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BRIEF REPORT

Facial Expressions of Emotion: Does the Prototype Represent Central Tendency, Frequency of Instantiation, or an Ideal?

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Two studies examined what prototypes of expressions of emotion represent: similarity to central tendency (CT), subjective frequency of instantiation (FI) as a category member, or judged suitability to express the respective emotion (ideal). Indices of typicality, FI, CT, and ideal were obtained by having separate groups of participants rate each of the 5 (emotions) × 5 (intensities) computer-generated drawings of facial expressions. Partial correlations revealed that ideals, and not FI or CT, explained most variance in judged typicality, indicating that expressions of emotion are goal-derived categories rather than common taxonomic categories. Furthermore, results showed that typicality and ideal are each linearly related to expression intensity, and that judged frequency tends to be highest for moderate intensity expressions.

Certain configurations of facial muscle contractions are widely regarded as *prototypical expressions* of a few basic emotions, in particular happiness, sadness, fear, anger, disgust, and surprise (e.g., Ekman & Friesen, 1975, 1978; Izard, 1997). For example, widely opened eyes, raised eyebrows, and a gaping mouth are considered to constitute the prototypical expression of surprise. Generally, the proposed prototypes are near to the *maximum* expression normal people could make, and some authors have already criticized their exaggerated nature (Fridlund, 1994; Russell, 1994).

If certain facial expressions are prototypes, the question arises as to what determines their typicality? Barsalou (1985) showed that the graded structures of *common taxonomic categories* (e.g., "birds") and *goal-derived categories* (e.g., "foods to eat on a diet") are influenced by different variables. *Graded structure* refers to the fact that examples within categories differ in their degree of typicality. The typicality of members of common taxonomic categories is determined predominantly by (a) their similarity to the *central tendency* of the category and (b) their *frequency of instantiation* as a category member. For example, a robin may be judged as typical for the category of birds because its features (e.g., size, color, vocal behavior) are near the average (for dimensional features) or the modal value (for categorical features) of the distribution formed by all birds. Furthermore, birds that are interpreted frequently as "birds" (e.g., sparrows) are also perceived as better members than infrequently encountered ones (e.g., ostriches). In contrast, good examples of goal-derived categories are generally less similar to the central tendency of their category than to an extreme value. For example, good exemplars for the goal-derived category of "foods to eat on a diet" have zero calories. Zero calories, however, is an ideal for diet food, not the central tendency. *Ideals* can be defined as characteristics that exemplars should have if they are to best serve a goal associated with their category (Barsalou, 1985). Ideal values are often true of only a few category members, because in most cases only a few category members best serve the goal associated with the category. Furthermore, ideal values are not confined to the center of categories like central tendencies; indeed, they are often (although not necessarily) quite extreme. Central tendency and ideals also differ in origin: Although central tendency depends on the particular exemplars

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a person has experienced, ideals depend on goals people have.

Barsalou (1985, 1987) proposed that common taxonomic and goal-derived categories differ in several respects: Common taxonomic categories typically (a) are *highly familiar biological or artifactual categories* that are culturally transmitted, whereas goal-derived categories are often less familiar and less central to cultural knowledge; (b) reflect *correlational structure,* that is, they circumscribe sets of things in the environment that share clusters of co-occurring properties, whereas members of goal-derived categories may even be quite dissimilar in many respects; (c) serve the purpose of *representing kinds of things in the environment,* whereas goal-derived categories often serve people's goals; (d) are used for *classification,* whereas goal-derived categories are often used for instantiation, that is, they are used to bind the variables of action-guiding schemas with instantiations appropriate in the process of achieving certain goals.

It is not clear whether categories of facial expressions of emotions are common taxonomic or goal-derived categories. On the one hand, they are highly familiar biological categories, representing perceptually salient clusters of co-occurring properties (like opened eyes, lifted brows, and an open mouth in surprise), with the clusters occurring in one emotion but not in others. Furthermore, they certainly represent things in the environment and can be used for classification. Thus, facial expressions of emotion may well be common taxonomic categories. On the other hand, it is generally assumed that the ability to produce facial expressions of emotion is part of evolved human nature (Darwin, 1872), serving the biological function of communicating emotions (e.g., Ekman, 1972). Although facial expressions of emotion are assumed to occur in an automatic and reflexlike manner rather than intentionally, their communicative function could be regarded as an analogue to the goal of communicating emotion. Finally, receivers of emotional signals may often process them to regulate their actions (Fridlund, 1994; Izard, 1997).

