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Darwin proposed and Ekman and Izard confirmed the presence of cross-cultural regularities in facial displays of emotion. Following their work, the author and his colleagues sought to find parallel mechanisms that would permit these displays to be decoded. A cross-cultural comparison of the display of anger and happiness in masks used in ritual social functions revealed that a set of geometric patterns, rather than actual facial features, conveyed these different emotional meanings. The power of nonrepresentational visual patterns to produce meaning was examined in a series of studies using materials that presented geometric shapes in a variety of line drawings, large-scale physical movement in classical ballet, and configurations among individuals in 17th-century Dutch art. Results across all studies suggested that for the emotions of anger and happiness, at least, meaning is carried in the geometric properties of the visual display.

Keywords: *emotion expression; emotion recognition; Darwin; Ekman; multimethod; sign stimuli*

It is nearly a century and a half since Darwin (1872/1998) proposed that facial displays of emotion took similar form in all people,

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across all cultures. His proposal stimulated vast bodies of research and theory debating the form and the source of emotional expression. Now, addressing an ever-expanding range of questions with an ever-increasing methodological capacity, this research nests Darwin's hypotheses within the new field its proponents call "affective neuroscience" (e.g., Davidson, Scherer, & Goldsmith, 2003; Panksepp, 1998). To examine this proposition empirically, a series of studies in a number of Western cultures (e.g., Ekman, 1971; Izard, 1971) demonstrated that human beings display their emotional states through similar facial configurations. In addition, Ekman (1971) showed that members of two nonliterate New Guinea cultures (i.e., Dani, Fore), who were unacquainted with written or photographic materials, were able to recognize accurately human facial expressions of a range of emotions presented in photographs (see Ekman, 2003, for a discussion of these studies).

A major research effort, resting on this work, examined the specific features, or "sign vehicles" (Ekman, 1982), that compose the facial display of a particular emotion. My colleagues and I were drawn to the less frequently studied question of how observers recognize emotion. We wondered if there might be a parallel set of feature detectors located in the brain that observers use to decode the display. This article reviews our efforts to use multiple methods, drawn from multiple fields, to explore the possibility that there are sets of innate appraisal mechanisms, or "autoappraisers" (Ekman, 2003), that permit observers to recognize a particular emotion that is being experienced by another person.

Our initial study sought to identify the sign vehicles that draw the observer's attention in a display of anger, reasoning that it would be of benefit to the person to recognize speedily that it faces danger from another (Hansen & Hansen, 1994; Lundqvist & Ohman, 2005). In this study, we wanted to identify the sign stimuli that are most commonly used to indicate that a display of anger is present by examining facial representations in which a diverse, cross-cultural sample of humans use specific sign stimuli (such as the orientation of the eyebrows) to convey threat, expecting that

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these representations would suggest the type of feature detectors used to decode the emotional display. To our surprise, our first study indicated that the overall geometric configuration provided by the facial features, rather than individual features, was how a culture defined the emotional representation. This unexpected result required a major change in the hypothesis, and our subsequent work sought ways to examine the emotional properties of visual configurations that could be examined, as much as possible, apart from visual patterns formed by facial features.

STUDY 1: THE REPRESENTATION OF THREAT IN FACIAL DISPLAYS

We sought a cross-cultural medium from which to determine which aspects of the emotion display are seen as most salient (Aronoff, Barclay, & Stevenson, 1988). Considering how difficult it is to obtain comparable data on emotional expression from a number of non-Western cultures, Mead (1955) suggested that the artwork of a culture, especially masks representing intense facial expressions used in dramatic public functions, are an accessible source of evidence to study species-specific factors in emotional displays. The facial expressions presented in masks are widely used to evoke highly specific responses in members of an audience, focus attention on specific facial elements from among the many stimuli that compose a human face, and permit the study of facial configurations with known social meaning as defined by members of that culture. Aronoff et al. (1988) expected that within each of a diverse set of cultures, masks used to convey threat would more frequently use the components of (previously identified) threatening facial displays than would masks used to convey positive emotions.

The details of this and other studies to be reviewed are provided in the original publications. Here, only enough of the method and results are presented to make the conclusions of that study understandable.

THREAT CHARACTERISTICS SCALE

To identify the facial characteristics that convey threat in plastic representations, students at two universities in the United

States were asked to "imagine that you are a New Guinea headhunter and are about to go off on an expedition. Please draw the mask that you want to wear in order to frighten your victims into surrender." After these drawings were collected, students were asked to imagine that they were about to go off to a courtship dance. "Please draw the mask you want to wear to win the heart of your beloved." Features selected for the Threat Characteristics Scale (Aronoff et al., 1988) from those present in these drawings were those that characterized anger in photographs and descriptions of angry facial movements (i.e., Ekman & Friesen, 1978; Izard, 1971) or equivalent artistic representations of such shapes. The items that compose this scale are presented in Table 1. As expected, students' frightening drawings contained significantly higher levels of these characteristics than did courtship drawings, with mean threat scores of 6.49 and 2.54, respectively, $F(1, 79) = 196.51$, $p < .001$.

