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Emotional Empathy, Facial Reactions, and Facial Feedback

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Abstract
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The human face has a fascinating capability to express emotions. The facial feedback hypothesis suggests that the human face not only expresses emotions but is also able to send feedback to the brain and modulate the ongoing emotional experience. It has furthermore been suggested that this feedback from the facial muscles could be involved in empathic reactions. This thesis explores the concept of emotional empathy and relates it to two aspects concerning activity in the facial muscles. First, do people high versus low in emotional empathy differ in regard to in what degree they spontaneously mimic emotional facial expressions? Second, is there any difference between people with high as compared to low emotional empathy in respect to how sensitive they are to feedback from their own facial muscles? Regarding the first question, people with high emotional empathy were found to spontaneously mimic pictures of emotional facial expressions while people with low emotional empathy were lacking this mimicking reaction. The answer to the second question is a bit more complicated. People with low emotional empathy were found to rate humorous films as funnier in a manipulated sulky facial expression than in a manipulated happy facial expression, whereas people with high emotional empathy did not react significantly. On the other hand, when the facial manipulations were a smile and a frown, people with low as well as high emotional empathy reacted in line with the facial feedback hypothesis. In conclusion, the experiments in the present thesis indicate that mimicking and feedback from the facial muscles may be involved in emotional contagion and thereby influence emotional empathic reactions. Thus, differences in emotional empathy may in part be accounted for by different degree of mimicking reactions and different emotional effects of feedback from the facial muscles.

Keywords: Emotional empathy, facial feedback, facial expression, emotion, empathy, mirror neurons

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Contents

Introduction

A brief background

The human face has a fascinating capacity to express emotions. The facial feedback hypothesis suggests that the human face not only expresses emotions, but sends feedback to the brain and modulates ongoing emotional experience. Furthermore, it has been suggested that such feedback from the facial muscles could be involved in empathic reactions.

This thesis explores the concept of emotional empathy and relates it to two aspects of facial muscle activity. First, do people with high versus low emotional empathy differ in the degree to which they spontaneously mimic emotional facial expressions? Second, is there any difference between people with high versus low emotional empathy in how sensitive they are to feedback from their facial muscles?

Emotions

What is an emotion?

There is no single unifying definition or theory of emotion. Nevertheless, several characteristics of an emotional reaction are frequently mentioned. In the three-component model of emotion, an emotional reaction consists of three parts: physiological, expressive, and conscious experience (e.g., Dimberg, 1997b; Lang, 1968; Myers, 2001; Öhman, 1986).

According to the James–Lange somatic theory, an eliciting stimulus causes physiological reactions, which in turn send feedback to the brain, resulting in a conscious experience of emotion (e.g., James, 1884). According to this theory, the physiological reactions precede the conscious experience of emotion.

Cannon (1927) had some objections to the James–Lange somatic theory. First, animal studies indicated that separating the viscera from the central nervous system does not change emotional behavior. Second, the same visceral changes could even be found in non-emotional states. Third, due to a low density of sensory nerve fibers, viscera are not a sensitive structure. Fourth, the changes in viscera are too slow to cause the quick-changing emotions. Fifth, induction of visceral changes does not induce emotions. The Cannon–Bard theory suggests that an eliciting stimulus simultaneously evokes a physiological reaction and a conscious experience of emotion (Cannon, 1927; Bard, 1928).

The two-factor theory of emotion (Schachter, 1966), a cognitive–affective theory, claims that arousal level indicates our strength of feeling and that the situation helps us label the emotion in question. The two-factor theory and the James–Lange somatic theory both assume that physiological arousal precedes emotional experience.

Zajonc (1980) proposed that some emotional reactions precede cognition. In support of this, it has been suggested that the thalamus in the brain can send sensory information along two independent pathways, one to the amygdala and the other to the cerebral cortex (LeDoux, 2000; LeDoux & Phelps, 2000). This design makes it possible to react quickly to relevant emotional stimuli via the amygdala pathway, before the more time-consuming cognitive interpretation is finished in the cerebral cortex. It has been proposed that it is possible that not all emotional reactions reach consciousness (e.g., LeDoux, 2000; LeDoux & Phelps, 2000). Lazarus (1982) emphasized that emotional response requires appraisal, but that such appraisal need not be conscious.

Emotions are commonly described as comprising several dimensions or a set of basic emotions. In the dimensional view, some authors have suggested two dimensions (Russell & Carrol, 1999; Watson, Wiese, Vaida, & Tellgren, 1999), one dimension being positive versus negative emotion and the other high versus low arousal. High arousal and positive valence means having positive energy, such as when excited. High arousal and negative valence could be exemplified by being fearful. Low arousal and positive valence could be described as a calm mental condition and, finally, low arousal and negative valence could be exemplified by sadness.

Fontaine, Scherer, Roesch, and Ellsworth (2007) proposed a four-dimensional model: evaluation-pleasantness, potency-control, activation-arousal, and unpredictability. This model can resolve the differences between more emotions than can the model with only two dimensions.

As mentioned above, some authors have preferred to describe emotions in terms of a number of basic emotions with discrete characteristics. In line with this and in opposition to the dimensional view, Izard (1992) stressed that basic emotions have unique feeling-motivating states and expressions that broad dimensions, such as high versus low arousal and positive versus negative valence, cannot capture. The basic emotions are supposed to have a biological basis (e.g., Darwin, 1872/1965; Ekman, 1973; Izard, 1991; Plutchik, 1991). Tomkins (1962) has further suggested that biologically given affect programs control emotional reactions, and he emphasized that the facial muscles function as a feedback system for emotional experience. In further support of the theory of basic emotions, it has been suggested that genetically coded emotional reaction systems are "wired" into the nervous system (e.g., Panksepp, 2007). There has been discussion of what emotions should be considered basic. Ekman (1992) suggested that happiness, sadness, fear, disgust, surprise, and anger are basic emotions, and raised the possibility that contempt, shame, guilt, embarrassment, and awe may also be found to be basic emotions. Plutchik (1991) argued that anger, fear, joy, disgust, anticipation, surprise, sorrow, and acceptance are basic emotions. In addition, Plutchik (2002) suggested that combinations of basic emotions can form certain mixed emotional states; for example, the basic emotions disgust and anger could combine to form the emotional states hatred or hostility.

Furthermore, distinct patterns in the autonomic nervous system (ANS) have been found for the negative emotions fear, anger, and disgust (Ekman, Levenson, & Friesen, 1983; Levenson, 1992; Levenson, Ekman, & Friesen, 1990). On the other hand, no distinct ANS pattern has been reported for positive emotions such as surprise or enjoyment. Ekman (1992) argued that there is no instant need for motor activity, with survival value, connected to positive emotions, in contrast to negative emotions, which are thought to be connected to responses such as flight or fight. This may explain why no distinct ANS patterns have evolved for positive emotions. There has been some criticism of the findings of emotion specific ANS patterns. For instance, the results from a meta-analysis by Cacioppo, Berntson, Larsen, Poehlmann and Ito (2000) did not support some of the emotion specific reaction patterns in the autonomic nervous system regarding fear reported in Levenson (1992). For a review of the psychophysiology of emotion, see Larsen, Berntson, Poehlmann, Ito and Cacioppo (2008).

What functions do emotions have?

From an evolutionary viewpoint, emotions are the result of millions of years of natural selection and are designed to solve problems related to survival and reproduction that were encountered frequently during evolution. In accordance with this, and in line with the concept of basic emotions, Plutchik (2002) suggested that emotions are adaptation patterns that increase the chances of individual and genetic survival. Cosmides and Tooby (2000, 2008) proposed that emotions are evolutionary adoptions that influence and control a great number of subordinate programs, such as goals, motivational priorities, information-gathering motivations, imposed conceptual frameworks (the emotional state determines what categories become evident), perception, memory, attention, physiology, emotional expressions and communication, behavior, specialized inference, reflexes, learning, and energy level.

