culture. In other words, when participants fail to recognize stimuli in Studies 1 and 2, we cannot ascertain whether this failure was attributable to the lack of cross-culturally decipherable movements associated with a given emotion, or idiosyncrasies of the particular actor's emotional movements. This limitation is particularly relevant to Study 1, in which we were unable to collect emotion recognition data for the stimuli among individuals from the same culture as the poser. In addition, there may be multiple bodily movements associated with a given emotion, some of which are shaped by culture and some of which are shaped by cross-culturally consistent aspects of human physiology or the environment. Using a greater diversity of emotional signals potentially would have provided a greater number of examples of movement associated with a given emotion, and thus, may have increased the likelihood that the set of emotional movements in the stimulus set corresponding to a given emotion would have included movement cues that are consistently associated with that emotion across cultures, if such cues exist. Therefore, the use of a greater number of posers might have increased cross-cultural emotion recognition accuracy and would have provided informative reliability data. We suggest that future studies of cross-cultural communication of emotion through movement use stimulus sets consisting of a greater number of posers.

General Conclusions

The current results are, to our knowledge, the first to show that biological motion cues alone are sufficient to elicit similar attributions of emotion across members of cultures without previous exposure to one another through media or personal contact. Through our bodily movements, humans can signal a rich variety of emotional states, including those that exist only as stable traits among other primate species (Tracy & Robins, 2008). Taken together, the results reported here demonstrate that visual information about biological motion provides a rich source of information that can be interpreted effectively even if the encoder and perceiver have not been exposed to a shared language or culture. We suggest that signals of emotions have high cross-cultural intelligibility because they are shaped and constrained by factors universal to all humans, including basic human needs, social intelligence, and physiology.

References

Atkinson, A. P., Dittrich, W. H., Gemmell, A. J., & Young, A. W. (2004). Emotion perception from dynamic and static body expressions in point-light and full-light displays. *Perception, 33,* 717–746. http://dx.doi.org/10.1068/p5096

Atkinson, A. P., Tunstall, M. L., & Dittrich, W. H. (2007). Evidence for distinct contributions of form and motion information to the recognition of emotions from body gestures. *Cognition, 104,* 59–72. http://dx.doi.org/10.1016/j.cognition.2006.05.005

Atkinson, A. P., Vuong, Q. C., & Smithson, H. E. (2012). Modulation of the face- and body-selective visual regions by the motion and emotion of point-light face and body stimuli. *NeuroImage, 59,* 1700–1712. http://dx.doi.org/10.1016/j.neuroimage.2011.08.073

Chapman, H. A., Kim, D. A., Susskind, J. M., & Anderson, A. K. (2009). In bad taste: Evidence for the oral origins of moral disgust. *Science, 323,* 1222–1226. http://dx.doi.org/10.1126/science.1165565

Cohen, J. (1960). A coefficient of agreement for nominal scales. *Educational and Psychological Measurement, 20,* 37–46. http://dx.doi.org/10.1177/001316446002000104

Coulson, M. (2004). Attributing emotion to static body postures: Recognition accuracy, confusions, and viewpoint dependence. *Journal of Nonverbal Behavior, 28,* 117–139. http://dx.doi.org/10.1023/B:JONB.0000023655.25550.be

Cox, T. F., & Cox, M. A. A. (1994). *Multidimensional Scaling*. London, UK: Chapman & Hall.

Dael, N., Mortillaro, M., & Scherer, K. R. (2012). Emotion expression in body action and posture. *Emotion, 12,* 1085–1101. http://dx.doi.org/10.1037/a0025737

Darwin, C. R. (1872). *The expression of the emotions in man and animals*. New York, NY: Appleton. http://dx.doi.org/10.1037/10001-000

de Gelder, B. (2009). Why bodies? Twelve reasons for including bodily expressions in affective neuroscience. *Philosophical Transactions of the Royal Society of London Series B, Biological Sciences, 364,* 3475–3484. http://dx.doi.org/10.1098/rstb.2009.0190

de Meijer, M. (1989). The contribution of general features of body movement to the attribution of emotions. *Journal of Nonverbal Behavior, 13,* 247–268. http://dx.doi.org/10.1007/BF00990296

de Waal, F. (1989). *Chimpanzee Politics: Power and Sex Among Apes*. Baltimore, MD: Johns Hopkins University Press.