An answer to the question whether central tendency, frequency of instantiation, or ideals determine graded structure in categories of facial expressions may clarify some uncertainty within the research area of facial expressions. As previously noted, facial expressions proposed to be prototypes are often quite extreme. This seems peculiar if one sees facial expressions as common taxonomic categories, in which typicality is determined by central tendency, which should not be a high, but rather an expression of medium intensity. However, if facial expressions are a variant of goal-derived categories, this extremeness becomes understandable because the ideals underlying graded structure of goal-derived categories are often extreme values. Furthermore, intense expressions are best suited to communicate specific emotions because they are most distinct from a neutral expression as well as from most other emotional expressions; technically speaking, they maximize signal-to-noise ratio. Recent studies using computer-manipulated facial stimuli varying in intensity supported this assumption. They found recognition to be faster for strongly exaggerated emotional stimuli than for less intense examples (Calder, Young, Rowland, & Perrett, 1997; Calder et al., 2000). Furthermore, prototypical facial expressions may be relatively infrequent. For example, Carroll and Russell (1997) found that, with the exception of smiles, Hollywood actors who are famous for their realistic acting rarely show the prototypical pattern of facial movements. Why is it that prototypes of facial expressions of emotion are instances that are rarely perceived and not the ones that are often seen? The answer might be that they are not common taxonomical categories but rather variants of goal-derived categories.

The aim of the present studies was to examine whether typicality of facial expressions of emotion is predicted best by their values on an *ideal* dimension (suitability to express a particular emotion), their *frequency of instantiation* (FI) as an expression of a particular emotion, or their deviation from the *central tendency* (CT) of the respective facial expression category. The studies followed Barsalou's (1985) procedure, who obtained typicality, FI, CT, and ideal scores by having different groups of observers judge exemplars under appropriate instructions. The exemplars judged were line drawings of expressions of anger, disgust, happiness, sadness, and surprise that systematically differed in intensity (Musterle & Rossler, 1986). If facial expressions are structured like common taxonomic categories, typicality should be predicted best by CT and FI. In contrast, if they are structured like goal-derived categories, the ideal dimension should predict typicality best.

Study 1

Method

Participants

Eighty-two students from various faculties located at the University of Bielefeld (50 women and 32 men)

served as participants. Their mean age was 24.4 years (SD = 3.6). They received no payment or credit for their participation.

Design

Four independent groups of participants were tested: the typicality group (n = 21) rated typicality, the FI group (n = 19) rated frequency of instantiation, the ideal group (n = 21) rated suitability to express the respective emotion, and the CT group (n = 21) rated the similarity of pairs of expressions to obtain a measure of CT.

Stimuli

The stimuli were computer-generated line drawings of facial expressions of emotion varying in intensity, published by Musterle and Rossler (1986). The expressions were produced by assuming a neutral face to be drawn on a rubberlike material containing extensible holes (mouth, eyes) and by displacing certain points (brows, nostrils, lips, etc.) corresponding to the regions that are displaced by facial muscles in real faces according to Ekman and Friesen (1978) and Hjortsjö (1969). Using their suggestions as to coordinated activity of muscles, five "pure" emotional expressions were constructed labeled "anger," "disgust," "friendliness," "grief," and "surprise" (see Figure 1, far right column; friendliness, which shows a smile and wrinkles around the eye, and grief, where the brows are drawn together and the corners of the mouth are pulled down, will be henceforth referred to by the more commonly used labels "happiness" and "sadness," respectively). Each face was defined by a set of force values for the artificial muscles. Intermediate intensity expressions were produced by linearly interpolating the force values (.25, .50, .75) between the neutral face (.00) and the full faces (1.00). A pretest was conducted to test subjective linearity of the intensity variation. Twenty students (13 women, 7 men; age: M = 22.8, SD = 2.2) judged intensity (e.g., "How intense is an expression of anger shown?"), for each of the five intensity levels of each emotion on 5-point rating scales ranging from 1 (*not at all intense*) to 5 (*as intense as possible*). The correlation between objective and average subjective intensity was high (r = .98, $p < .001$), indicating subjective linearity of the intensity variation.