Rolls (1990) identified a number of functions of emotion. First, emotion elicits endocrine and automatic responses in order to prepare for actions. For example, increased heart rate could be interpreted as preparation for rapidly escaping a dangerous situation or as preparation for fighting. Second, emotion makes flexible behavioral responses possible, allowing one to consider the situation before responding (Gray, 1975). Third, emotion serves a motivating function: in their most basic form, positive emotions motivate approaching behavior and negative emotions motivate avoidance (Gray, 1975). Fourth, emotions have communicating functions. The ability to send and receive emotional messages could, from an evolutionary viewpoint, have a survival value because, for example, it is essential to know who is friendly and who is hostile. Fifth, emotion serves to increase social bonding. Attachment between parent and child and between parents increases the child's chances of survival (Dawkins, 1989; in Rolls, 1990). Sixth, emotions affect the evaluation of memories and events (Blaney, 1986). Seventh, emotions can improve the storage of memories, while emotions highlight what should be stored in memory. Furthermore, the emotional state can affect what memories are easy to recall.

Throughout evolution, there has been a survival advantage to avoiding dangerous situations. The prepared learning theory (Dimberg, 1983; Seligman, 1970, 1971; Seligman & Hager, 1972; Öhman, 1986) suggests that certain fear-relevant stimuli are easy to learn and resistant to extinction. Humans and other species are thought to be inherently predisposed to quickly learn to fear such stimuli. In particular, stimuli associated with phobic reactions, for example to snakes or spiders, are easy to learn to fear and resistant to extinction (e.g., Öhman, 1986). Furthermore, Dimberg (1983) studied angry and happy faces in an aversive electrodermal conditioning paradigm. In support of the prepared learning theory, it was concluded that angry faces, unlike neutral and happy faces, produced a persistent conditioning effect.

Emotion and facial expressions

It has been suggested that some emotions are primary and associated with distinct facial expressions. Ekman (1973) proposed that fear, anger, sadness, happiness, disgust, and surprise are basic emotions and associated with distinct facial expressions. Discrete facial expressions have been demonstrated to correspond to subjective emotional experience (e.g., Ekman, Friesen, & Ancoli, 1980; for a review see, Matsumoto, Keltner, Shiota, O'Sullivan, & Frank, 2008). Darwin (1872/1965) proposed that human facial expressions are evolved phenomena that serve important communicative functions. Darwin emphasized the similarity between emotional expressions in humans and animals. In Darwin's view, emotional expressions are remnants of more complete behavioral actions. The expression of anger, for example, is a remnant of an attacking behavior with furrowed brow and displayed teeth. In support of this evolutionary view of facial expressions, only 36 hours after birth, human neonates have been found to be able to imitate facial expressions (Field, Woodson, Greenberg, & Cohen, 1982). Other studies of nonhuman primates provide additional support for this evolutionary proposition (e.g., Andrew, 1963).

Moreover, cross-cultural studies have found supporting evidence that the facial expressions for anger, fear, enjoyment, sadness, and disgust are distinct and universal (e.g., Ekman, 1992). On the other hand, a critical review of Russell (1994) suggested that posed facial expressions, forced-choice response format and within-subjects design may have contributed to the results and it was concluded that facial expressions and emotion labels probably are related but that the relation to some degree vary with culture.

Tomkins (1962, 1963) suggested that emotional facial expressions are generated by emotion-specific, evolution-based “affect programs”; in support of this notion, it has been proposed that genetically coded emotional reaction systems are “wired” into the nervous system (e.g., Panksepp, 2007).

Furthermore, it has been suggested that humans are biologically disposed not only to sending emotional messages through the facial expression, but also to receiving them (e.g., Dimberg, 1997b). Dimberg, Thunberg, and Elmehed (2000) demonstrated that this ability to interpret and respond to emotional facial expressions functions even at a subconscious level. Unconscious exposure to happy faces evoked distinct facial reactions in the zygomatic major muscle involved in smiling, while angry faces evoked distinct reactions in the corrugator supercilii muscle involved in angry frowning expressions. In accordance with this, it has been demonstrated that exposure to distinct emotional facial expressions results in different activation patterns in the brain (e.g., Blair, Morris, Frith, Perrett, & Dolan, 1999; Breiter et al., 1996; Whalen et al., 1998). Based on these findings, Matsumoto et al. (2008) proposed that this indicates that humans are equipped with distinct emotion perception systems.

In addition to functioning as a communicative channel to the environment, facial expressions are thought to function as a feedback system *within* the individual. The facial feedback hypothesis suggests that feedback from the facial muscles modulates ongoing emotional experience and, according to a strong version of the hypothesis, even initiates emotional reactions. For a more thorough discussion, see the chapter “Facial feedback” later in the present thesis.

How to measure facial reactions?

The human face contains a large number of muscles and a single facial expression involves the action of several individual muscles (e.g., Hjortsjö, 1970), see Figure 1 below for an illustration of the facial muscles. One way to measure facial reactions is to use some kind of coding system. Ekman and Friesen (1976b), who developed the Facial Action Code (FAC), took as their starting point the analysis of the anatomical basis of facial movement. Their method can be used to describe visible facial movements.

Another approach to measuring facial reactions is to use facial electromyography (EMG), which has been found to be a sensitive tool for measuring facial reactions (e.g., Dimberg, 1990). EMG can supply unbiased measurements of even small facial muscle reactions that no visual coding technique can capture. In EMG measurements, electrodes are attached to the surface of the skin above the studied facial muscles. Fridlund and Cacioppo (1986) described in detail the technical issues and placement of electrodes in EMG research. Positive emotional reactions have been found to be related to increased tension in the zygomatic major muscle, which is activated in a smiling reaction. Negative emotional reactions have, on the other hand, been found to relate to increased tension in the corrugator supercilii muscle, which is involved in lowering the brow to form a frown in an angry facial expression. For cognitive induced emotions, Schwartz, Fair, Salt, Mandel, and Klerman (1976) found that subjects reacted with corresponding positive and negative facial muscle activity in the zygomatic major muscle and the corrugator supercilii muscle when imagining happy, angry, and sad situations. Other studies have found positive and negative facial reactions to external stimuli such as pictures of emotional facial expressions. Several studies have demonstrated positive facial reactions among subjects shown pictures of faces expressing happiness and negative facial reactions among subjects shown pictures of faces expressing anger (e.g., Dimberg, 1982, 1990). It has been suggested that humans are biologically predisposed to having different facial reactions to different emotional facial expressions (Buck, 1984; Dimberg, 1997b).

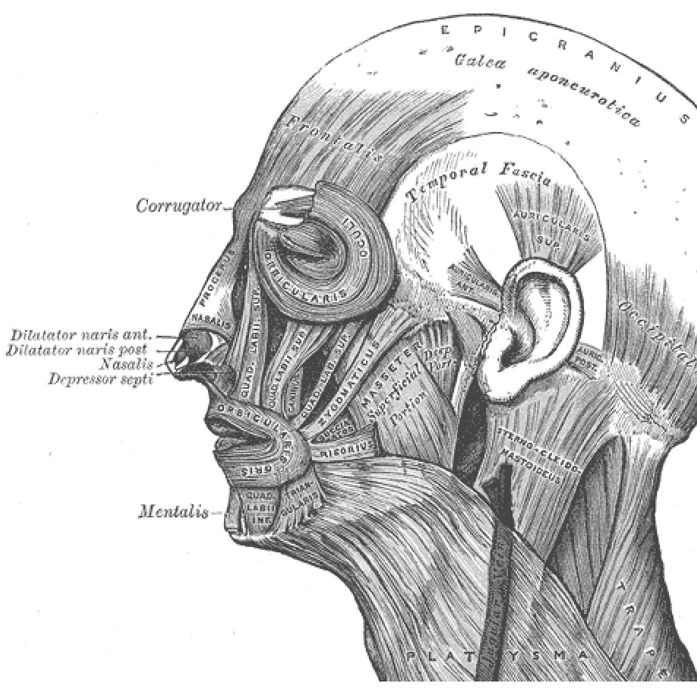

Figure 1. An illustration of the facial muscles adapted from the 20th U.S. edition of Gray's Anatomy of the Human Body, originally published in 1918 (Retrieved May 18, 2010, from http://en.wikipedia.org/wiki/File:Gray378.png).