Ekman, P. (1965). Differential communication of affect by head and body cues. *Journal of Personality and Social Psychology, 2,* 726–735. http://dx.doi.org/10.1037/h0022736

Ekman, P. (1994). Strong evidence for universals in facial expressions: A reply to Russell's mistaken critique. *Psychological Bulletin, 115,* 268–287. http://dx.doi.org/10.1037/0033-2909.115.2.268

Ekman, P., & Cordaro, D. (2011). What is meant by calling emotions basic. *Emotion Review, 3,* 364–370. http://dx.doi.org/10.1177/1754073911410740

Ekman, P., Sorenson, E. R., & Friesen, W. V. (1969). Pan-cultural elements in facial displays of emotion. *Science, 164,* 86–88. http://dx.doi.org/10.1126/science.164.3875.86

Elfenbein, H. A., & Ambady, N. (2002a). Is there an in-group advantage in emotion recognition? *Psychological Bulletin, 128,* 243–249. http://dx.doi.org/10.1037/0033-2909.128.2.243

Elfenbein, H. A., & Ambady, N. (2002b). On the universality and cultural specificity of emotion recognition: A meta-analysis. *Psychological Bulletin, 128,* 203–235. http://dx.doi.org/10.1037/0033-2909.128.2.203

Farb, N. A., Chapman, H. A., & Anderson, A. K. (2013). Emotions: Form follows function. *Current Opinion in Neurobiology, 23,* 393–398. http://dx.doi.org/10.1016/j.conb.2013.01.015

Feinerer, I., Hornik, K., & Meyer, D. (2008). Text mining infrastructure in R. *Journal of Statistical Software, 25,* 1–54. http://dx.doi.org/10.18637/jss.v025.i05

Fellows, I. (2012). *wordcloud* (R package version 2.2). Retrieved from http://CRAN.R-project.org/package=wordcloud

Frank, M. G., & Stennett, J. (2001). The forced-choice paradigm and the perception of facial expressions of emotion. *Journal of Personality and Social Psychology, 80,* 75–85. http://dx.doi.org/10.1037/0022-3514.80.1.75

Fridlund, A. J. (1994). *Human facial expression: An evolutionary view*. San Diego, CA: Academic Press.

Gamer, M., Lemon, J., Fellows, I., & Singh, P. (2010). *irr: Various coefficients of interrater reliability and agreement* (R package version 0.83). Retrieved from http://CRAN.R-project.org/package=irr

Gendron, M., Roberson, D., van der Vyver, J. M., & Barrett, L. F. (2014). Cultural relativity in perceiving emotion from vocalizations. *Psychological Science, 25,* 911–920. http://dx.doi.org/10.1177/0956797613517239

Gould, S. J., & Vrba, E. S. (1982). Exaptation-A missing term in the science of form. *Paleobiology, 8,* 4–15. http://dx.doi.org/10.1017/S0094837300004310

Heberlein, A. S., Adolphs, R., Tranel, D., & Damasio, H. (2004). Cortical regions for judgments of emotions and personality traits from point-light walkers. *Journal of Cognitive Neuroscience, 16,* 1143–1158. http://dx.doi.org/10.1162/0898929041920423

Hejmadi, A., Davidson, R. J., & Rozin, P. (2000). Exploring Hindu Indian emotion expressions: Evidence for accurate recognition by Americans and Indians. *Psychological Science, 11,* 183–187. http://dx.doi.org/10.1111/1467-9280.00239

Hertenstein, M. J., Keltner, D., App, B., Bulleit, B. A., & Jaskolka, A. R. (2006). Touch communicates distinct emotions. *Emotion, 6,* 528–533. http://dx.doi.org/10.1037/1528-3542.6.3.528

Izard, C. E. (2011). Forms and functions of emotions: Matters of emotion-cognition interactions. *Emotion Review, 3,* 371–378. http://dx.doi.org/10.1177/1754073911410737

Johansson, G. (1973). Visual perception of biological motion and a model for its analysis. *Perception & Psychophysics, 14,* 201–211. http://dx.doi.org/10.3758/BF03212378

Kleinsmith, A., De Silva, P. R., & Bianchi-Berthouze, N. (2006). Cross-cultural differences in recognizing affect from body posture. *Interacting with Computers, 18,* 1371–1389. http://dx.doi.org/10.1016/j.intcom.2006.04.003

Kring, A. M., & Gordon, A. H. (1998). Sex differences in emotion: Expression, experience, and physiology. *Journal of Personality and*

Social Psychology, 74, 686–703. http://dx.doi.org/10.1037/0022-3514.74.3.686

Levenson, R. W. (2011). Basic emotion questions. *Emotion Review, 3,* 379–386. http://dx.doi.org/10.1177/1754073911410743

Light, R. J. (1971). Measures of response agreement for qualitative data: Some generalizations and alternatives. *Psychological Bulletin, 76,* 365–377. http://dx.doi.org/10.1037/h0031643

