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Happiness is unique: A latent structure of emotion recognition traits revealed by statistical model comparison

Atsunobu Suzuki [a,*], Takahiro Hoshino [b], Kazuo Shigemasu [c]

[a] Graduate School of Environmental Studies, Nagoya University, Furo-cho, Chikusa-ku, Nagoya 464-8601, Japan
[b] Graduate School of Economics, Nagoya University, Furo-cho, Chikusa-ku, Nagoya 464-8601, Japan
[c] Department of Psychology, Teikyo University, 359 Otsuka, Hachioji, Tokyo 192-0395, Japan

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A B S T R A C T

Is an individual who is sensitive to the facial expressions of a given emotion also sensitive to those of other emotions? This study addressed this simple but fundamental question by examining the latent structure underlying the sensitivity scores for basic emotions expressed by faces (Suzuki, Hoshino, & Shigemasu, 2006a). Eight hundred and five participants took part in the study, and for each participant, the sensitivity scores for happiness, fear, anger, disgust, and sadness were calculated. Variants of a single-factor model were fit to the matrix of correlations among the five sensitivity scores. A solution for the best-fit model indicated an equal contribution from the single factor to the four negative emotions (path coefficient = 0.635) and a smaller contribution to happiness (0.183). Our results imply minimally overlapped mechanisms underlying the recognition of positive and negative emotions.

1. Introduction

Facial expressions of certain emotions are similar in diverse cultures. These emotions include happiness, surprise, fear, anger, disgust, and sadness, and are termed *basic emotions* (Ekman, 1994). However, the human ability to recognize even basic emotions from facial expressions is not perfect; recognition performance differs among cultures (Russell, 1994) and individuals (O'Sullivan, 1982). A simple but fundamental question is whether an individual who is sensitive to the facial expressions of a given basic emotion is also sensitive to those of other basic emotions. In other words, how are the "traits" underlying the recognition of different basic emotions related to each other, or how are they latently structured? Compared to the many studies done on cognitive abilities (Kovas & Plomin, 2006) and personality traits (Yamagata et al., 2006), only a few have examined the latent structure of emotion recognition traits (ERTs).

As suggested by Matsumoto et al. (2000), the above question can be restated as whether there exists a *general ERT* that contributes to the recognition of all basic emotions, a concept similar to general cognitive ability. The research team measured ERTs as hit rates in recognizing basic emotions from prototypical facial expressions. The study presented participants with very brief stimuli that were difficult to recognize, thereby increasing individual differences. The results showed positive correlations of around 0.3 between the hit rates in recognizing all the basic emotions. However, the hit rate in happiness recognition indicated a ceiling effect, which hindered a definitive interpretation of the correlations.

In a recent study, we measured ERTs as the intensities of basic emotions perceived from ambiguous facial expressions, which we called *sensitivity scores* (Suzuki, Hoshino, & Shigemasu, 2006a). Ambiguous facial expressions were generated by morphing computer images of two prototypical facial expressions of different basic emotions. The use of ambiguous facial expressions increased the task difficulty sufficiently to eliminate the ceiling effect in happiness recognition. Results showed almost no correlation between the sensitivity score for happiness and for any other basic emotion, suggesting the independence of happiness recognition.

Other studies also suggest that happiness recognition may be unique. Compared to the recognition of faces with negative emotional expressions, the recognition of happy faces is shown to be faster (Petrides & Furnham, 2003). Neuropsychological studies have often reported a deficit of negative emotion recognition, such as in amygdala-damaged patients (Adolphs et al., 1999) and in older adults (Suzuki, Hoshino, Shigemasu, & Kawamura, 2007). Given that happiness is the only positive basic emotion, these findings may imply that there are distinct mechanisms for positive and negative emotion recognition. An influential theory of personality that proposes that sensitivities to reward and punishment can be dissociated (Depue & Collins, 1999) is relevant to this implication.

* Corresponding author. Address: Graduate School of Environmental Studies, Nagoya University, Furo-cho, Chikusa-ku, Nagoya 464-8601, Japan. Tel./fax: +81 52 789 4842.
E-mail address: atsuzuki@nagoya-u.jp (A. Suzuki).

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The apparent dissociation between positive and negative emotion processing undermines the concept of a general ERT. Theoretically, however, the recognition of positive and negative facial expressions cannot be completely independent. The recognition of facial expressions primarily involves visual analysis of faces, which constitutes a core mechanism underlying the recognition of all emotions (Bruce & Young, 1986; Haxby, Hoffman, & Gobbini, 2000). Although the subsequent recognition processes for different emotions may vary, the initial common mechanism would ensure at least a minimal overlap between the recognition of positive and negative emotions.