Facial feedback

What is facial feedback?

The facial feedback hypothesis can be traced to Darwin (1872/1965), who proposed that an explicitly expressed emotion will be intensified and that, if such expression is repressed, the emotion will be less intense. When Darwin (1872/1965) discussed emotional expression and feedback effects, he had the whole body in mind. Later, James (1884) proposed that conscious emotion is based on bodily changes that precede the conscious emotion (feeling). James (1884) was concerned not only with the facial muscles, but also, for example, with circulatory, visceral, and respiratory changes. Cannon (1927) pointed out that the changes James (1884) proposed to cause the subjective experience of emotion were too slow and too diffuse to discriminate between emotions. According to Cannon, the alteration of physiology and conscious emotions are parallel processes, neither of which precedes the other.

Tomkins (1962) placed greater emphasis on the specific role of the face in the subjective experience of emotions. Tomkins argued that the facial muscles and receptors have a high density of neurons and send feedback to the brain. According to Tomkins, innate “affect programs” are activated by various stimuli and affect the facial muscles. Facial muscles in turn send sensory feedback to the brain. This feedback to the brain can reach a conscious level, though it can also be active at an unconscious level. Tomkins (1991) later came to regard the skin receptors of the face as more important than the facial muscles to facial feedback effects.

The facial feedback hypothesis states that facial expression affects the subjective experience of emotions (for reviews, see Adelmann & Zajonc, 1989; Cornelius, 1996; Matsumoto, 1987; McIntosh, 1996; Soussignan, 2002). There are several versions of the facial feedback hypothesis. The *necessity hypothesis* claims that facial feedback is required for emotional experience. Keillor, Barrett, Crucian, Kortenkamp, and Heilman (2002) more or less ruled out this hypothesis when they investigated a patient suffering from bilateral facial paralysis. The patient reported normal emotional reactions when shown emotionally evocative slides, despite being unable to react with the facial muscles and consequently not obtaining any facial feedback. According to the *sufficient hypothesis*, emotional facial expressions can initiate emotional experience without any external emotional stimuli, and a review (Adelmann and Zajonc, 1989) found some support for the hypothesis. Finally, the *modulation hypothesis* suggests that emotional facial expressions can modulate an ongoing emotional experience. The modulating version of the facial feedback hypothesis has been supported by a number of studies over many years (e.g., Dimberg & Söderkvist, 2009; Duncan & Laird, 1977, 1980; Flack, 2006; Flack, Laird, & Cavallaro, 1999; Laird, 1974; Rhodewalt & Comer, 1979; Strack, Martin, & Stepper, 1988). “The facial feedback hypothesis” usually refers to the *modulating* version of the hypothesis and will do so in the present thesis.

How does facial feedback work?

Izard (1971) and Tomkins (1962) suggested that proprioceptive patterns send feedback to the brain, while Tomkins (1980) suggested that cutaneous sensation supplies such feedback. Gellhorn (1964) proposed that facial contraction patterns interact with cutaneous facial impulses in the cortex, while Ekman (1984) believed that the motor cortex was connected to facial muscles and simultaneously sent information to hypothalamic areas to stimulate activity in the autonomic nervous system. Laird (1974, 1984) proposed that self-perception was one way for facial feedback to work. In Laird’s view, an eliciting stimulus leads to changes in physiological arousal and in expressive patterns, such as facial expressions, and these two components are involved in an emotional self-attribution process. Zajonc, Murphy, and McIntosh (1993) suggested that changes in brain temperature regulate the emotional experience, as follows: Facial muscles involved in emotional expressions regulate hypothalamus temperature, by regulating the flow of blood cooled by nasal breathing. The cooling of the hypothalamus in turn affects the emotional experience. Lower temperature in the hypothalamus is associated with positive emotions and higher temperature with negative emotions. Zajonc et al. (1993) tested this hypothesis by introducing cold or warm air into the nasal cavity; the results indicated that cool air was pleasant and warm air unpleasant. In addition, Hennenlotter et al. (2009) found that botulinum toxin-induced denervation of the corrugator supercilii muscle, which is involved in angry facial expressions, reduced the activation of central circuitries of emotion in the brain during the intentional imitation of angry facial expressions. This finding supports the assumption that feedback from the facial muscles and/or skin modulates emotional reactions, as suggested by the facial feedback hypothesis. To sum up, how facial feedback works is not understood in detail, but sensory feedback from the facial muscles and/or skin is the most frequently suggested mechanism.

What is the function of facial feedback?

Facial feedback may have consequences at both the intra- and inter-person levels. At an intra-person level, facial feedback is thought to play a role in emotional reactions. As mentioned above, facial reactions may constitute an essential aspect of emotional reactions (e.g., Dimberg, 1997a). Furthermore, feedback from one’s own facial reactions may affect the unfolding of one’s emotional process (e.g., Tomkins, 1962). At an inter-person level, facial feedback may be involved in transferring emotional states between people through a process that, via mimicking and facial feedback, results in emotional contagion (e.g., Hatfield, Rapson, & Le, 2009). As mentioned above, the tendency to mimic facial expressions can be both automatically and unconsciously evoked (Dimberg, 1997a; Dimberg et al., 2000). Furthermore, it has been found that subjects not only mimic various facial expressions, but also report experiencing emotion corresponding to the mimicked expressions (Dimberg, 1988; Lundqvist & Dimberg, 1995). This emotional contagion has some evolutionary advantages. Emotional contagion through facial feedback facilitates the creation of "resonance" between people's emotional states. This emotional resonance may play a role in the process of emotional attachment between parent and child (e.g., Ekman & Oster, 1979). Furthermore, the ability to detect another's state of mind could be an evolutionary advantage: if one person is afraid, then it may be an adaptive response, with survival value, for another person to be afraid too. In addition, a study by Stel, van den Heuvel, and Smeets (2008) found that adolescents with autistic spectrum disorders (ASD) do not experience feedback from facial expressions as controls do. This indicates that absence of facial feedback may be involved in the social interaction problems frequently experienced by people with ASD. Furthermore, the ability to react emotionally to another person and experience an emotion corresponding to his/hers has been proposed to be an important aspect of emotional empathy (e.g., Davis, 1996; Levenson & Ruef, 1992).

How to study facial feedback?

The classical way to study the facial feedback effect is to instruct the participants to contract specific facial muscles associated with specific emotions (e.g., Flack, 2006; Laird, 1974) and to let them rate their subjective experience of emotion. It is facial configuration and the contraction of specific facial muscles that is thought to give rise to the facial feedback effect. In this type of study, the true aim must be concealed by a cover story to minimize the possibility of experimental expectations influencing the results. Flack (2006) investigated the influence of facial expressions, vocal expressions, and bodily postures on the emotional experience of surprise, disgust, happiness, fear, sadness, and anger. Bodily postures and facial expressions tended to affect self-rated emotions, with the strongest effect for facial expressions. The instructions for producing facial expressions, for example, for happiness, were "draw the corners of your mouth up and back, letting your mouth open a little" and for anger "push your eyebrows together and down. Clench your teeth tightly, and push your lips together." Furthermore, Strack et al. (1988) found support for the facial feedback hypothesis using a method in which the participants held a pen between their teeth to make a happy facial expression or a pen between their lips to make a not happy/sulky facial expression.