Löken, L. S., Wessberg, J., Morrison, I., McGlone, F., & Olausson, H. (2009). Coding of pleasant touch by unmyelinated afferents in humans. *Nature Neuroscience, 12,* 547–548. http://dx.doi.org/10.1038/nn.2312

Manera, V., Schouten, B., Becchio, C., Bara, B. G., & Verfaillie, K. (2010). Inferring intentions from biological motion: A stimulus set of point-light communicative interactions. *Behavior Research Methods, 42,* 168–178. http://dx.doi.org/10.3758/BRM.42.1.168

Marsh, A. A., Adams, R. B., Jr., & Kleck, R. E. (2005). Why do fear and anger look the way they do? Form and social function in facial expressions. *Personality and Social Psychology Bulletin, 31,* 73–86. http://dx.doi.org/10.1177/0146167204271306

Marsh, A. A., Ambady, N., & Kleck, R. E. (2005). The effects of fear and anger facial expressions on approach- and avoidance-related behaviors. *Emotion, 5,* 119–124. http://dx.doi.org/10.1037/1528-3542.5.1.119

Marsh, A. A., Elfenbein, H. A., & Ambady, N. (2003). Nonverbal "accents": Cultural differences in facial expressions of emotion. *Psychological Science, 14,* 373–376. http://dx.doi.org/10.1111/1467-9280.24461

McDonald, J. H. (2013). *Handbook of biological statistics* (3rd ed.). Baltimore, MD: Sparky House Publishing.

Montepare, J., Koff, E., Zaitchik, D., & Albert, M. (1999). The use of body movements and gestures as cues to emotions in younger and older adults. *Journal of Nonverbal Behavior, 23,* 133–152. http://dx.doi.org/10.1023/A:1021435526134

Morrison, I., Löken, L. S., & Olausson, H. (2010). The skin as a social organ. *Experimental Brain Research, 204,* 305–314. http://dx.doi.org/10.1007/s00221-009-2007-y

Mortillaro, M., Mehu, M., & Scherer, K. R. (2011). Subtly different positive emotions can be distinguished by their facial expressions. *Social Psychological and Personality Science, 2,* 262–271. http://dx.doi.org/10.1177/1948550610389080

Parkinson, C., Kohler, P. J., Sievers, B., & Wheatley, T. (2012). Associations between auditory pitch and visual elevation do not depend on language: Evidence from a remote population. *Perception, 41,* 854–861. http://dx.doi.org/10.1068/p7225

Parkinson, C., & Wheatley, T. (2015). The repurposed social brain. *Trends in Cognitive Sciences, 19,* 133–141. http://dx.doi.org/10.1016/j.tics.2015.01.003

Peirce, J. W. (2007). PsychoPy—Psychophysics software in Python. *Journal of Neuroscience Methods, 162,* 8–13. http://dx.doi.org/10.1016/j.jneumeth.2006.11.017

R Core Team. (2013). *R: A language and environment for statistical computing*. Vienna, Austria: R Foundation for Statistical Computing. Retrieved from http://www.r-project.org/

Roelofs, K., Hagenaars, M. A., & Stins, J. (2010). Facing freeze: Social threat induces bodily freeze in humans. *Psychological Science, 21,* 1575–1581. http://dx.doi.org/10.1177/0956797610384746

Rosenthal, R., Hall, J. A., DiMatteo, M. R., Rogers, P. L., & Archer, D. (1979). *Sensitivity to Nonverbal Communications: The PONS Test*. Baltimore, MD: Johns Hopkins University Press.

Runeson, S., & Frykholm, G. (1983). Kinematic specification of dynamics as an informational basis for person-and-action perception: Expectation, gender recognition, and deceptive intention. *Journal of Experimental Psychology: General, 112,* 585–615. http://dx.doi.org/10.1037/0096-3445.112.4.585

Russell, J. A. (1980). A circumplex model of affect. *Journal of Personality and Social Psychology, 39,* 1161–1178. http://dx.doi.org/10.1037/h0077714

Russell, J. A. (1993). Forced-choice response format in the study of facial expression. *Motivation and Emotion, 17,* 41–51. http://dx.doi.org/10.1007/BF00995206

Russell, J. A. (1994). Is there universal recognition of emotion from facial expression? A review of the cross-cultural studies. *Psychological Bulletin, 115,* 102–141. http://dx.doi.org/10.1037/0033-2909.115.1.102

Sauter, D. (2010). More than happy: The need for disentangling positive emotions. *Current Directions in Psychological Science, 19,* 36–40. http://dx.doi.org/10.1177/0963721409359290