DATA COLLECTION AND SCORING PROCEDURE

Masks of known threatening or nonthreatening social function were obtained from museum and bibliographic sources and were included in the sample if (a) the society traditionally used masks in important social functions, (b) the ethnography was clear enough to identify the social function of each mask, (c) masks of the aged were not included in order not to score wrinkles, (d) the masks were made only of wood, and (e) there were at least 10 threatening and 10 nonthreatening masks available for that society. It was surprisingly difficult to determine the social function of the many masks that we were able to obtain. We were able to get a complete set of masks for eight cultures but only partial samples for the remaining nine cultures that we had originally identified. Therefore, a mixed sample was created from the qualifying masks that came from societies not reaching the criterion of 10 masks of each type. Photographic slides of the masks were made, and coders, working independently, projected the slides from one culture at a time onto a screen and coded for the appearance of each of the threatening signs. The total number of threatening signs was taken to be the index of the amount of threat present in each mask.

TABLE 1
Proportion of Appearance of a Threatening Characteristic in Threatening and Nonthreatening Masks Across All Cultures

Threatening Characteristic	*Threatening Masks*	*Nonthreatening Masks*	χ^2
Horns or pointed head	31.84	8.54	33.80***
Disheveled hair	16.05	8.78	4.84*
Lines on forehead	61.05	32.68	31.92***
Pointed ears	7.10	3.17	3.18*
Top of head flat	16.84	9.51	4.67*
Eyebrows oriented down and in toward nose	23.68	11.95	9.36*
Vertical lines between eyebrows	56.32	26.34	36.69***
Triangular nose (flared nostrils)	30.79	10.73	24.45***
Eyes oriented down and in toward nose	13.95	4.88	9.68**
Protruding or triangular eyes	54.74	13.90	73.76***
Diagonal cheekbone lines (oriented down and in toward nose)	22.89	13.90	5.25*
Diagonal cheek lines (oriented down and away from nose)	28.95	13.66	13.89***
Moustache	29.47	20.49	4.27*
Mouth as a downward curve	20.53	10.98	6.84**
Mouth open and showing teeth	48.94	9.76	74.16***
Several lines on chin	20.26	8.05	12.27***
Pointed chin	15.26	22.68	3.51*
Pointed beard	17.63	6.10	12.75***
Other projections from face	36.58	3.17	70.83***

SOURCE: From "The Recognition of Threatening Facial Stimuli," by J. Aronoff, A. M. Barclay, and L. A. Stevenson, 1988, *Journal of Personality and Social Psychology, 54*, pp. 647-655. Copyright 1988 by the American Psychological Association. Reprinted with permission.
*$p < .05$. **$p < .005$. ***$p < .0005$.

RESULTS

For the sample as a whole, there was a highly significant main effect for type of display, $F(1, 285) = 216.36, p < .001$. Furthermore, each culture, examined individually, revealed a similar difference. Finally, the ability of each of the stimuli to discriminate between threatening and nonthreatening displays was examined. The proportion of the masks of each type that contained each characteristic was examined with the chi-square test. Table 1 presents the results of this examination, which indicated that 18 of 19 characteristics discriminated significantly between the two types of masks.

DISCUSSION

The cross-cultural confirmation of the sign stimuli identified for the Threat Characteristics Scale suggests that the recognition of a threatening display rests on a biological foundation vested somewhere in the neuromuscular system. Thus, another pancultural hypothesis confirmed! However, a serious problem keeps us from simply relating these sign stimuli to facial features. Although some of these signs are a direct expression of the changes observed in a human face when angry (e.g., eyebrows drawn together in a downward direction), ears on a human head do not become more pointed, the head does not become flat, nor does the beard develop multiple points. Recognizing that such changes are impossible gives us a much more parsimonious way to characterize this hypothesis. Rather than postulating that a large array of signal detectors in the brain are isomorphic to each of the facial features (for anger and other emotions), it is possible that a few geometric shapes, specifically, the characteristics of angularity and diagonality, carry the subjective meaning of threat in the display conveyed to an observer. Furthermore, although not examined in this study, we note that curved lines appeared less often when comparing threatening to nonthreatening masks.

A fascinating experiment by Bassili (1978) encourages the view that the appearance of an emotional facial display creates a larger geometric pattern. Bassili put luminescent dots on people's faces and, in a dark room, asked them to put on a happy and an angry facial expression. In the happy demonstration, a burst of points of light expanded outward to form a rounded shape. In the angry demonstration, the luminescent dots imploded down and in, forming a *V* shape.