The facial feedback effect has been replicated a number of times (for reviews, see Cornelius, 1996; Matsumoto, 1987; McIntosh, 1996; Soussignan, 2002). However, there has also been some criticism of the facial feedback hypothesis. For example, Tourangeau and Ellsworth (1979) investigated the emotions fear and sadness by letting participants watch films supposed to elicit fear, sadness, or no emotion while they held their facial muscles in positions corresponding to fear, sadness, none-emotional grimace, or no instructions at all. No significant effects of facial expressions on self-rated emotions were found in this study. The results of Tourangeau and Ellsworth (1979) may indicate that it is difficult to differentiate between facial feedback effects arising from various negative emotions, such as fear and sadness. It has further been proposed that the facial feedback effect could be affected by situational demands (e.g., Buck, 1980; Ekman & Oster, 1982). Buck (1980) first identified the risk that adopting a facial expression could lead the participant, either consciously or unconsciously, to understand what emotion the experimenter wished the participant to experience and to respond in line with that expectation in self-reporting emotions.

In response to criticism that the facial feedback effect could be due to situational demands, Strack et al. (1988) developed a methodology that dealt with these problems and still obtained a facial feedback effect. First, Strack et al. used a between-subjects design to minimize the risk of participants seeing through the cover story. Second, they used a convincing cover story about developing tools to allow handicapped people to use the mouth instead of the hand for writing. Third, instead of instructing participants on how to adopt facial expressions, they let the participants hold a pen between their teeth (happy condition) or between the lips (not happy/sulky condition). Fourth, instead of directly asking participants how they felt, they let them rate funny cartoons with respect to funniness. The underlying assumption was that, if feedback from the face influenced emotions, it would also influence the ratings of the funny cartoons in the same direction. Fifth, they asked participants afterwards if they had seen through the cover story, but no one had.

In one alternative approach to testing the facial feedback hypothesis, Davis, Senghas, and Ochsner (2009) found that inhibiting facial expressions reduced the emotional experience when watching negative and neutral video clips but had no effect for positive video clips. Furthermore, Hennenlotter et al. (2009) reported that facial feedback from an intentional angry expression modulated neural activity in emotion-relevant circuitries in the brain. A review (Adelmann and Zajonc, 1989) of a large number of facial feedback studies concluded that the subjective experience of emotion increased when facial posing was congruent with an emotional stimulus and that inhibition of facial posing reduced subjective experience of emotion.

Empathy

What is empathy?

There is unfortunately no single common definition of empathy. The concept of sympathy has also been used, and there is overlap between the concepts of empathy and of sympathy. As Batson (2009) put it, "With remarkable consistency exactly the same state that some scholars have labeled empathy others have labeled sympathy." The following are some of the definitions that have emerged. Dymond (1949) used the term empathy to refer to "the imaginative transposing of oneself into the thinking, feeling and acting of another and so structuring the world as he does." Stotland (1969) defined empathy as "an observer's reacting emotionally because he perceives that another is experiencing or is about to experience an emotion." Wispé (1986) defined empathy as "the attempt of one self-aware self to understand the subjective experiences of another self," and proposed that empathy was a way of knowing. Wispé (1986) referred to sympathy as "the heightened awareness of another's plight as something to be alleviated," suggesting that sympathy is a way of relating. For Levenson and Ruef (1992) empathy is the ability to detect how another person is feeling while Decety and Jackson (2004) defined empathy as:

> Empathy accounts for the naturally occurring subjective experience of similarity between the feelings expressed by self and others without losing sight of whose feelings belong to whom. Empathy involves not only the affective experience of the other person's actual or inferred emotional state but also some minimal recognition and understanding of another's emotional state.

Hoffman (2008) defined empathy as "an emotional state triggered by another's emotional state or situation, in which one feels what the other feels or would normally be expected to feel in his situation." Furthermore, Batson (2009) identified eight distinct uses of the term "empathy" in scientific study of the concept:

1. "Knowing Another Person's Internal State, Including His or Her Thoughts and Feelings"
2. "Adopting the Posture or Matching the Neural Responses of an Observed Other"
3. "Coming to Feel as Another Person Feels"
4. "Intuiting or Projecting Oneself into Another's Situation"
5. "Imaging How Another is Thinking and Feeling"
6. "Imaging How One Would Think and Feel in Other's Place"
7. "Feeling Distress at Witnessing Another Person's Suffering"
8. "Feeling for Another Person Who is Suffering"

To sum up, the ability to share another person's inner life and, based on this sharing, react is the hallmark of empathy. The reactions in question can be divided into two main classes, cognitive and emotional reactions. Cognitive reactions refer to the ability to understand the situation of another. Having an emotional reaction means reacting emotionally based on another's situation, so empathy can be divided into two main dimensions, emotional empathy and cognitive empathy. Emotional empathy refers to becoming emotionally aroused in response to the emotional state of another (e.g., Mehrabian and Epstein, 1972; Davis, 1996; Jackson, Melzoff, & Decety, 2005). In contrast, cognitive empathy refers to the ability to infer mental states and adopt the perspective of another (e.g., Davis, 1996). In support of the division into cognitive and emotional empathy, Nummenmaa, Hirvonen, Parkkola, and Hietanen (2008) reported that emotional and cognitive empathy have different characteristic activation patterns in the brain. Furthermore, Shamay-Tsoory, Aharon-Peretz, and Perry (2009) found that lesions in different anatomical structures reduced emotional and cognitive empathy, respectively.

Davis (1996) proposed that emotional and cognitive empathy are two related but distinct constructs in an organizational model of empathy. His model includes several constructs concerning the responses of one individual to the experiences of another. These constructs include processes taking place within the observer as well as the affective and nonaffective outcomes resulting from those processes.

How and why empathy has evolved are intriguing questions. According to de Waal (2008), emotional empathy is a phylogenetically ancient capacity: shared representations are automatically triggered with the perception of another's emotional state, which in turn leads to a matching emotional state in the observer. Supporting this evolutionary view, Langford et al. (2006) reported an intensified pain response in mice seeing other mice in pain. Cognitive empathy, perspective taking, and concern for others are thought to be aspects of empathy that developed later in evolutionary history, as they require high cognitive capacity (e.g., de Waal, 2008).

Empathy and mirror neurons

It has been suggested that mirror neurons are involved in mimicry and thereby emotional contagion and empathy (Iacoboni, 2005). A mirror neuron is a neuron that fires both when an action is performed and when the same action is *observed* in another (e.g., Rizzolatti & Craighero, 2004). Blakemore and Frith (2005) proposed the existence of a mirror system with three levels. The first level involves automatic contagion from biological movements. The second level is a mirroring system that requires biological movements and goal-directed actions for activation. At the third and highest level, intentions are supposed to be mirrored. Thus, the first level, which does not require goal activation, may be involved in mimicking emotional facial expressions and thereby in emotional contagion through feedback from the facial muscles.

How to measure empathy?

Several empathy measures are available that apply various definitions of empathy and focus on either its emotional or cognitive aspects. For a review of empathy measures, see Chlopan, McCain, Carbonell, and Hagen (1985) and Davis (1996).