Sauter, D. A., Eisner, F., Ekman, P., & Scott, S. K. (2010). Cross-cultural recognition of basic emotions through nonverbal emotional vocalizations. *Proceedings of the National Academy of Sciences of the United States of America, 107,* 2408–2412. http://dx.doi.org/10.1073/pnas.0908239106

Sauter, D. A., Eisner, F., Ekman, P., & Scott, S. K. (2015). Emotional vocalizations are recognized across cultures regardless of the valence of distractors. *Psychological Science, 26,* 354–356. http://dx.doi.org/10.1177/0956797614560771

Scherer, K. R., & Wallbott, H. G. (1994). Evidence for universality and cultural variation of differential emotion response patterning. *Journal of Personality and Social Psychology, 66,* 310–328. http://dx.doi.org/10.1037/0022-3514.66.2.310

Shariff, A. F., & Tracy, J. L. (2009). Knowing who's boss: Implicit perceptions of status from the nonverbal expression of pride. *Emotion, 9,* 631–639. http://dx.doi.org/10.1037/a0017089

Shariff, A. F., & Tracy, J. L. (2011). What are emotion expressions for? *Current Directions in Psychological Science, 20,* 395–399. http://dx.doi.org/10.1177/0963721411424739

Sievers, B., Polansky, L., Casey, M., & Wheatley, T. (2013). Music and movement share a dynamic structure that supports universal expressions of emotion. *Proceedings of the National Academy of Sciences of the United States of America, 110,* 70–75. http://dx.doi.org/10.1073/pnas.1209023110

Sorce, J. F., Emde, R. E., Campos, J., & Klinnert, M. D. (1985). Maternal emotional signaling: Its effects on the visual cliff behavior of 1-year-olds. *Developmental Psychology, 21,* 195–200. http://dx.doi.org/10.1037/0012-1649.21.1.195

Susskind, J. M., Lee, D. H., Cusi, A., Feiman, R., Grabski, W., & Anderson, A. K. (2008). Expressing fear enhances sensory acquisition. *Nature Neuroscience, 11,* 843–850. http://dx.doi.org/10.1038/nn.2138

Tracy, J. L., & Matsumoto, D. (2008). The spontaneous expression of pride and shame: Evidence for biologically innate nonverbal displays. *Proceedings of the National Academy of Sciences of the United States of America, 105,* 11655–11660. http://dx.doi.org/10.1073/pnas.0802686105

Tracy, J. L., & Randles, D. (2011). Four models of basic emotions: A review of Ekman and Cordaro, Izard, Levenson, and Panksepp and Watt. *Emotion Review, 3,* 397–405. http://dx.doi.org/10.1177/1754073911410747

Tracy, J. L., & Robins, R. W. (2004). Show your pride: Evidence for a discrete emotion expression. *Psychological Science, 15,* 194–197. http://dx.doi.org/10.1111/j.0956-7976.2004.01503008.x

Tracy, J. L., & Robins, R. W. (2007). Emerging insights into the nature and function of pride. *Current Directions in Psychological Science, 16,* 147–150. http://dx.doi.org/10.1111/j.1467-8721.2007.00493.x

Tracy, J. L., & Robins, R. W. (2008). The nonverbal expression of pride: Evidence for cross-cultural recognition. *Journal of Personality and Social Psychology, 94,* 516–530. http://dx.doi.org/10.1037/0022-3514.94.3.516

Tracy, J. L., Shariff, A. F., Zhao, W., & Henrich, J. (2013). Cross-cultural evidence that the nonverbal expression of pride is an automatic status signal. *Journal of Experimental Psychology: General, 142,* 163–180. http://dx.doi.org/10.1037/a0028412

Van Dyck, E., Maes, P. J., Hargreaves, J., Lesaffre, M., & Leman, M. (2013). Expressing induced emotions through free dance movement. *Journal of Nonverbal Behavior, 37,* 175–190. http://dx.doi.org/10.1007/s10919-013-0153-1

Venables, W. N., & Ripley, B. D. (2002). *Modern applied statistics with S*. New York, NY: Springer. http://dx.doi.org/10.1007/978-0-387-21706-2

Wallbott, H. G. (1998). Bodily expression of emotion. *European Journal of Social Psychology, 28,* 879–896. http://dx.doi.org/10.1002/(SICI)1099-0992(1998110)28:6<879::AID-EJSP901>3.0.CO;2-W

Zaki, J., Bolger, N., & Ochsner, K. (2008). It takes two: The interpersonal nature of empathic accuracy. *Psychological Science, 19,* 399–404. http://dx.doi.org/10.1111/j.1467-9280.2008.02099.x

Received April 21, 2015
Revision received March 17, 2016
Accepted April 3, 2016 ■