STUDY 2: ANGULARITY AND DIAGONALITY IN THREATENING DISPLAYS

The drawings made in Study 1 by university students were examined to investigate the hypothesis that representations of threatening facial features use angular and diagonal patterns (Aronoff et al., 1988). In these drawings, such patterns are conveyed primarily by triangular forms and diagonal lines. Therefore, coders counted the number of triangles used to construct the features of the face (i.e., a triangular nose, tooth, or ear) as well as the

number of diagonal lines drawn that were not already used in forming a triangle (to avoid double counting). The mean number of triangles used in the threatening drawings was 6.61, compared to 1.68 used in the intimate drawings, $F(1,79) = 25.58$, $p < .001$, and the number of diagonal lines was 13.10, compared to 5.58, $F(1,79) = 20.39$, $p < .001$, for these two types of drawings, respectively. Thus, this pilot study indicates that these two types of geometric forms constitute significant information that conveys the meaning of threat in facial displays and possibly more broadly in other nonfacial objects, as well.

STUDY 3: THE SUBJECTIVE MEANING OF ANGULARITY AND DIAGONALITY

The next step in this research series was to show that different geometric shapes yield very different subjective responses (Aronoff et al., 1988). Visual configurations have drawn considerable attention since Lorenz (1943) suggested that the physical configuration of babies releases care-giving behavior in adult observers. A wide-ranging exploration of the physiognomic properties of infants and adults, reviewed by Zebrowitz (1998), shows that the babyishness (or more rounded property) of a human face is seen as more cute and more attractive and evokes protective attraction responses in the observer. Often in this work, authors (e.g., McArthur & Baron, 1983) suggest that such subjective reactions rest on a biological mechanism that developed to ensure speedy identification of the intentions of others. In light of this converging pattern of evidence, we hypothesized that diagonal lines and acute angles would elicit subjective emotional responses associated with threat, in comparison to the more positive emotional response evoked by curved or straight lines.

STIMULUS MATERIALS

Ten features common to the threatening displays but without obvious representation of actual facial features were selected for examination from Study 1's results. These were visual patterns without obvious denotative meaning (i.e., two right triangles). For each stimulus, a comparison pattern, matched for locus on the face and complexity of the pattern, was selected from among the

nonthreatening displays. These stimuli are presented in Figure 1, and each of these patterns presented angular, diagonal, or curved forms in a variety of ways.

RESPONSE SCALES

Twenty adjective pairs (e.g., bad and good, weak and strong, passive and active) were selected to reflect the robust subjective dimensions of evaluation, potency, and activity so well confirmed in the work using the semantic differential test (Osgood, Suci, & Tannenbaum, 1957). These word pairs were arranged as 7-point semantic differential scales.

STIMULUS PRESENTATION

A single visual stimulus was reproduced at the top of a page, with the semantic differential scales arranged on the page below. We used this format to create a booklet with a separate page for each of the 20 stimuli. Undergraduate students examined the stimulus display at the top of a page and provided their subjective rating on the semantic differential scales below.

RESULTS

Factor analysis of the data reproduced the three semantic differential scales, and analyses of the three resulting composite scales revealed highly significant main effects for threat level on each of the three scales, $F(1, 198) = 422.07$, 304.44, and 185.79, $p < .0005$, for evaluation, potency, and activity, respectively. In this analysis, the hypothesized threatening stimuli displays (as compared to their nonthreatening counterparts) were perceived as significantly less positive (3.78 vs. 4.63), more potent (4.60 vs. 3.97), and more active (4.64 vs. 3.99). Furthermore, simple effects tests for the comparison of each threatening and nonthreatening stimuli comparison showed the same effect on nearly all comparisons, across all scales. This result was particularly strong when a straight line, presented diagonally or angularly, was compared with a curvilinear pattern oriented along the major axes.