Materials

The materials were presented in booklets. For the typicality, FI, and ideal groups, each booklet comprised six pages. The first page contained a general instruction and asked for age and gender. Each of the following five pages was headed by the name of an emotion category (anger, disgust, happiness, grief, or surprise), followed by the question asking for typicality, FI, or ideal. Next, five pictures of facial expressions were depicted. The first picture was always the neutral face. The four other pictures were intensity variants of the facial expressions congruent with the emotion label that headed the page. The five pictures were aligned vertically on the left side of the page, ordered by increasing intensity. There was a 5-point rating scale to the right of each face. The order of emotions within the booklet was varied randomly between participants.

In the typicality group, the question was, for example, "How typical is such a facial expression for *anger*?" The endpoints of the rating scales were labeled 1 (*not at all typical*) and 5 (*very typical*). This question was intended to assess typicality in its usual meaning. In the FI condition, participants were asked: "How often could you observe that expression in another person, when this person is *angry*?" The endpoints of the rating scales were labeled 1 (*not frequently at all*) and 5 (*very frequently*). This question was intended to assess the frequency of an expression as a member of the respective emotional expression category. The question in the ideal condition was phrased: "How suitable is such a facial expression to express *anger*?" The endpoints of the rating scales were labeled 1 (*not at all suitable*) and 5 (*very suitable*). "Expressing emotion" was assumed to be the (implicit) goal associated with facial expressions of emotion, and was thus used as the *ideal dimension* on which the expressions may vary (cf. Barsalou, 1985).

To assess the role of CT, a CT score was obtained for each face. As substantiated by Barsalou (1985), a member's "average similarity to other category members must be at least roughly the same as its similarity to their central tendency" (p. 630), analogous to the average difference between a number and several other numbers being the same as its difference to the other number's mean. Accordingly, the average similarity to each of the other category members served as an index of CT. Each participant in the CT group judged the similarity of all possible different pairs of instances within each emotion category on a 5-point scale ranging from 1 (*not similar at all*) to 5 (*very similar*). They were handed a booklet analogous to that used in the other groups, except that pairs of faces were judged instead of individual faces, and that the 10 pairs of faces within each emotion category were presented on two pages rather than on one page. Each page contained five pairs, with the two faces forming a pair being horizontally aligned, and the rating scale