The Interpersonal Reactivity Index (IRI) was constructed to measure both the emotional and cognitive aspects of empathy (Davis, 1980, 1983). The IRI consists of four subscales. The perspective-taking (PT) scale measures "the tendency to spontaneously adopt the psychological point of view of others." The fantasy scale (FS) assesses the respondents' tendency to "transpose themselves imaginatively into the feeling and actions of fictitious characters in books, movies, and plays." The last two subscales tap emotional reactions. The empathic concern (EC) scale "assesses 'other-oriented' feelings of sympathy and concern for unfortunate others," while the personal distress (PD) scale "measures 'self-oriented' feelings of personal anxiety and unease in tense interpersonal settings." Baron-Cohen and Wheelwright (2004) remarked that the IRI may capture processes beyond the construct of empathy, processes such as imagination and emotional self-control.

The Empathy Quotient (EQ) of Baron-Cohen and Wheelwright (2004) is an empathy measure that includes items intended to capture both cognitive and affective components of empathy. According to Baron-Cohen and Wheelwright (2004), the EQ was developed as a pure measure of empathy. The EQ represents a relatively new attempt to measure empathy and needs to be validated against existing measures.

Two widely used measures of empathy are the Hogan Empathy Scale and the Questionnaire Measure of Emotional Empathy (QMEE). The Hogan Empathy Scale focuses on the cognitive aspect of empathy (Hogan, 1969), defining empathy as "the intellectual or imaginative apprehension of another's condition or state of mind." The Hogan Empathy Scale has been found to capture role-taking ability and, to some extent, degree of social functioning (Chlopan et al., 1985; Davis, 1996).

The QMEE (Mehrabian & Epstein, 1972) attempts to measure emotional empathy defined as "a vicarious emotional response to the perceived emotional experiences of others." According to Mehrabian and Epstein (1972) and Stotland (1969), there is a critical difference between empathic emotional responsiveness and the cognitive role-taking process.

The QMEE consists of 33 items, the responses to which range from +4 (very strong agreement) to –4 (very strong disagreement), with 0 (don't know) in the middle. The 33 items are divided in seven inter-correlated subscales, as follows: "Susceptibility to emotional contagion," "Appreciation of the feelings of unfamiliar and distant others," "Extreme emotional responsiveness," "Tendency to be moved by others' positive emotional experiences," "Tendency to be moved by others' negative emotional experiences," "Sympathetic tendency," and "Willingness to be in contact with others who have problems."

"Susceptibility to emotional contagion" is measured by items such as "People around me have a great influence on my moods," stronger agreement indicating higher emotional empathy. "Appreciation of the feelings of unfamiliar and distant others" is represented by items such as "Lonely people are probable unfriendly," stronger agreement indicating lower emotional empathy. "Extreme emotional responsiveness" is measured by items such as "Sometimes the words of a love song can move me deeply," stronger agreement indicating higher emotional empathy. "Tendency to be moved by others' positive emotional experiences" is captured by items such as "Another's laughter is not catching for me," stronger agreement indicating lower emotional empathy. "Tendency to be moved by others' negative emotional experiences" is captured by items such as "seeing people cry upsets me," stronger agreement indicating higher emotional empathy. "Sympathetic tendency" is measured by items such as "It is hard for me see how some things upset people so much," stronger agreement indicating lower emotional empathy. "Willingness to be in contact with others who have problems" is represented by items such as "When a friend starts to talk about his problems, I try to direct the conversation to something else," stronger agreement indicating lower emotional empathy.

The QMEE primarily measures parallel responses, but includes some responses that could be regarded as not parallel or possibly reactive. A *parallel* emotional response refers to an emotional response in the receiving person that matches the sender's emotional state, while a *reactive* emotional response refers to a receiver's emotional response that differs from the sender's. One QMEE item that could be regarded as measuring a not-parallel or possibly reactive outcome is: "It upsets me to see helpless old people." A response that agrees with this statement is interpreted as indicating higher emotional empathy.

Mehrabian and Epstein (1972) were guided by two basic hypotheses when developing the QMEE. First, a person with high emotional empathy is less likely to engage in aggressive behavior, particularly when cues from the victim are immediate. Second, a person with high emotional empathy is more likely to engage in helping behavior when he or she notices distress in another. These two hypotheses were confirmed experimentally by Mehrabian and Epstein (1972).

Furthermore, females and males were found to differ significantly in their scores on the QMEE. In connection with this, Eisenberg and Lennon (1983) found sex differences in self-reported scales of empathy, with females scoring higher than males. On the other hand, when physiological reactions or nonverbal reactions to another's emotional state were measured, no distinct sex differences were found. Thus, Eisenberg and Lennon (1983) suggested that the sex differences in self-reported empathy scales may be explained by differences between the sex roles of males and females that became apparent in self-reported scales.

There has been some criticism of the QMEE. Jolliffe and Farrington (2006) remarked that the scale was not a pure measure of emotional empathy, because it includes items with some cognitive aspects of empathy as sympathy. According to Jolliffe and Farrington (2006), sympathy, unlike emotional empathy, could involve an emotional reaction that need not be the same as that of the target. A *reactive* emotional response, according to Jolliffe and Farrington (2006), should be regarded as sympathy. Furthermore, they criticized the QMEE because it was validated on university students. Baron-Cohen and Wheelwright (2004) remarked that the QMEE may measure emotional arousability in general rather than arousability to other people's emotions in particular. Chlopan et al. (1985) noted that people scoring high on the QMEE tended to score high on neuroticism measures, and suggested that arousability was the underlying construct tying these findings together. In conjunction with this, Mehrabian, Young, and Sato (1988) regarded the emotional empathic tendency (emotional empathy) as in part a subcategory of the more general arousability construct. According to Mehrabian et al. (1988):

> Arousability is a measure of how much one is affected emotionally (indexed by arousal) by complex, unusual, or varied events. Empathic tendency is in part a subcategory of arousability since it assesses how much a person is affected emotionally by others' emotional expressions (which, in turn, are high information, complex, unexpected, or varied events). It follows that emotional empathy and arousability should be positively and highly correlated.

Mehrabian (1977) found the correlation between a measure of stimulus screening (the converse of arousability) and the QMEE to have a correlation coefficient of –.65 ($p < .01$), meaning that higher emotional empathy is related to higher arousability.

Emotional empathy and physiological reactions

Wiesenfeld, Whitman, and Malatesta (1984) investigated physiological reactions in females with extreme high versus low emotional empathy, measured using the QMEE, when shown videotaped scenes of smiling, crying, and quiescent 5-month-old infants. The group with high emotional empathy displayed larger skin conductance responses to the stimuli video clips than did the group with low emotional empathy. In self-reports of emotional reactions, people with high versus low emotional empathy were found to report higher levels of sadness when shown video clips of crying infants. Furthermore, people with high versus low emotional empathy reported a stronger desire to pick up infants. In addition, the group with high versus low emotional empathy tended to smile more when shown video clips of smiling infants. The results further revealed that the group with high versus low emotional empathy differed significantly in the waveform of the cardiac response. In addition, the group with high emotional empathy tended to display changed heart rate, whereas no tendency to changed heart rate in response to the stimuli video clips was evident in the group with low emotional empathy.

Sonnby-Borgström (2002) investigated facial reactions of people with high versus low emotional empathy who were shown pictures of happy and angry facial expressions. Emotional empathy was measured using the QMEE and the facial reactions were measured using electromyography (EMG) for four levels of exposure time: the pre-attentive (17 ms), automatic (17–40 ms), medium (45–75 ms), and controlled (100–1000 ms) levels. At the pre-attentive level, no significant mimicking reaction was found. At the automatic level, people with high empathy tended to mimic the facial expressions depicted in the presented pictures, but there was no such tendency in the low-empathy group. When exposures times were at the medium level, the high-empathy group was found to mimic the facial expressions in presented pictures, smiling when shown a happy facial expression and frowning when shown an angry expression; the low-empathy group, however, tended to smile when shown angry faces. At the controlled level, no mimicking reactions could be detected in either the high- or low-empathy group. Furthermore, an interaction effect between self-reported feelings and emotional empathy was found for the zygomatic major muscle, which is involved in smiling facial reactions. This interaction effect arose because people with low empathy were found to smile more when reporting negative feelings, while people with high empathy tended to smile less when reporting negative feelings. This interaction effect was not obtained for the corrugator supercilii muscle, which is involved in frowning facial reactions.