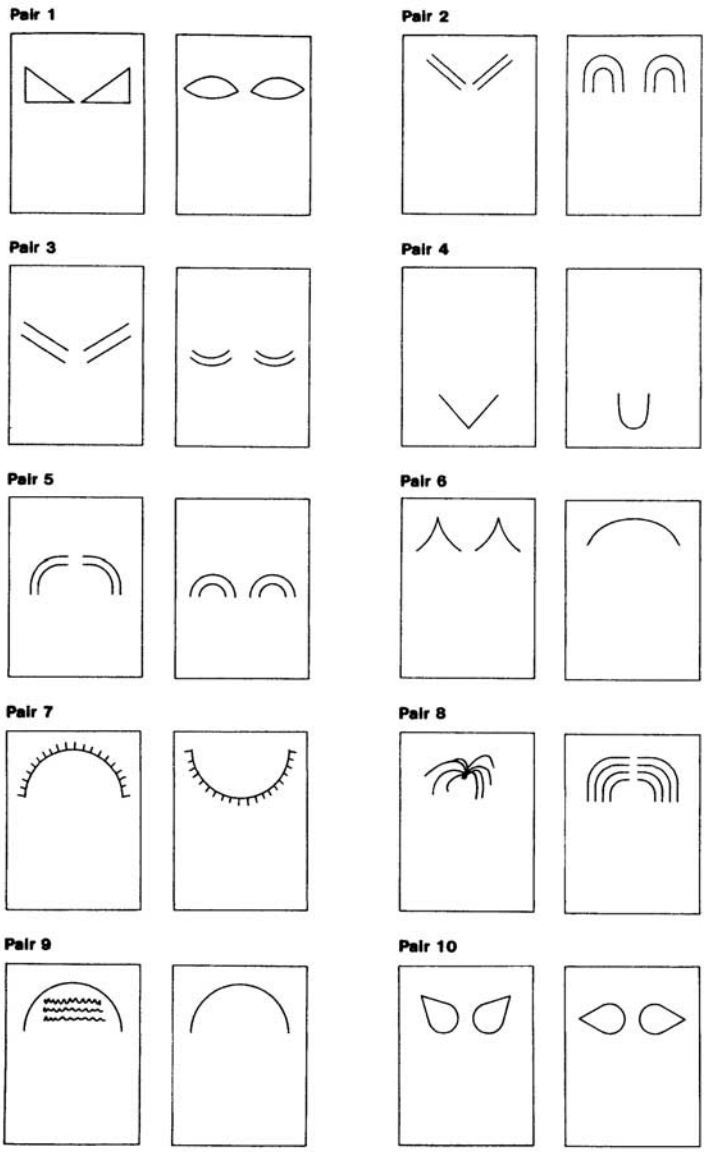

Figure 1: Pairs of High and Low Threatening Stimulus Displays
SOURCE: From "The Recognition of Threatening Facial Stimuli," by J. Aronoff, A. M. Barclay, and L. A. Stevenson, 1988, *Journal of Personality and Social Psychology*, *54*, pp. 647-655. Copyright 1988 by the American Psychological Association. Reprinted with permission.
NOTE: The more threatening stimulus of a pair is presented on the left.

DISCUSSION

This study was our first effort to separate the geometric shapes created by facial features from the representations of the features themselves. Across the many forms used in Study 3, the more angular or diagonal pattern evoked a more negative, potent, and active construal than did the curvilinear pattern. These visual configurations are quite different from the information that is customarily understood to convey the meaning of threat: eyebrows that are drawn down together, threatening gestures, or angry words. Study 3's results are interesting because they demonstrate that visual stimuli that are presumably content free also possess the power to convey meaning to observers.

It is intriguing to consider whether certain articles of clothing, such as eyeglasses with diagonal orientations, or pointed beards may be used to convey a sense of danger to the observer. It is exciting to hypothesize that studies (Efron, 1972) that contrast the angular hand movements of members of one ethnic group with the curvilinear gestures of another may have identified another nonverbal channel to evoke the same subjective meanings as are elicited by the facial presentations of these geometric patterns. Much further afield, we may wonder if artists and architects use the visual configurations found in facial displays to produce similar subjective responses in their audiences (Burgoon & Saine, 1978).

Simple visual line displays, physical objects, and body gestures seem distant from a facial display, yet it is useful to consider why angular and diagonal configurations have the same capacity to evoke discomfort as facial features. These questions focus attention on a central mechanism that may underlie at least this aspect of emotion recognition. Although highly speculative, it seems far more parsimonious to search for a single central mechanism that is associated with a feature common to many components of a facial display, as well as parallel configurations in nonfacial stimuli, than it is to expect that an array of signal detectors identify the separate components of a facial display.

STUDY 4: GEOMETRIC PATTERNS IN HUMAN MOVEMENT ENCODE AFFECT-BASED MEANING

It is difficult to represent the shape of a facial feature without conveying simultaneously the feature itself. In a search for an emotionally rich domain in which this problem can be avoided, we sought to follow the pioneering work of Efron (1972) and examine whether the precisely defined movement patterns that appear in classical ballet use angular and diagonal spatial forms to convey the meaning of threat and use rounded spatial forms to convey the meaning of affection and warmth (Aronoff, Woike, & Hyman, 1992).

Such movement patterns are ideally suited to provide a confirmatory test of our hypothesis. The visual configuration is unrelated to actual facial expressions, takes a natural rather than a schematic form, encodes clear, affect-related meanings, and produces significant cognitive and emotional reactions in members of the audience. The story of a ballet typically describes events taken by individuals whose character is clearly delineated (e.g., young lovers, evil sorcerers, good fairies, restricting mothers, noble kings and queens). We suggest that differences in movement patterns between characters with such clearly articulated purposes is comprehensible because the movement patterns themselves hold clear meanings to the observers.