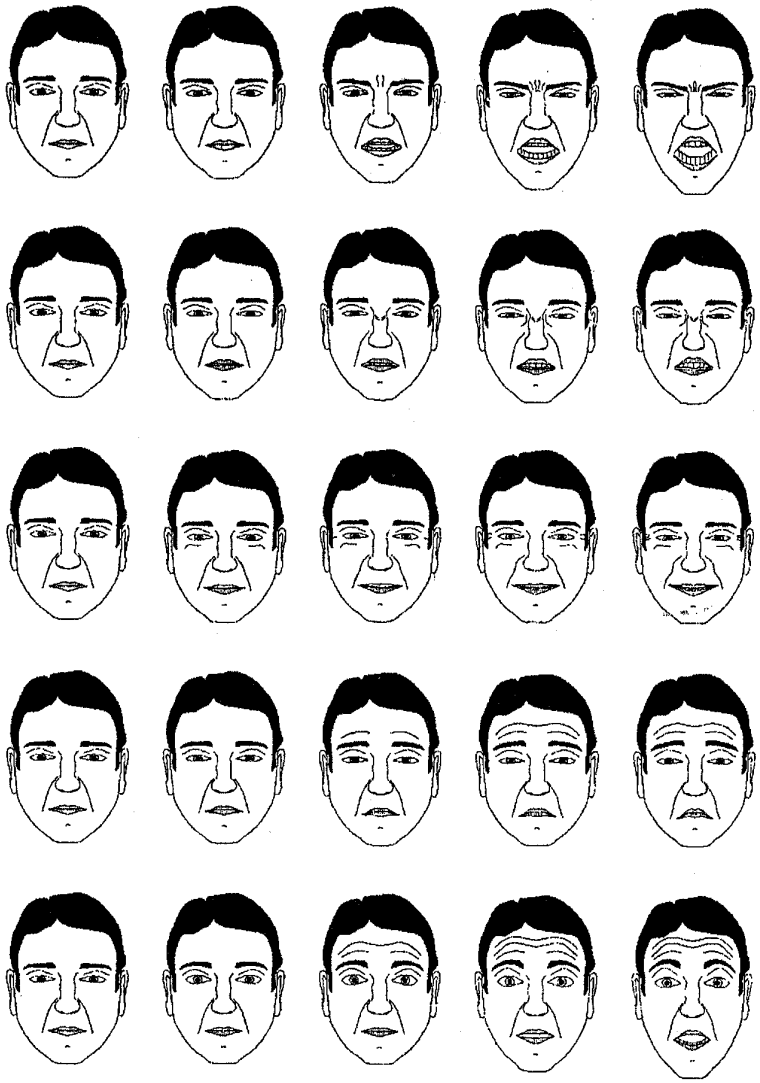

Figure 1. The stimuli were scanned and subsequently smoothed with commercial graphics software (Paint Shop Pro 4.0; Jasc Software, Eden Prairie, MN) to reduce artifacts caused by digitalization. For each emotion category (anger, disgust, happiness, sadness, and surprise), five stimuli were presented, representing proportions of .00, .25, .50, .75, and 1.00 intensity of the respective emotion relative to the neutral face. Adapted from Musterle and Rossler, 1986, Figure 4.

printed to the right of each pair. Within each emotion category, the order of all pairs was fixed. The order of the emotion categories, however, varied randomly between participants.

Procedure

The participants were approached on the university campus and handed the booklet if they agreed to participate in a short study.

Results and Discussion

Figure 2 (upper panel) shows the mean scores for typicality, ideal, FI, and CT, for each of the 5 × 5 (Intensity × Emotion) faces. Consistent with expectations (e.g., Ekman & Friesen, 1975), typicality increased with intensity of expression: Whereas typicality averaged around minimum ("not typical at all"), when the neutral face was judged for the respective

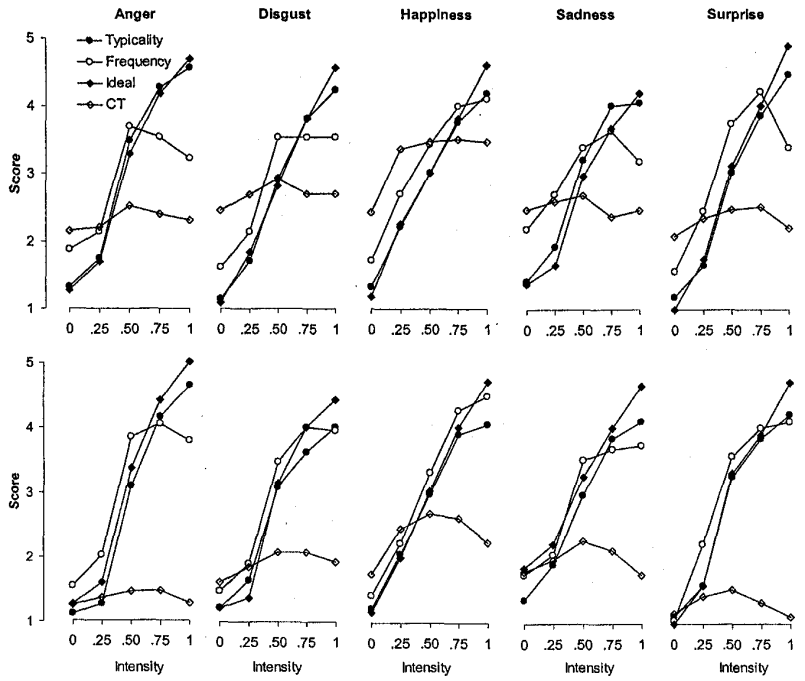

Figure 2. Mean typicality, frequency of instantiation, ideal, and central-tendency index ratings (CT), based on the similarity ratings, for each of the five intensities of each of the five emotions in Study 1 (upper panel) and Study 2 (lower panel). Note that the zero intensity expression was the same neutral face for all emotions.