Sonnby-Borgström, Jönsson, and Svensson (2003) replicated the study by Sonnby-Borgström (2002), showing pictures of happy and angry facial expressions to subjects for 17, 56, and 2350 ms. At a pre-attentive level (17 ms), no mimicking reaction was found in either the low- or high-emotional-empathy groups. At an automatic level (56 ms), the group with high emotional empathy reacted with a significant mimicking reaction consisting of increased activity in the zygomatic major muscle when shown happy faces versus angry faces and increased activity in the corrugator supercilii muscle when shown angry versus happy faces. No significant mimicking reaction was reported in the low-empathy group. When the exposure time was at a controlled level (2350 ms), the high-empathy group tended to mimic. At the same exposure level, the low-empathy group tended to increase the activity in the zygomatic major muscle when shown pictures of angry faces. However, note that a mimicking reaction when exposed to angry and happy faces probably consists of one component of imitating and one component of positive or negative emotional reaction. For a further discussion of this subject, see Lundqvist and Dimberg (1995) and Lundquist (1995).

In summary, people with high versus low levels of emotional empathy, measured using the QMEE, seem to display stronger electrodermal responses, stronger self-reported emotional reactions, a stronger desire to pick up infants, and a higher propensity to mimic facial expressions. Two studies reported that people with low emotional empathy tended to display an inverse reaction in the zygomatic major muscle when shown pictures of angry facial expressions; that is, they tended to smile when shown angry faces. In addition, people with low emotional empathy were found to smile more when reporting negative feelings, while people with high emotional empathy tended to smile less when reporting negative feelings.

Emotional empathy and facial feedback

According to Hatfield et al. (2009), emotional contagion is a three-stage process, mimicry leading to feedback, which results in emotional contagion. Hatfield et al. (2009) identified three types of mimicry that may be involved in the process, i.e., facial mimicry, vocal mimicry, and postural mimicry.

If emotional contagion derived from facial feedback is involved in emotional empathic processes, as suggested by Hatfield et al. (2009), then it would be interesting to explore two questions. The first is whether people with high versus low emotional empathy spontaneously react more with their facial muscles when exposed to emotional facial expressions. The second is whether people with high versus low emotional empathy differ in sensitivity to feedback from their own facial configuration. The first question has already been explored to some extent. People with high versus low emotional empathy have been found to spontaneously mimic emotional facial expressions to a higher degree, at least when shown emotional facial expressions for short times, i.e., 45–75 ms (Sonnby-Borgström, 2002; Sonnby-Borgström et al., 2003). The second question, not yet explored, is the main question addressed in the present thesis.

Aim of the present thesis

As mentioned above, Hatfield et al. (2009) suggested mimicking and facial feedback to result in emotional empathic reactions via emotional contagion. The present thesis intends to explore two questions in connection with this suggestion. First, do people with high versus low emotional empathy mimic emotional facial expressions to a higher degree? Second, do people with high versus low emotional empathy differ in regard of emotional effects of facial feedback?

If emotional contagion, through mimicry and facial feedback, is an important aspect of emotional empathy, then people with high emotional empathy would presumably receive more feedback from the facial muscles than would people with low emotional empathy. There are at least two ways to influence the amount of facial feedback. The first is that people with high versus low emotional empathy differ in the degree to which they imitate emotional facial expressions. For example, if people with low emotional empathy were found to imitate emotional facial expressions less than did people with high emotional empathy, then it would be reasonable to assume that people with low emotional empathy would receive less feedback from the facial muscles and thus be subject to less emotional contagion. A second possibility is that people with high versus low emotional empathy differ in sensitivity to feedback from the facial muscles. That is, the same facial configuration does not have the same effect on the emotional experience of people with high versus low emotional empathy. Various combinations of the propensity to mimic emotional facial expressions and sensitivity to one's own facial configuration are possible. For example, it is possible that people with high versus low emotional empathy are both more likely to imitate facial expressions and more sensitive to their own facial configuration.

The first question, whether people with high versus low emotional empathy differ in degree of mimicry when shown emotional facial expressions, was explored in Experiment 1. The second question, whether the same facial configuration has different emotional feedback effects for people with high versus low emotional empathy, was investigated in Experiments 2–4.

Experiment 1 explored whether people with high versus low emotional empathy differed in the extent to which they spontaneously activated mimicking facial reactions when shown pictures of emotional facial expressions. The participants in Experiment 1 were selected from a larger sample to form two groups, one with an extraordinarily low and another with an extraordinarily high level of emotional empathy. Their facial muscle reactions were measured using EMG technique.

Experiment 2 compared people with high versus low emotional empathy with respect to their sensitivity to feedback from the facial muscles. The sample of participants was divided at the median to form one group with high and another with low emotional empathy. The participants' facial muscles were manipulated to form a happy or a sulky facial expression. For the happy expression, participants held a wooden stick between their teeth, automatically forming a smile, while for the sulky condition they held a wooden stick between their lips, automatically forming a sulky facial expression. Ratings of stimuli video clips provided an indirect measure of emotional reactions and thereby the facial feedback effect.

Experiment 3 explored whether the results of Experiment 2 would be further clarified if the groups differed more in terms of emotional empathy than they did in Experiment 2. Thus, participants with extraordinarily low and with extraordinarily high levels of emotional empathy were selected from a larger sample to form two groups. The facial muscles were manipulated and ratings of stimuli video clips were measured in the same way as in Experiment 2.

In Experiment 4, the facial manipulations differed from the two used in Experiments 2 and 3. In one condition, the participants formed a smile by lifting the corners of the mouth and in the other they formed a frown by lowering the eyebrows. This was done to investigate whether the results of Experiments 2 and 3 could be extended to other facial manipulations, also earlier reported to give rise to facial feedback effects. The sample of participants was divided at the median to form one group with high and another with low emotional empathy. The two groups were compared with respect to effects of facial feedback. The facial muscles were manipulated and the same stimuli video clips were rated as in Experiments 2 and 3 as a measure of the dependent variable.

Empirical studies

Paper I

Experiment 1

Background

It has been suggested (Hsee, Hatfield, Carlson, & Chemtob, 1990; MacDonald, 2003) that imitating another person's facial expression may induce a similar emotion in the receiver through feedback from the facial muscles and that this emotional contagion constitutes one aspect of empathy. It has also been suggested that the predisposition to send and receive emotional messages is biologically based (Buck & Ginsburg, 1997; Darwin, 1872/1965; Dimberg, 1990; Preston & de Waal, 2002). In line with this evolution-based notion, newborns have been found to imitate both facial gestures and specific facial expressions (Field et al., 1982; Meltzhoff & Moore, 1977) and Dimberg (e.g., 1982, 1990) found adults to mimic emotional facial expressions. It has even been found that this mimicking behavior can be detected when people are unconsciously exposed to happy and angry faces (Dimberg et al., 2000). Thus, it could be concluded that mimicking behavior is not only directed by conscious cognitive processes, but also by automatic/unconscious processes (e.g., Dimberg et al., 2000; Hodges & Wegner, 1997). For example, pictures of happy faces have repeatedly been found to increase electromyographic (EMG) activity in the zygomatic major muscle, whereas angry faces increase EMG activity in the corrugator supercilii muscle (e.g., Dimberg, 1982). The zygomatic major muscle is involved in a smiling, cheek-elevating reaction, while the corrugator supercilii muscle is involved in lowering the eyebrow to form a frown (Hjortsjö, 1970).