Physical movements in classical ballet provide information through three very different means: static poses, signals produced by the shape of the arms, and kinetic patterns shaped by the entire human body as it moves through space. In most static poses the dancer ceases movement and assumes a position that ranges from the vertical to a steeply diagonal display. In addition, a strikingly round image is produced in the arabesque pose, in which the dancer stands on one leg with the other leg extended backward in ways that shape the whole body into a single curved figure. A second source of geometric information is provided by the arms, which are continuously shaped into precisely delineated shapes. These displays seem to function as a separate signal system in which the arms can be extended outward into a linear shape or, by bending them at the elbow and turning the hands in or out, can create a

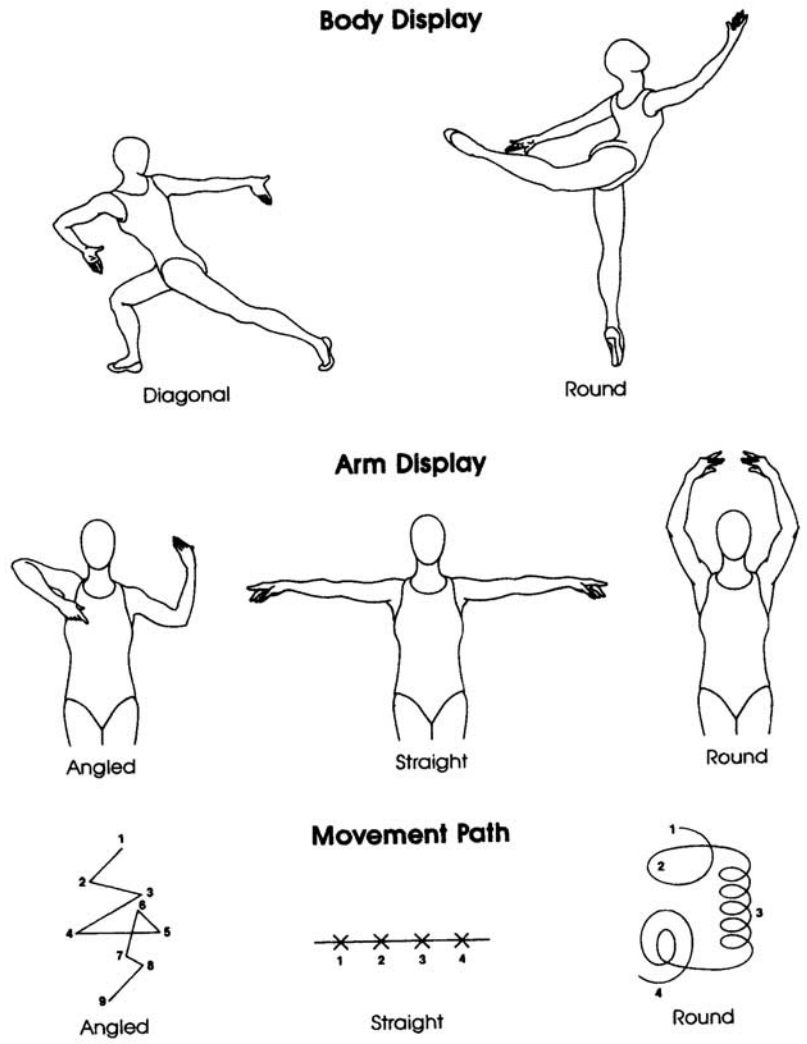

Figure 2: Visual Configurations in Human Movement
SOURCE: From "Which Are the Stimuli in Facial Displays of Anger and Happiness? Configurational Bases of Emotion Recognition," by J. Aronoff, B. A. Woike, and L. M. Hyman, 1992, *Journal of Personality and Social Psychology*, *62*, pp. 1050-1066. Copyright 1992 by the American Psychological Association. Reprinted with permission.
NOTE: Each number indicates the point of a major characteristic act.

round or angular shape. Finally, the body traces a round, straight, or angular shape as it moves through space. These configurations are illustrated in Figure 2. Thus, in Study 4, we expected, in

comparing the configurations presented by threatening or warm characters, that threatening characters would use poses that are more steeply diagonal, arm displays that are more angular, and movement sequences that are more angled, whereas warm characters would use more rounded poses, more round arm displays, and more round movement configurations.

METHOD

Videotapes of classical ballet performances were obtained from public sources and screened to find characters that could meet the attributes outlined on the semantic differential scales for evaluation (e.g., good or bad) as described in the published story for the ballet. Threatening characters were those described as unpleasant, cruel, or destructive (e.g., Lizzie Borden, Caliban, Cinderella's stepsisters, Macbeth), whereas warm characters were those portrayed as happy, affectionate, or helpful (e.g., Juliet, Prospero, Giselle, Apollo). All instances of solo dancing that lasted at least 20 seconds was transferred to a coding tape, with sections of mime, group dancing, duets, and ordinary movement excluded. Coders were trained to score the tape for each of the types of display using different instruments as needed for each category, and the sound was always turned off to not influence the coding of the visual display. The angle of poses was determined by a coder stopping the tape at each pose and measuring the angle of the body with the use of a TV protractor devised for this purpose. Each instance of static and moving arabesque configurations was counted by another set of coders. Coders obtained the duration of a display by depressing a recording key during the appearance of the target display: angled, straight, or round arm and movement patterns as shown in Figure 2.