Therefore, in this study, we decided to examine and compare three possible models of the latent structure of ERTs. The assumptions of the models ranged from the complete independence of happiness (Model 1) – a strong case for Suzuki et al. (2006a) – to a uniform contribution of a general ERT to all the basic emotions (Model 3) – a strong case for Matsumoto et al. (2000). We also examined a middle ground between the two extremes assuming that a general ERT contributed differently to happiness and to other emotions (Model 2). Our hypothesis was that Model 2 was best-fit to the data. To be more specific, we predicted a significantly smaller but not null contribution of a general ERT to happiness than to other emotions, implying a minimal overlap between positive and negative emotions. A statistical model comparison was conducted to examine this hypothesis.

2. Method

This study consisted of two experiments, A and B. The two experiments were based on the same procedure, but used different sets of stimuli.

2.1. Participants

In experiments A and B, 528 undergraduates (male = 404; aged 18–31 years, M = 18.8, SD = 1.1) and 374 undergraduates (male = 282; aged 18–34 years, M = 18.9, SD = 1.3), respectively, at The University of Tokyo participated for course credit or for payment (500 yen). Of these participants, 97 (male = 73; aged 18–26 years, M = 18.7, SD = 1.1) took part in both experiments, which were conducted approximately one month apart.

2.2. Procedure and stimuli

In each experiment, participants were tested together in a large classroom, which featured a big screen at the front of the room. They were shown 36 grayscale images of facial expressions that were each presented for 25 s (experiment A) or for 20 s (experiment B). Participants were asked to rate the intensities of six basic emotions (happiness, surprise, fear, anger, disgust, and sadness) displayed by each facial expression. The intensity was rated on a six-point scale from 0 (*not at all*) to 5 (*very much*).

Stimuli used in experiment A were the facial images of a Japanese woman (Suzuki et al., 2006a). Although the use of a single typical exemplar was common in experiments using morphed facial expressions (Calder, Young, Perrett, Etcoff, & Rowland, 1996; Young et al., 1997), a set of stimuli where exemplars' characteristics (e.g., gender, race) were counterbalanced was desirable for enhancing the external validity of the measurement. Therefore, in experiment B, facial images of an additional exemplar were used as stimuli. To be specific, we chose the facial images of a Caucasian male, "JJ," from the Pictures of Facial Affect (Ekman & Friesen, 1976). The Pictures of Facial Affect is the most common and internationally used stimuli set in research on emotion recognition. The addition of the widely used JJ stimuli ensures comparability between this paper's findings and those of previous literature.

In both experiments, six of the 36 stimuli used were the prototypical facial expressions of each basic emotion, and 30 were morphed facial expressions created using FaceTool (software developed by the Harashima and Naemura Laboratory at the University of Tokyo). For each of the 15 possible pairs of the six prototypical facial expressions (e.g., happiness and disgust), two morphs were created by blending a pair of prototypical facial expressions in ratios of 3:2 (e.g., 60% happiness and 40% disgust) and 2:3 (e.g., 40% happiness and 60% disgust) (Fig. 1).

2.3. Calculation of sensitivity scores

In both experiments, the set of stimuli contained 11 facial expressions displaying each basic emotion (e.g., for happiness, there were one happiness prototype, five 60%-happiness morphs, and five 40%-happiness morphs). A participant's sensitivity score for a given basic emotion was calculated by applying a graded-response model (GRM) to the participant's intensity-rating responses to the 11 facial expressions displaying the emotion.

The GRM postulates that a participant(s)'s response to a given stimulus (i; i = 1,...,11) is described by two types of parameters that represent stimulus properties (item parameters; α_i, β_{ij}; j = 1,...,5) and by the participant's sensitivity score for the relevant emotion (θ_s). According to the model, the probability (P^*_{ijs}) that the participant will select intensity points higher than or equal to j is expressed as follows:

$$P^*_{ijs} = 1/[1 + \exp\{-1.7\alpha_i(\theta_s - \beta_{ij})\}]$$

The above equation reflects the assumption that the probability of choosing higher intensity points increases monotonically with θ_s. Fig. 2 illustrates this equation, wherein the horizontal axis represents θ_s and the vertical axis represents P^*_{ijs}.

The item parameters represent the stimulus properties constituting difficulty factors and determine the exact shapes of the P^*_{ijs}

Fig. 1. Examples of stimuli. From left to right, a happiness prototype, a 60%-happiness and 40%-disgust morph, a 40%-happiness and 60%-disgust morph, and a disgust prototype. From Suzuki et al. (2006a, p. 340). Copyright 2005 by Elsevier B.V.