In accordance with the proposition that mimicking reactions contributes to emotional contagion and thereby empathic emotional reactions (Hatfield et al., 2009), people with high versus low emotional empathy have been found to be more likely to mimic pictures of emotional facial expressions, at least when exposure last 45–75 ms. (Sonnby-Borgström, 2002; Sonnby-Borgström et al., 2003).

As mentioned in the introduction, Sonnby-Borgström (2002) and Sonnby-Borgström et al. (2003) reported no significant mimicking reaction for longer exposure times (i.e., 100–2350 ms) among people with either high or low emotional empathy. Sonnby-Borgström (2002) interpreted this as indicating no difference in conscious interpretation between people with high versus low emotional empathy. Experiment 1 of the present thesis challenged this interpretation, because this lack of significant difference between people with high versus low emotional empathy may have been due to lack of statistical power to detect differences. Thus, Experiment 1 investigated, using a larger sample of participants than used in either Sonnby-Borgström (2002) or Sonnby-Borgström et al. (2003), whether there are any differences in spontaneous facial mimicking reactions between people with high versus low emotional empathy when the exposure time to emotional facial expressions was 5000 ms. People with extraordinarily high and low levels of emotional empathy were selected and compared in Experiment 1. Based on the hypothesis that people with high emotional empathy are more emotionally reactive, the group with high versus low emotional empathy was expected to display more pronounced spontaneous facial reactions.

In addition, Experiment 1 investigated whether there are any differences between people high versus low emotional empathy regarding the conscious interpretation of an emotional stimulus. This was accomplished by letting participants rate how they experienced pictures of emotional facial expressions.

Method

The participants in Experiment 1 were 144 students with equal numbers of males and females; the mean age was 22.3 (SD = 2.8) years. The participants were rewarded for participation with a cinema ticket.

A Swedish translation (Dimberg, 2010) of the QMEE (Mehrabian & Epstein, 1972) was used to measure emotional empathy. The Swedish translation has a test-retest reliability 0.77 and a Cronbach alpha coefficient of 0.77 (Dimberg, 2010). From a large sample, n>500, the 72 with the highest and the 72 with the lowest scores formed two groups, one with low and another with high emotional empathy. Males and females were selected separately into high- or low-empathy groups, respectively, since females generally rate themselves higher on the QMEE.

The participants were shown pictures of emotional facial expressions projected on a screen. The size of the pictures was 25 × 35 cm and the distance from the participants to the picture was 1.5 m. The pictures, of six happy and six angry expressions, were selected from Ekman and Friesen's *Pictures of facial affect* (1976a). The stimulus exposure time was 5 s and the intervals between trials were varied between 25 and 35 s. To control exposure times and trial intervals a Contact Precision Instrument (CPI) was used. The participants were shown six presentations each of one happy and one angry picture. The order of the stimulus categories was counterbalanced across participants.

A cover story was used to conceal the true purpose of the experiment. The participants were told that sweat gland activity was being measured in their faces, a cover story earlier found to be effective (e.g., Dimberg, 1982, 1990). When interviewed after the experiment, no participants reported being aware that their facial muscle activity had been measured. The true purpose of the experiment was revealed after the interview.

Facial EMG was measured using Ag/AgCl miniature electrodes filled with electrode paste and bipolarly attached to the zygomatic and corrugator muscle regions on the left side of the face (Fridlund & Cacioppo, 1986). The left side of the face was chosen since it has been reported that this side of the face has more distinct muscle reactions (e.g., Dimberg & Petterson, 2000). Relevant areas of the participants' skin were cleaned with alcohol and rubbed with electrode paste, to reduce the electrode site impedance, before the electrodes were attached. The EMG signals were amplified using CPI amplifiers, band-pass filtered from 10 to 1000 Hz, and analyzed using contour-following integrators with a time constant of 20 ms. A 12-bit analog-to-digital converter digitized the integrated signals. This digitized signal was stored on a computer at a sampling frequency of 100 Hz. The difference between the mean EMG activity during the 5-s exposure and the mean EMG activity in the last second before stimulus onset was regarded as the change in EMG activity.

After the facial EMG was measured, 24 participants with high emotional empathy and 24 with low emotional empathy rated how they experienced the presented pictures. To rate the pictures, they used a "happiness" scale ranging from 0 (not at all happy) to 9 (very happy) and an "anger" scale ranging from 0 (not at all angry) to 9 (very angry).

Design

The experimental design was two factorial, with Group, high or low empathy, as a between-subjects factor and Emotion, angry or happy stimulus face, as a repeated-measure factor. The EMG data were collapsed over the six trials with the same picture, and z-transformed. One analysis of variance was performed for the zygomaticus major muscle and another for the corrugator supercilii muscle. A priori *t*-tests were conducted to compare the difference between the EMG reactions to happy and angry faces.

The ratings for the happy and angry faces were analyzed using separate analysis of variance, with Group as a between-subjects factor and Emotion as a within-subjects factor. A priori *t*-tests were conducted to compare differences between ratings for the group with high versus low emotional empathy.

Results

Pictures of happy versus angry facial expressions tended to evoke greater activity in the zygomatic major muscle ($F(1, 142) = 3.49$, $p < .10$, partial $\eta^2 = 0.024$). Furthermore, as illustrated in the left panel of Figure 2, the analyses of variance disclosed an interaction effect between Group and Emotion ($F(1, 142) = 6.43$, $p < .05$, partial $\eta^2 = 0.043$). A priori *t*-tests revealed that the group with high emotional empathy differentiated between happy and angry faces ($t(142) = 3.11$, $p < .05$, one-tailed), whereas the group with low emotional empathy did not ($t < 1$).

Pictures of angry versus happy faces evoked greater activity in the corrugator supercilii muscle ($F(1, 142) = 4.33$, $p < .05$, partial $\eta^2 = 0.030$). However, as can be seen in the right panel of Figure 2, there was an interaction effect between Group and Emotion ($F(1, 142) = 5.34$, $p < .05$, partial $\eta^2 = 0.036$). A priori t-tests revealed that the group with high emotional empathy differentiated between angry and happy faces ($t(142) = 3.10$, $p < .05$, one-tailed), whereas the group with low emotional empathy did not ($t < 1$).

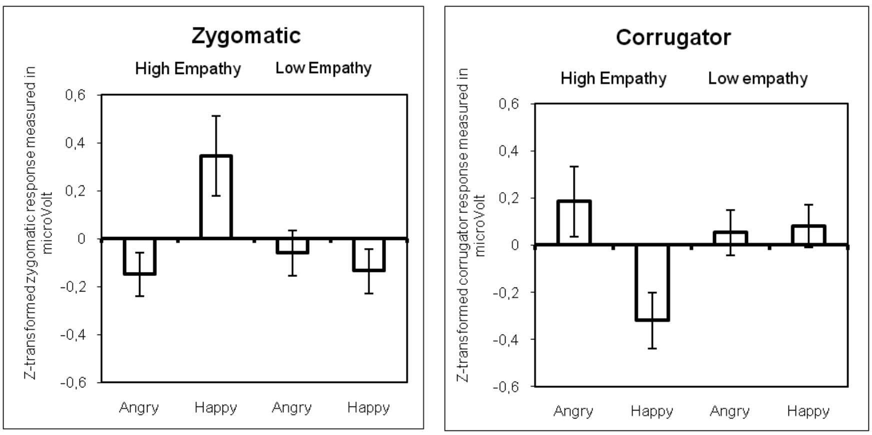

Figure 2. The mean facial EMG response (+/- SE) to angry and happy faces in the high- and low-empathy groups for the zygomatic major muscle (left panel) and the corrugator supercilii muscle (right panel). Reprinted with kind permission from Hogrefe Publishing.