RESULTS

Because our predictions were the same for all dependent measures, we thought to determine if there was an underlying commonality between measures by performing a preliminary factor analysis to group the variables. Two factors emerged from this analysis: one represented static signals, and the other represented kinetic signals. We tested our hypothesis using multivariate analysis of variance (MANOVA) on each of the separate factors, an

overall MANOVA, and separate analysis of variance on each of the variables. Each of these tests provides striking support for the hypothesis. Although a close examination of the details of the differential use of these displays (as presented in the original report) will give a more full picture of how behavior displays (along with costume, music, and story) are used by the choreographer to define character, we can summarize these results by noting that roundedness (and lessened diagonality and angularity) was strongly associated with warm characters, whereas the reverse display was strongly associated with threatening characters.

Note that the configuration-meaning associations that were found in representations of facial displays have now been found to be present in the large-scale movement patterns formed by whole bodies in nonexperimental, ongoing, natural human experience. The weakness of studying natural movement is the same as that of studying the natural appearance of facial expressions: There are so many stimuli present, in so many degrees and combinations, that it is difficult to find precisely the stimuli that provide meaning to the observer. That task requires a different method, which was used in the next study.

STUDY 5: TESTS OF THE EMOTIONAL RESPONSES TO THE COMPONENTS OF A STIMULUS

The ethologists (cf. Eibl-Eibesfeldt, 1989), using arrays of models of naturally occurring features of an organism's environment, taught us how to decompose situations into the precise stimuli that carry information that elicits a class of behavior. In three related true experiments, we followed this method to vary some of the most important geometrical features that are present in a human facial expression in a way that isolates the visual pattern from an ordinary facial display (Aronoff et al., 1992).

In the first of these experiments, we examined the capacity of diagonality and roundedness to convey the subjective meaning of threat and warmth. As before, we made up booklets of pages on which we presented a stimulus at the top of a page, followed by semantic differential scales below. In this visual series, we crossed 4 degrees of diagonality with 4 degrees of roundedness to see if mere reduced curvilinearity and increased diagonality would be seen as more bad, more powerful, and/or more active.

The results from this apparently simple experiment targeting specific features of complex configurations that we had examined in the previous studies were not at all simple. Results for diagonality were only marginally positive ($p < .07$) for badness, which had been the primary finding in previous studies, although results were robust ($p < .001$) for the dimensions of potency and activity. Results for roundedness showed a strong confirmation for the dimension of goodness, but we were surprised that the more round figure was seen as more powerful. This surprising pattern of results led to a much better understanding of the potential character of the autoappraisers that might underlie these effects.

Two subsequent studies were done using the same technique. First, simple inspection of the forms showed that the more rounded figure is also a larger form. Unfortunately, in constructing the shapes for this study, we were attentive to the height of the figures but not to the magnitude of the area within the ellipse. Thus, we had inadvertently confounded shape with size. To remedy this error, we conducted another experiment in which we were able to test the effect of roundedness while holding the area of the form constant. The results of this experiment were clear: A more rounded form is more good and less active for both, but it is not more potent. This error provided data on a question that we had not asked. Perhaps there is an autoappraiser that associates magnitude with potency. Perhaps that autoappraiser is related to the experience of looming. This possibility will be examined in greater detail in future studies.

The marginal result for diagonality is far more interesting. Perhaps a diagonal line is not as simple a stimulus as we had thought, especially when we consider that the face is a symmetrical structure. For example, it may be seen as one arm of an acute angle. The changes in the human face (Ekman & Friesen, 1975) show a variety of symmetrical diagonals that together create *V*-shaped forms in a number of facial areas. Perhaps the autoappraiser is more precisely designed to respond to a *V*-shaped figure? True experiments, which use models to isolate the different aspects of a facial movement, are the most appropriate tool to determine the precise sign vehicles involved. The next experiment completed this series by asking, what is the stimulus in a diagonal form, and what information about threat does it convey?

Following the same procedures as before, the third experiment in this series sought to deconstruct the *V*-shaped figure by creating an array of comparison figures that represent its component parts:

a *V*-shaped figure (the hypothesized sign stimulus), a diagonal line (to test the effect of diagonality vs. angularity), two parallel diagonal lines (to test the effect of two diagonals that do not create an acute angle), a single and a double vertical line (to establish the base against which to test for diagonality), and finally, a *V*-shaped figure pointed upward (to test for the orientation of the acute angle). To increase the range of models derived from the human face, we drew these figures both as lines and as narrow ellipses (see Figure 3). We expected to find that the subjective responses to threat would be greatest for the *V*-shaped figure.