emotion category, the most extreme expression always received the highest ratings. Ideal scores were similarly linearly related to expression intensity, consistent with the expectation that expressions of emotion, as tools of communication, should maximize signal-to-noise ratio.

In contrast, FI was generally not linearly related to expression intensity; rather, FI tended to follow an inverted U-shape, that is, the ratings increased until their peak at medium intensities, after which they decreased. This general trend is consistent with Carroll and Russell's (1997) hypothesis that less intense facial expressions of emotion occur more often than intense ones. An exception to this trend was happiness, where FI ratings were very similar to the typicality ratings.

A CT score for each face was computed by averaging the similarity judgments of the four comparisons involving that face. Generally, low and high intensities had lower CT scores than medium intensities. This pattern of results is consistent with expectations because the medium intensity face objectively instantiates the CT of the presented faces.

The further data analysis paralleled that of Barsalou (1985) and was intended to determine which variable—CT, FI, or ideal—predicts typicality best. This analysis focused on the correlations between the averages of the different scores. In other words, the "cases" in this analysis were not participants, but were the 25 facial expressions that served as stimuli. The most informative statistics are partial correlations (first order correlations are depicted in Table 1) based on the assumption that there are three predictor variables—ideal, CT, and FI—for typicality as the criterion variable. The partial correlation between typicality and ideal, controlling for CT and FI, was .96 ($p < .001$); the correlation of typicality and FI, controlling for ideal and CT, was .50 ($p < .05$); and the correlation of typicality and CT, controlling for ideal and FI, was −.37 ($p < .10$). Hence, closeness to ideals explained a high proportion of unique variance (92%), whereas the unique variance explained by FI (25%) and CT (13%) was comparatively low.

Study 2

Study 2 sought to replicate Study 1 with a different operationalization of typicality: "how good an ex-

Table 1
First Order Correlations Between Mean Judgments of Typicality, Frequency of Instantiation (FI), Suitability to Express the Respective Emotion (Ideal), and the Central-Tendency Score Based on the Similarity Judgments (CT)

Variable	CT	FI	Ideal	Intensity
Typicality				
Study 1	.23	.88**	.99**	.97**
Study 2	.16	.96**	.99**	.97**
CT				
Study 1	—	.46*	.25	.23
Study 2	—	.24	.14	.12
FI				
Study 1	—	—	.86**	.83**
Study 2	—	—	.95**	.93**
Ideal				
Study 1	—	—	—	.99**
Study 2	—	—	—	.97**

Note. The correlations with manipulated intensity of the facial expressions (.00, .25, .50, .75, and 1.00 of maximum expression) are depicted as a measure of linearity.
*$p < .05$. **$p < .01$.

ample" an expression is for the respective emotion category. This task has been used as an alternative to having typicality judged directly (e.g., Barsalou, 1985; Fehr & Russell, 1984), and Barsalou (1985) suspected that goodness-of-example judgments are less prone to an FI interpretation than typicality judgments.

Method

Participants

Participants were 74 unpaid students of diverse courses (42 women and 32 men). Their mean age was 23.5 (SD = 3.4) years. Nine additional participants (6 in the similarity-judgment condition) were run but dropped from analysis because of missing values on at least one judgment.

Design

Nineteen participants were randomly assigned to each of the three judgment conditions that used printed materials (the typicality, ideal, and FI judgments). Seventeen additional raters participated in the similarity-judgment condition.

