Differences in facial expressions of four universal emotions

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Abstract

The facial action coding system (FACS) was used to examine recognition rates in 105 healthy young men and women who viewed 128 facial expressions of posed and evoked happy, sad, angry and fearful emotions in color photographs balanced for gender and ethnicity of poser. Categorical analyses determined the specificity of individual action units for each emotion. Relationships between recognition rates for different emotions and action units were evaluated using a logistic regression model. Each emotion could be identified by a group of action units, characteristic to the emotion and distinct from other emotions. Characteristic happy expressions comprised raised inner eyebrows, tightened lower eyelid, raised cheeks, upper lip raised and lip corners turned upward. Recognition of happy faces was associated with raised cheek, lid tightening and raised outer brow. Characteristic sad expressions comprised furrowed eyebrow, opened mouth with upper lip being raised, lip corners stretched and turned down, and chin pulled up. Only lower brow and raised cheek were associated with sad recognition. Characteristic anger expressions comprised lowered eyebrows, eyes wide open with tightened lower lid, lips exposing teeth and stretched lip corners. Recognition of angry faces was associated with lowered eyebrows, raised upper lids and lower lip depression. Characteristic fear expressions comprised eyes wide open, furrowed and raised eyebrows and stretched mouth. Recognition of fearful faces was most highly associated with raised upper lip and nostril dilation, although both occurred infrequently, and with raised inner brow and widened eyes. Comparisons are made with previous studies that used different facial stimuli.
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1. Introduction

Facial expressions are used in humans and animals for communication, in particular to convey one's emotional state (Darwin, 1965). This communication can be reflexive, as situations may evoke emotions

that are spontaneously expressed on the face. In other instances, particularly in humans, facial expressions may be volitional signals intended for communication and may not reflect the true emotional state of the person (Ekman and Friesen, 1975). Impairment in emotional processing, specifically emotion recognition, has been described in psychiatric disorders including schizophrenia, depression and bipolar disorder, and in neurological disorders (review: Kohler et al., 2004). Since the earliest descriptions of schizophrenia, decreased and muted facial expressions of emotions have been reported as a hallmark of the illness; however, there have been few attempts to investigate this impairment further in schizophrenia and other psychiatric disorders.

Six basic emotions—happiness, sadness, anger, fear, disgust and surprise—and their corresponding facial expressions are recognized across different cultures (Huber, 1931; Eibl-Eibesfeldt, 1970; Izard, 1971; Ekman and Friesen, 1975). Descriptions have been made about which facial muscles are involved in the formation of each of the basic emotions (Huber, 1931; Plutchik, 1962; Ekman and Friesen, 1975; Gosselin et al., 1997). For happy expressions, Ekman and Friesen (1975) described facial expressions of tense lower eyelids, raised cheeks and lip corners pulled up; for sad expressions, inner eyebrows raised and drawn together, and lip corners pulled down; for anger expressions, lowered eyebrows drawn together, tense lower eyelids, pressed lips or lips parted in a square shape; for fear expressions, eyebrows raised and drawn together, wide open eyes with tense lower eyelids and stretched lips. Based on facial muscle movement, Ekman and Friesen (1978) developed the Facial Action Coding System (FACS) by identifying the presence of specific actions of facial muscles called Action Units (AUs). Gosselin et al. (1997) tested Ekman and Friesen's predictions about facial expressions of six emotions in two conditions—posed or unfelt and evoked or felt. In that study, actors used two different methods of displaying facial expressions of six emotions—trying to experience the target emotion according to the Stanislawski technique, while expressing the emotion (evoked emotion) or merely displaying the emotion without the emotional experience (posed emotion). FACS analyses of facial expressions by a single rater revealed that AUs for each emotion were concordant with Ekman and

Friesen's descriptions. Occurrence rates of AUs for evoked and posed facial expressions showed considerable overlap, in particular for happy and surprise expressions. Other studies that investigated facial landmark changes associated with emotional expression focused on measurement of muscle activity with electromyography (EMG). Limitations of this methodology include that only select muscle groups, such as corrugator supercilii orbicularis oculi and zygomaticus major have been measured, showing the corrugator to be associated with sad and the zygomaticus with happy emotions (Schwartz et al., 1976). Tassinary and Cacioppo (1989) elucidated that expressions of action units involving brow and cheek regions are associated with discrete facial muscle activity as measured by surface EMG. More recently, considerable overlap has been shown between surface and intramuscular recordings of facial EMG during happy, sad and angry expressions (Aniss and Sachdev, 1996).

In our study, three certified FACS raters examined 128 images of extremely happy, sad, angry and fearful faces that were selected for use in a functional imaging study and piloted for recognition in a group of healthy subjects. Disgust was not included because of our assumption that it may not present a pure emotion, but rather a mixture of other universal emotions (Kohler et al., 2003). Surprise was not included because its valence depends entirely on the triggering event and it can therefore be any of the other emotions, with a rapid onset. The purpose of our study was to investigate which facial changes are most frequent in happy, sad, angry and fearful expressions, and which facial changes are essential for accurate recognition of the particular emotion. The study included the following specific aims: (1) Which action units characterize the different emotions? We hypothesized that each emotion can be defined by the presence of action units common to faces with the particular emotion. (2) Which action units distinguish different emotions from each other? We hypothesized that facial expressions of each emotion consist of unique action units that are distinct from other emotions. (3) How do posed and evoked emotions differ with respect to action units? We hypothesized that different action units are used for the expression of posed and evoked emotions. (4) Do men and women utilize different action units for the expression