We can summarize the results by saying that the test comparing the round shapes with the linear shapes showed that the more rounded (a line vs. a narrow ellipse) shapes were seen as more good and less active but did not show an effect for potency. The test of the hypothesis, that threat would be conveyed by an acute angle with a downward-pointing vertex (as in the movements of the human face), was examined through an orthogonal contrast, in which this shape is compared with all other configurations. In the most important test, for badness, the *V*-shaped figure was significantly more bad than all the other figures. It was interesting that this figure was not seen as more potent. Rather, figures made of two lines were seen as more potent than figures composed of single lines. In other words, the magnitude effect seen before was replicated. For activity, there seems to be a magnitude and a diagonality effect but no effect for an acute angle. These results also pull out just that aspect of an object that evokes an experience of badness, as compared to the components that may control responses to other forms. But the main point is clear: Models that decompose a shape into its component parts allow us to confirm the emotional meanings that are produced by the sign stimuli that underlie a wide variety of human activity.

STUDY 6: THE CONFIGURATIONAL STRUCTURE OF HUMAN GROUPS IN 17TH-CENTURY DUTCH ART

The geometric shapes that we have reviewed, drawn from the movement of the human face as it experiences anger or happiness (Bassili, 1978), appear to have the power to control affective reactions without employing the signs that we customarily use to convey emotional meanings. These shapes underlie much of the

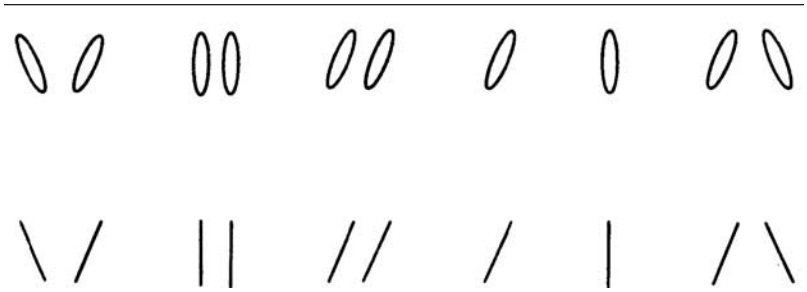

Figure 3: Deconstructing the V-Shaped Figure
SOURCE: From "Which Are the Stimuli in Facial Displays of Anger and Happiness? Configurational Bases of Emotion Recognition," by J. Aronoff, B. A. Woike, and L. M. Hyman, 1992, *Journal of Personality and Social Psychology*, *62*, pp. 1050-1066. Copyright 1992 by the American Psychological Association. Reprinted with permission.

design of all objects, whether they are eyeglasses, furniture, automobiles, jackets, packages, dogs, fonts, buildings, or city plans. In fact, it is commonplace to speak of emotionally warm or inviting chairs or threatening or uncomfortable buildings. The next step in this program was to determine if such hypothesized autoappraisers affect the judgment of broad configural stimuli as they appear in large-scale arrangements of people, places, and things (Aronoff, 2005). Such a study could have been performed using any of the above objects. The area of 17th-century Dutch art was chosen because of the range of scenes and the ease of determining the emotional import of the groups of individuals. Most of the large configurations of stimuli (e.g., dogs) listed above do not come with labels describing their emotional message, and other groupings (e.g., buildings) have multiple purposes that combine different intentions. Still other sets of objects are rare or unique (e.g., city plans). The great art from 17th-century Netherlands often has intense emotional and moral purposes with an established consensus of meaning, both in that period and in the present. And sufficient examples survive to provide an adequate sample for study.

Our hypothesis for configurations formed by groupings of objects is the same as that offered for simple shapes: Threatening configurations take meaning from diagonal and angular forms with low levels of curved lines, whereas happy and intimate configurations take meaning from curved forms with reduced levels of diagonal and angular forms. The study followed simple decision rules: All the books on this period in the Michigan State University art library were examined, and paintings were selected for

inclusion in the sample if they had a color reproduction of at least a half page that represented a group of two to six people in an indoor scene of ordinary life (i.e., no portraits, religious scenes, landscapes, cities, or oceans), with no more than two paintings by the same artist and with a clear statement in the text accompanying the painting that it represented a threatening or happy scene. In general, the scenes represented intimate moments, angry exchanges, drunken orgies, brothel transactions, musical interactions, and games. Threatening and warm examples were found for nearly all types of scene. A color copy of each painting in the sample was made, and the visual configuration that was formed by the physical relationship among the actors involved in the painting was scored on three dimensions.