Stimuli and Materials

The booklets that contained the materials for typicality, ideal, and FI judgments were analogous to the ones used in Study 1. Every page was headed by the category name (e.g., "Category: Expression of Happiness"). The instruction for the typicality judgments was "Please indicate for each of the five pictures, how good an example the depicted expression is for that category," and the endpoints of the 5-point rating scale were labeled "a bad example" (1) and "a good example" (5). The instruction for the FI judgments was, for example, "Please indicate for each of the five pictures, how often that expression is shown, when a person is happy"; and the instruction for the ideal for communication judgment was, for example, "Please indicate for each of the five pictures, how suitable such a facial expression is to express happiness." For the similarity-judgment task, the stimuli were displayed on a computer screen, one pair at a time, with the pictures horizontally aligned. Above them, the category name (e.g., happiness) was displayed (to enhance comparability with the other conditions, and with Barsalou, 1985), along with the consecutive number of the pair. The next three lines contained the question: "How similar are these two facial expressions?", a 5-point rating scale with the labeled endpoints "not at all similar" (1) and "very similar" (5), and a hyperlink labeled "next picture."

Procedure

The participants who worked with printed materials were recruited in the same way as in Study 1. The participants who performed the similarity-judgment task were approached in the Internet terminal pool. If they agreed to participate in a short psychological study, they were given a URL to access the experiment. The experiment was controlled by a CGI script written in PERL, and the materials were displayed via an Internet browser as an HTML document. After reading the instructions, the participants clicked on a hyperlink with the mouse, which displayed the first pair of facial expressions. All pairs of facial expressions belonging to the same emotion category were presented in succession. Each participant received a new random sequence of emotion categories and a new random sequence of pairs within the emotion categories. Furthermore, the location (left or right) of the two faces was randomly determined. The participants made their similarity judgments by clicking on HTML radio buttons, and they navigated from one stimulus pair to the next by using hyperlinks.

Results and Discussion

The results for typicality, ideal, and CT scores of Study 1 were clearly replicated (Figure 2, lower panel). Only FI exhibited a slightly different pattern compared with that obtained in Study 1, in that FI was

no longer nonmonotonically related to expression intensity for anger and disgust. All first order correlations were positive (Table 1), although the correlations with CT were low and not significant. The partial correlation of typicality and ideal, controlling for FI and CT, was again very high ($r = .87$, $p < .001$); the partial correlation of typicality and FI, controlling for ideal and CT, was not significant ($r = .34$, $p > .10$); neither was the partial correlation between typicality and CT, controlling for ideal and FI ($r = .02$, $p > .10$). Thus, the general pattern of partial correlations closely corresponded to that obtained in Study 1, with ideal accounting for much more unique variance (76%) than FI (12%) and CT (<1%). It might be noted that the partial correlation of FI was significantly positive in Study 1 but not significantly different from zero in Study 2. Barsalou (1985) suspected that the term *typicality* sometimes means frequency of encounter in common speech, and that asking for goodness-of-example judgments is less prone to a frequency interpretation. Consequently, typicality and FI should have more common variance in Study 1 than in Study 2, which is consistent with the higher partial correlation in Study 1.

General Discussion

The main question addressed was whether categories of facial expressions of emotion are structured like common taxonomic or goal-derived categories. The results strongly indicate that they are structured like goal-derived categories, where typicality of members varies according to their suitability to obtain a certain goal. This indicates that suitability to express the respective emotion is highly salient in people's representations of categories of facial expressions of emotion and has become the standard by which typicality is judged (cf. Barsalou, 1985). In contrast, because typicality is not well predicted by CT and FI, categories of facial expression seem not to be structured like common taxonomic categories. In other words, typicality judgments do not reflect subjective measures of CT or relative frequency of expressions encountered in life. From a category theoretic view, facial expressions of emotions seem to be special: Although they share many features with common taxonomic categories, such as (a) being familiar categories central to cultural knowledge, (b) being about things in the environment that have a correlational structure and form salient groups of entities, and (c) probably being often used for classification (e.g., he is surprised, angry, sad, and so on), their graded structure is not well predicted by CT or FI, but by an ideal. This pattern may be characteristic for evolved signals, which are naturally occurring and are used by receivers to regulate their actions in biologically relevant domains. This speculation suggests that with other biological signals (e.g., determinants of attractiveness), similar patterns would be observed.

