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Facial expression megamix: Tests of dimensional and category accounts of emotion recognition

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Abstract

We report four experiments investigating the perception of photographic quality continua of interpolated ('morphed') facial expressions derived from prototypes of the 6 emotions in the Ekman and Friesen (1976) series (happiness, surprise, fear, sadness, disgust and anger). In Experiment 1, morphed images made from all possible pairwise combinations of expressions were presented in random order; subjects identified these as belonging to distinct expression categories corresponding to the prototypes at each end of the relevant continuum. This result was replicated in Experiment 2, which also included morphs made from a prototype with a neutral expression, and allowed 'neutral' as a response category. These findings are inconsistent with the view that facial expressions are recognised by locating them along two underlying dimensions, since such a view predicts that at least some transitions between categories should involve neutral regions or identification as a different emotion. Instead, they suggest that facial expressions of basic emotions are recognised by their fit to discrete categories. Experiment 3 used continua involving 6 emotions to demonstrate best discrimination of pairs of stimuli falling across category boundaries; this provides further evidence of categorical perception of facial expressions of emotion. However, in both Experiment 1 and Experiment 2, reaction time data showed that increasing distance from the prototype had a definite cost on ability to identify emotion in the resulting morphed face. Moreover, Experiment 4 showed that subjects had some insight into which emotions were blended to create specific morphed images. Hence, categorical perception effects were found even though subjects were sensitive to physical properties of these morphed facial expressions. We suggest that rapid classification of prototypes and better across boundary discriminability reflect the underlying organisation of human categorisation abilities.

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1. Introduction

People are very skilled at understanding each other's facial expressions. We know that babies are very interested in faces (Johnson et al., 1991), and that they show precocious ability to respond to different facial expressions (Field et al., 1982). We also know that, for tests using a fixed range of alternative choices, certain configurations of facial features resulting from specific patterns of facial muscle movements are recognised throughout the world as corresponding to particular basic emotions (Ekman, 1992, 1994). Moreover, selective changes in ability to recognise emotion from the face have been reported after brain injury; sometimes, patients may remain able to recognise other social cues such as identity from the face, even though they have problems in recognising facial emotion (Calder et al., 1996b; Etcoff, 1984; Sprengelmeyer et al., 1996; Young et al., 1993). The physiological literature also suggests differences in the neural coding of facial identity and expression in other primates (Desimone, 1991; Hasselmo et al., 1989), and PET studies of humans have shown differences between brain regions involved in the analysis of identity and expression (Sergent et al., 1994), and demonstrated the possible existence of emotion-specific responses to facial expressions (Morris et al., 1996).

These facts are consistent with the long evolutionary history of facial expressions of emotion (Darwin, 1872; Ekman, 1973), but we know little about the perceptual basis of how emotions are recognised. One of the fundamental issues that is still disputed concerns whether facial expressions are perceived as varying continuously along certain underlying dimensions, or as belonging to qualitatively discrete categories (Ekman, 1982; Ekman et al., 1972). This issue has been difficult to resolve because many data can be accommodated within either view, and hybrid models are sometimes proposed. For example, Woodworth and Schlosberg (1954) identified happiness (in which they included love and mirth), surprise, fear (including suffering), anger (and determination), disgust and contempt as distinct, recognisable categories of emotion, but then suggested on the basis of their confusabilities that they can be considered to be located around the circumference of a circle (running happiness–surprise–fear–anger–disgust–contempt–happiness) with two orthogonal diagonals corresponding to the dimensions pleasant–unpleasant (running from the region of happiness to the region of anger) and attention–rejection (running from the surprise and fear boundary to the boundary between disgust and contempt). This suggestion is shown in Fig. 1a. A modern variant of this idea is the Russell (1980) circumplex model, in which more extreme degrees of an emotion fall around the edge of a two-dimensional emotion space encoding orthogonal bipolar dimensions of pleasure and arousal, with milder emotions falling more toward the centre.

The intention of such models is to create a two-dimensional solution to the problem of perceptually classifying facial expressions. Woodworth and Schlosberg (1954) drew an analogy to the colour circle, in which hue is arranged around the circumference and saturation along red–green and blue–yellow opponent axes.

In the present study, we took advantage of image-manipulation techniques to

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