The major test of the hypothesis was performed by constructing a continuum of shapes made by the major actors in the scene, which included (a) a *V*-shape configuration (see Figure 4) made by characters who were close together at the bottom of the scene but tilted outward so that they were far apart at the top, (b) a set of parallel diagonal figures or multiple figures that were tilted in all directions, (c) a more neutral arrangement in which the actors were vertical, (d) a scene in which one person was vertical, with the other person leaning inward, and (e) the opposite pole to (a), formed by figures that leaned in toward each other to form an overall curved pyramidal shape (see Figure 5). As Figure 4 shows, the female character on the left leans outward from her toe to the top of her head to form one side of the *V*, and the right arm of the male character creates the other diagonal to complete the *V* shape between them. In Figure 5, the overall rounded shape is formed by the outline of the three characters leaning in toward each other. In a second test of the geometrical hypothesis, we counted the number of round objects (e.g., hats, ruffs or collars, draped clothing) that a scene contained, and in a third test, we counted the number of diagonal objects (e.g., tilted legs, arms, or heads) a scene contained. Note that the third test (on diagonality) replicates the pilot examination performed on undergraduate student drawings presented in Study 2 but now uses the work of masters such as Rembrandt, Vermeer, ter Borch, and Steen. The results of these tests were robust and showed the expected differences well beyond $p < .005$ in all categories.

The method used in this study is helpful because it allows us to broaden the stimuli previously found to affect emotional meaning to large-scale configurations formed by sets of objects and people.

Figure 4: Outline of *The Card Players* by Cornelis de Man

The use of a particular form of artistic expression, such as 17th-century Dutch art, has the disadvantage, of course, of being complexly determined by other modalities, meanings, transient styles, arbitrary conventions, and commercial pressures. But the fact that the emotional meanings conveyed by the arrangement among sets of people parallel those obtained from ritual masks, baby faces, undergraduate student facial expressions, line drawings of simple geometric forms, and body movement patterns in classical ballet suggests that the primary geometric features of roundedness,

Figure 5: Outline of *Glass of Lemonade* by Gerard ter Borch

linearity, diagonality, angularity, and magnitude make a substantial contribution to the understanding of emotional meaning. The totality of these converging results leads away from an explanatory mechanism vested in cultural conventions or in single-feature detectors directly linked to facial structures; rather, it directs us

toward some broad biological mechanism that prepares the individual to recognize these emotional expressions. However, to come closer to examining the mechanism that Darwin proposed requires a very different kind of method.

PROPOSED STUDY 7: THE AUTOAPPRAISER

Ekman (2003) writes vividly about our ability to recognize aspects of emotional expression speedily and without cognitive elaboration. It is reasonable to assume that some form of biological preparedness is elicited by the perception of a facial expression. To explore a mechanism that might underlie the recognition of angry and happy emotional expressions, it is necessary to find a means to examine biological mechanisms directly. Until recently, this step was thought to be possible only at some future time. In the past 10 years, a new science, called affective neuroscience by its proponents, is beginning to reveal which parts of the brain are involved in experiencing and decoding emotion displays. It is exciting to think of how to use the functional Magnetic Resonance Imaging laboratory to explore the geometric patterns that are related to subjective meaning just as these laboratories are examining which part of the brain responds to angry, fearful, disgusted, or happy facial expressions. Imagine asking people to view a horizontal line that morphed into a circle and returned to a horizontal line that then morphed into an acute angle and being able to track the involvement of the different parts of the brain that are known to respond to facial representations that express anger or happiness. The more direct examination of these mechanisms is needed and is possible, and these studies are now being prepared.

A GENERAL COMMENT

These days, assisted by an evolutionary worldview, we find it easy to propose biological bases for a wide variety of functional relationships. But in each field, we find the same dilemma: Universal principles are easy to propose but hard to examine and even more difficult to validate. When examining such propositions, it is even more helpful than usual to triangulate on a problem, to address the limitations inherent in any method with the strengths

available from another (Crano, 1981; Rohner, 1975). This article has sought to illustrate an approach to studying universality in expressive culture. We first explored Mead's creative solution to the difficulty of obtaining adequate cross-cultural samples of expressive behavior; our results indicate that her approach is a feasible way to study topics of very broad interest. Furthermore, we have tried to show the value in triangulating methods to better understand a problem. In the case of emotion expression and recognition, all work needs to begin with the actual movements of the face of a person experiencing an emotion, it needs to obtain results from disparate cultures, and finally, recognizing that the situations in which all human experience takes place are too complex to permit us to grasp variables precisely, we need to be ready to use experimental means in noncomparative contexts to examine parts of the processes thought to be at work. In the case of emotion recognition, as we use multiple methods to amass information on different aspects of the problem, we must also keep in mind at all times the actual movements of the human face as our methods become more refined and our theories become more abstract.

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