The present data further support the assumption underlying numerous studies on facial expressions of emotion: Prototypes are intense expressions. Furthermore, typicality was found to be linearly related to intensity of expression. This novel finding converges with recent studies that have similarly used computer-manipulated materials to examine the influence of linear variations of intensity on face perception. For example, Benson, Campbell, Harris, Frank, and Tovee (1999) and Calder et al. (2000) found intensity of expression to be linearly related to rated emotion content, and Benson et al. (1999) and Calder et al. (1997) found expression recognition to be faster for highly exaggerated expressions. Recognition speed can serve as an index of typicality because typical examples are generally recognized faster than less typical examples (e.g., Fehr, Russell, & Ward, 1982). Rated suitability to express the corresponding emotion was also linearly related to expression intensity. This result is consistent with the idea that the function of facial expressions of emotion is communicative because intense expressions maximize distinctiveness between different expressions and are therefore ideal for communication. Concerning FI, the results were somewhat equivocal: Whereas Study 1 suggested that medium intensity expressions of anger, disgust, sadness, and surprise are judged as more frequently occurring than extreme ones, Study 2 suggested the opposite for expressions of anger, disgust, and happiness. Thus, the results only partially support Carroll and Russell's (1997) hypothesis that prototypes are infrequent. However, in interpreting these results, it should be considered that judged frequency might not represent actual frequency perfectly.

The abovementioned generalizations pertain overall to the categories of anger, disgust, sadness, and surprise, where FI exhibited a pattern very different from typicality in Study 1. In contrast, happiness was the only category, where FI and typicality were clearly associated. Although FI and typicality were generally more closely associated in Study 2, the association was again the highest for happiness. Display rules valid in Western cultures may be partially responsible for this result (cf. Ekman, 1972). In particular, display rules requiring the deintensifying, neutral-

ization, or masking of happiness expressions may apply only in infrequently encountered situations, such as funerals or ceremonies; and additionally, the display rules concerning happiness expressions might even encourage the intensifying of happiness expressions in many situations.

The present study may be criticized for certain methodological choices. First, the stimulus material consisted of cartoonlike line drawings instead of realistic photographic-quality reproductions of facial expressions. However, this limitation may be compensated by elimination of irrelevant and possibly interfering visual features that inevitably occur in photographs such as the famous Ekman and Friesen (1978) pictures, which often vary subtly in illumination and camera angle, even when taken of the same person (see also Calder, Young, Perret, Etcoff, & Rowland, 1996). It may be noteworthy that Calder et al. (1996), using morphed photographic-quality pictures of facial expressions, replicated results of Etcoff and Magee (1992), who used line drawings of facial expressions as stimuli, showing that continuous tone images and line drawings can be functionally equivalent. Most important, however, no other published series of pictures contains a systematic variation of expression intensity. Nonetheless, it would be advantageous to rerun the study using photographic materials, preferably by using morphing technology to artificially produce facial expressions of emotion of varying intensities conveyed by the same person (e.g., Benson et al., 1999; Calder et al., 1997, 2000), or entirely artificial expressions (e.g., Massaro & Egan, 1996; Wehrle, Kaiser, Schmidt, & Scherer, 2000). A second criticism may concern the limited set of examples for each category. In particular, it may be argued that the categories include not only pure expressions of varying intensity, but also expression blends. Future studies should thus include expression blends. Third, all variables were obtained using judgments and may thus not exactly reflect actual FI, CT, or ideals. It is thus important to bear in mind that the results pertain to subjective measures of FI, CT, and ideals. Future studies should find ways of measurement that are independent of judgments. Fourth, all category members were presented on the same page for the typicality, FI, and ideal judgments, ordered by expression intensity, which might have biased responses. However, a bias caused by properties of the stimuli should influence judgments of typicality, FI, and ideals in the same way. Because the main analysis concerned comparisons between *different* judgments of the *same* stimulus materials, this concern does not compromise the central implication that categories of facial expressions are structured according to an ideal dimension, and not by CT and FI.

