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The Chinese Facial Emotion Recognition Database (CFERD): A computer-generated 3-D paradigm to measure the recognition of facial emotional expressions at different intensities

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ABSTRACT

The Chinese Facial Emotion Recognition Database (CFERD), a computer-generated three-dimensional (3D) paradigm, was developed to measure the recognition of facial emotional expressions at different intensities. The stimuli consisted of 3D colour photographic images of six basic facial emotional expressions (happiness, sadness, disgust, fear, anger and surprise) and neutral faces of the Chinese. The purpose of the present study is to describe the development and validation of CFERD with nonclinical healthy participants ($N=100$; 50 men; age ranging between 18 and 50 years), and to generate normative data set. The results showed that the sensitivity index d' [$d'=Z$(hit rate)–Z(false alarm rate), where function $Z(p)$, $p\in[0,1]$], for all emotions was 0.94. The emotion was more readily detected in happiness, and less easily detected in surprise and sadness. In general, this study replicated the previous findings on the recognition accuracy of emotional expression with the Westerner faces. However, our paradigm extends the previous work by including a wider sensitivity range to differentiate subtle perception of emotion intensities. The CFERD will be a useful tool for emotion recognition assessment in affective neurosciences research, especially for the Chinese and cross-cultural studies.

1. Introduction

The recognition of emotions from others' faces is a universal and fundamental skill for social interaction (Ekman, 1992). Facial expressions have been used to investigate the neural substrates for emotional perception and emotional control. Over the past few decades, numerous studies have investigated how the types and strength of emotions are recognised from facial expression stimuli (Adolphs, 2002). In addition, studies have examined why and how the individuals with specific psychiatric or neurological illness (e.g., autistic spectrum disorder, affective disorder, schizophrenia, Huntington's disease or Alzheimer's disease) are impaired in their ability to recognise the facial expressions of emotion (Adolphs, 2002).

Many studies have been conducted to illuminate the universality of emotions and the exact characteristics that distinguish basic emotions (Ekmam, 1999). In general, there is evidence to support the fact that six universal basic emotions exist: happiness, anger, sadness, fear, disgust and surprise. These basic emotions have been used in studies investigating the sensitivity and differentiation of emotion perception of facial expressions (Young et al., 2002). In studies involving face perception, 2D static face images are often used. For example, the set of faces from the Pictures of Facial Affect database (Ekman and Friesen, 1976) consists of photographs of five males and six females displaying each of the six basic facial expressions and a neutral expression. Although this database has proved to be an invaluable tool to quantify emotion, there are only a small number of faces included. Other databases available to researchers include the Facial Recognition Technology (FERET) database, Richard's MIT database, the Yale Face Database, Korean Face Database (KFDB), Japanese Female Facial Expression (JAFFE) Database and the Chinese Academy of Sciences—Pose, Expression, Accessory and Lighting (CAS-PEAL) database (Gross, 2005). These databases are often composed of pictures with distinctive facial features, external facial paraphernalia (e.g., hair) and rather gross emotional strength gradation.

Although substantial research studies have documented the universality of several emotional expressions, others have shown evidence for cross-cultural differences of facial emotion recognition (Elfenbein and Ambady, 2002; Freeman et al., 2009). Some attention

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has been directed towards examining cultural differences (Ducci et al., 1982; Matsumoto, 1989; Mesquita and Frijda, 1992; Russell, 1994). Although accuracy levels for most groups in the studies were significantly above the levels expected from chance guessing, European and American participants generally scored higher in these studies using American expressions than did Asian or African participants (Ekman, 1972; Izard, 1971). A more recent study had also demonstrated an overgeneralisation effect that is related to the racial matching between the facial stimuli and the perceivers. White perceivers' stereotyping of Blacks and Asians has been shown to influence this emotional perception (Zebrowitz et al., 2010). In a study investigating the cross-cultural patterns in dynamic ratings of positive and negative natural emotional behaviour (Sneddon et al., 2011), the results indicate that there is substantial agreement across cultures in the valence and patterns of ratings of natural emotional situations but that participants from different cultures show systematic variation in the intensity rating of emotion. Furthermore, there is evidence that native Japanese in Japan and Caucasians in the United States showed greater amygdala activation to fear expressed by members of their own cultural groups (Chiao et al., 2008). Thus, it seems that although emotion recognition is universal across cultures, there is also a subtle cultural variation in recognition accuracy and intensities.