A final question concerns the nature of the internal state communicated by facial expressions. Although this study originated from the emotion theoretic view of facial expressions (i.e., that certain facial expressions convey emotional state), this does not exclude the possibility that facial expressions convey information other than emotion, for example information about social motives, or behavioral intentions (e.g., Fridlund, 1994), or action tendencies (e.g., Frijda & Tcherkassof, 1997). The approach used here could be easily extended to Fridlund's behavioral ecology view, by asking for suitability to express corresponding intention instead of emotion.

References

Barsalou, L. W. (1985). Ideals, central tendency, and frequency of instantiation as determinants of graded structure in categories. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 11,* 629–654.

Barsalou, L. W. (1987). The instability of graded structure: Implications for the nature of concepts. In U. Neisser (Ed.), *Concepts and conceptual development: Ecological and intellectual factors in categorization* (pp. 101–140). Cambridge, England: Cambridge University Press.

Benson, P. J., Campbell, R., Harris, T., Frank, M. G., & Tovee, M. J. (1999). Enhancing images of facial expressions. *Perception & Psychophysics, 61,* 259–274.

Calder, A. J., Rowland, D., Young, A. W., Nimmo-Smith, I., Keane, J., & Perrett, D. I. (2000). Caricaturing facial expressions. *Cognition, 76,* 105–146.

Calder, A. J., Young, A. W., Perrett, D. I., Etcoff, N. L., & Rowland, D. (1996). Categorical perception of morphed facial expressions. *Visual Cognition, 3,* 81–117.

Calder, A. J., Young, A. W., Rowland, D., & Perrett, D. I. (1997). Computer-enhanced emotion in facial expressions. *Proceedings of the Royal Society London, 264,* 919–925.

Carroll, J. M., & Russell, J. A. (1997). Facial expressions in Hollywood's portrayal of emotion. *Journal of Personality and Social Psychology, 72,* 164–176.

Darwin, C. (1872). *The expression of the emotions in man and animals.* London: Murray.

Ekman, P. (1972). Universals and cultural differences in facial expressions of emotion. In J. K. Cole (Ed.), *Nebraska Symposium on Motivation* (Vol. 19, pp. 207–283). Lincoln: University of Nebraska Press.

Ekman, P., & Friesen, W. V. (1975). *Unmasking the face: A*

guide to recognizing emotions from facial clues. Englewood Cliffs, NJ: Prentice Hall.

Ekman, P., & Friesen, W. V. (1978). *The facial action coding system.* Palo Alto, CA: Consulting Psychologists Press.

Etcoff, N. L., & Magee, J. J. (1992). Categorical perception of facial expressions. *Cognition, 44,* 227–240.

Fehr, B., & Russell, J. A. (1984). Concept of emotion viewed from a prototype perspective. *Journal of Experimental Psychology: General, 113,* 464–486.

Fehr, B., Russell, J. A., & Ward, L. M. (1982). Prototypicality of emotions: A reaction time study. *Bulletin of the Psychonomic Society, 20,* 253–254.

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

Frijda, N. H., & Tcherkassof, A. (1997). Facial expressions as modes of action readiness. In J. A. Russell & J. M. Fernández-Dols (Eds.), *The psychology of facial expression* (pp. 78–103). Cambridge, England: Cambridge University Press.

Hjortsjö, C. H. (1969). *Man's face and mimic language.* Lund, Sweden: Studentlitteratur.

Izard, C. (1997). Emotions and facial expressions: A perspective from differential emotions theory. In J. A. Russell & J. M. Fernández-Dols (Eds.), *The psychology of facial expression* (pp. 57–77). Cambridge, England: Cambridge University Press.

Massaro, D. W., & Egan, P. B. (1996). Perceiving affect from the voice and the face. *Psychonomic Bulletin & Review, 3,* 215–221.

Musterle, W., & Rossler, O. E. (1986). Computer faces: The human Lorenz matrix. *BioSystems, 19,* 61–80.

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.

Wehrle, T., Kaiser, S., Schmidt, S., & Scherer, K. R. (2000). Studying the dynamics of emotional expression using synthesized facial muscle movements. *Journal of Personality and Social Psychology, 78,* 105–119.

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