Increasing research has been dedicated to delineating the psychophysical relationship between the continua of emotional stimuli and the responses, neural processing and impairments of emotion recognition. For example, the amygdala and some of its functionally connected structures mediate specific neural responses to fearful expressions (Morris et al., 1998; Whalen et al., 2004), and the early visual processing of emotional faces can be influenced by amygdalar activity (Morris et al., 1998). Besides, it was found that the processing of visual and emotional information were attributable to the perception of eyes and brows (Radua et al., 2010). Furthermore, processing of emotional faces was associated with an increased activation in a number of visual, limbic, temporoparietal and prefrontal areas; the putamen; and the cerebellum; and selective differences between neural networks underlying the basic emotions in limbic and insular brain regions were found (Fusar-Poli et al., 2009). Those studies applied still black and white 2D photographs of facial expressions as experimental stimuli in most instances (Adolphs, 2002; Elfenbein and Ambady, 2002). Studies have applied stimuli of varying qualities obtained under differing conditions, mostly including posed emotions. The facial orientation of these 2D photographs is fixed or hard to manipulate with different viewpoints (from right to left, as well as up- and downward). Furthermore, most of the study paradigms had participants to identify or to recognise the categories of emotions illustrated in the photographs, instead of more sensitive task of rating their certainty of perception of emotional expressions at different intensities. There is evidence that some facial expressions (e.g., happiness) tend to reach the ceiling level easily and cause low differential power when applying the typical faces with intended emotions (Hess and Blairy, 2001; Palermo and Coltheart, 2004). In addition, those facial stimuli are typically of a restricted ethnicity and age ranges in which the Chinese faces are relatively sparsely used (e.g., FERET Database, Richard's MIT database and the Yale Face Database). Although the recently developed CAS-PEAL database provides a large-scale face database of Chinese, its expression variation concerning the facial affect is limited to smile, frown and surprised (Gao et al., 2008). Therefore, the need for establishing a computer-generated 3D paradigm based on facial expressions of Chinese is gathering strength. Thus, we developed the Chinese Facial Emotion Recognition Database (CFERD), a colour image database of facial expressions of Chinese people that can be used as a refined measuring tool for the study of affect behaviour and affective neurosciences. Moreover, we applied the computer-generated 3D paradigm to measure the recognition of facial emotional expressions at different intensities. The purpose of the present study, therefore, is to describe the development and validation of CFERD with nonclinical healthy participants, to generate a normative data set.

2. Materials and methods

2.1. Subjects and design

The study group consisted of 20 healthy nonclinical subjects for the first step and 80 healthy nonclinical subjects for the second-step procedure. They were recruited from community, with age ranging from 18 to 50 years. They had no past or current psychiatric disorders based on the Mini International Neuropsychiatric Interview (MINI) (Sheehan et al., 1998) and did not have any familial history of Axis I Disorders, Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV) disorder. Participants were excluded from the study if they met DSM-IV criteria for substance dependence within the previous 3 months, if they could not provide informed consent or if they had a documented neurological or ophthalmic condition.

2.2. Measures

Facial emotion recognition task

2.2.1. Image acquisition

Image acquisition was based on the FaceGen Modeller (Singular Inversions Inc., Toronto, Canada) software package. The 3D Chinese faces were obtained from its database of digital images (Fig. 1). This set of faces had been used in perceptual investigations in which race is a critical manipulation (Matheson and McMullen, 2011).

2.2.2. Validation study

A two-step procedure was used to validate the facial emotion recognition measurement. The participants were presented a series of face images which were programmed in a computer using the E-Prime (Psychology Software Tools Inc., Pittsburgh, USA) software package. The stimuli consisted of static colour photographic images of six basic facial emotional expressions (happiness, sadness, disgust, fear, anger and surprise) which were morphed between neutral faces to each basic emotional

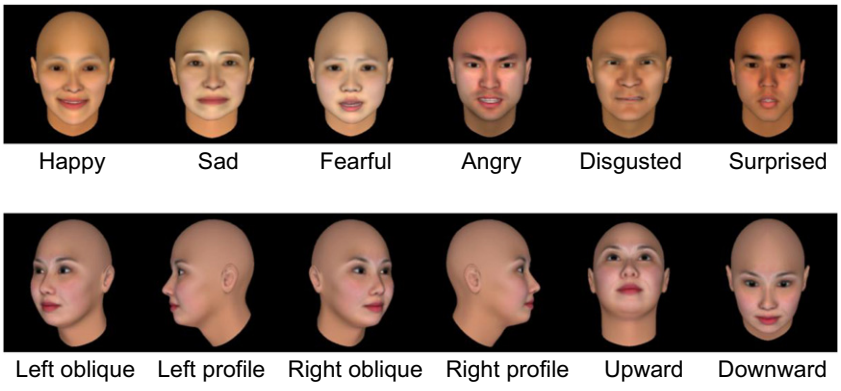

Fig. 1. Sample faces for the CFERD, which comprise pictures of men and women, each depicting six different facial expressions with different viewpoint.