The analysis of the ratings of angry and happy faces revealed that the angry faces expressed more anger ($F(1, 46) = 574.19$, $p < .05$, partial $\eta^2 = 0.926$) and happy faces expressed more happiness ($F(1, 46) = 1273.02$, $p < .05$, partial $\eta^2 = 0.965$). A priori t-test revealed that the group with high emotional empathy on average rated the angry faces as more angry than did the low-empathy group ($t(46) = 2.32$, $p < .05$, one-tailed), the means being 6.5 and 5.6 for the high- and low-empathy groups, respectively. Furthermore, a priori t-test indicated that the happy faces were rated as happier by the group with high emotional empathy ($t(46) = 1.71$, $p < .05$, one-tailed), the means being 7.7 and 7.3 for the high- and low-empathy groups, respectively.

Discussion

The interaction between emotional empathy groups (high or low) and emotional expression in the presented picture (angry or happy) for both the corrugator supercilii and the zygomatic major muscle indicated that the response patterns of the two groups differed. In line with predictions, the group with high emotional empathy had larger zygomatic reactions to happy versus angry facial expressions and larger corrugator reactions to angry versus happy facial expressions. The group with low emotional empathy did not differentiate between angry and happy facial expressions in their facial reaction patterns. These results are in accordance with the findings of Wiesenfeld et al. (1984), who reported that people with high versus low emotional empathy tend to smile more when shown smiling infants. Sonnby-Borgström (2002) found that people with high emotional empathy mimicked pictures of emotional facial expressions when exposure times were 45–75 ms but not when they were as long as 100–1000 ms or shorter than 17 ms. Sonnby-Borgström et al. (2003) found that people with high emotional empathy mimicked pictures of emotional facial expressions when exposure times were 56 ms but not 17 ms. When exposure times were 2350 ms, there was a tendency for people with high emotional empathy to mimic the pictures shown. In summary, Sonnby-Borgström (2002) and Sonnby-Borgström et al. (2003) found mimicking behavior when exposure times were 45–75 ms but not when times were shorter or longer. The results of Experiment 1 indicated mimicking reactions among people with high emotional empathy, even for longer exposure times, such as 5 s. People with low emotional empathy displayed no mimicking reactions in either Sonnby-Borgström (2002), Sonnby-Borgström et al. (2003), or Experiment 1, regardless of exposure time. It could be concluded that people with high versus low emotional empathy have a greater propensity to mimic emotional facial expressions.

As mentioned above, people with low emotional empathy did not discriminate between happy and angry facial expressions in their facial reactions. One could therefore question whether the group with low emotional empathy can discriminate between these two stimuli. However, the rating data suggest that both groups (with low and with high emotional empathy) discriminated between angry and happy faces. Note, however, that the group with high versus low emotional empathy rated the happy faces as happier and the angry faces as angrier. These results support the interpretation of the EMG results, that people with high emotional empathy are more sensitive to emotional facial expressions. As mentioned in the introduction to Experiment 1, Sonnby-Borgström (2002) suggested that there was no difference in conscious interpretation between people with high versus low emotional empathy for emotional facial expressions. The results of Experiment 1 do not support this notion, instead indicating that people with high versus low emotional empathy are more sensitive to emotional facial expression in terms of conscious interpretation as well.

In conclusion, people with high emotional empathy spontaneously mimic angry and happy faces. On the other hand, people with low emotional empathy do not mimic angry or happy faces. Furthermore, people with high versus low emotional empathy rated angry faces as angrier and happy faces as happier. This indicates that people with high versus low emotional empathy are more sensitive to emotional facial expressions with respect to both spontaneous facial reactions and how they rate their experience of emotional facial expressions.

Common method in Experiments 2–4

Procedure

The participants were recruited by asking larger groups of students whether they would like to participate in an experiment in which they would be shown films while their physiological responses were measured. A Swedish translation (Dimberg, 2010) of the QMEE (Mehrabian & Epstein, 1972) was used to measure emotional empathy. In the experimental situation, the participants sat on a chair located 2 m from a 59-cm TV screen. The experimenter sat 1.5 m behind and 1 m to the side of the participant, out of the participant's field of vision. While holding a manipulated facial expression, the participants rated four short humorous video clips with respect to funniness. The participants made a mark on a continuous scale, consisting of a 100-mm line, ranging from "not funny" on the left to "very funny" on the right. The marks on the scale were later transformed into numerical values by measuring the distance in mm from the left end of the scale to the mark. Participation in the experiment was rewarded with a cinema ticket.

Stimulus

Four humorous films, *Take off*, *Korv* (Sausage), *Pingis* (Table tennis), and *Jukebox*, were used as stimuli. They were selected from a Swedish TV program entitled *Lösnäsan* (Detachable nose). The films were 14, 23, 38, and 42 s long and were shown in a counterbalanced order on a 59-cm TV. The stimulus films had earlier been pretested by 14 participants, and the mean values of the funniness ratings of the films were 48, 39, 52, and 46 mm on the 100-mm scale described above. A higher value indicates higher funniness.

Paper II

Experiment 2

Background

As mentioned in the introduction, emotional contagion is thought to be one aspect of emotional empathy (Hatfield et al., 2009; Mehrabian & Epstein, 1972). Hatfield et al. (2009) suggested a process that starts with mimicking emotional facial expressions, which in turn yield feedback from one's own facial muscles, and ends up in emotional contagion. Experiment 1 explored the first stage of this process, the mimicking behavior. In Experiment 2 the second stage, the feedback from the facial muscles, was investigated. In particular, it explored whether there were any differences between people with high versus low levels of emotional empathy in terms of the emotional effects of various facial configurations.

Experiment 2 thus investigated whether there were any differences between people with high versus low emotional empathy, not only in how they spontaneously reacted when shown emotional facial expressions (as in Experiment 1), but also regarding sensitivity to feedback from the facial muscles when they are manipulated.

In line with the facial feedback hypothesis, the first hypothesis stated that the humorous films used in Experiment 2 would be rated as funnier by people with a manipulated happy versus a manipulated sulky facial expression. The second and third hypotheses were based on the assumption that people with high emotional empathy might be more sensitive to emotional stimulation; therefore, it could be assumed that they would be more sensitive to stimulation from their own facial muscles. Thus, the second hypothesis stated that people with high versus low emotional empathy would rate the films as funnier when they had a manipulated happy facial expression, while the third hypothesis stated that people with high versus low emotional empathy would rate the films as less funny when they had a manipulated sulky facial expression.

Method

The participants were 112 students at Uppsala University (54 males and 58 females), 18–34 years old with a mean age of 22 (SD = 2.4). To form two groups with high and low degrees of emotional empathy, participants were divided at the median, separately for men and women, into two groups within each condition with reference to QMEE scores. In the happy condition, the group with high emotional empathy had a mean QMEE rating of 54 (SD = 16) and the group with low emotional empathy had one of 22 (SD = 18). In the sulky condition, the group with high emotional empathy had a mean QMEE rating of 58 (SD = 19) and the group with low emotional empathy had one of 22 (SD = 25).

A cover story was used to conceal the true purpose of the experiment. The participants were told that skin conductance and the level of the enzyme amylase in the saliva were going to be measured. Electrodes were attached to two fingers of the left hand to measure skin conductance and a wooden stick covered with a web was placed in the mouth to measure amylase in the saliva. In fact, neither of these two measurements was made.

The participants were randomly assigned to a happy or sulky facial manipulation group. In the happy condition group, participants tensed the facial muscles associated with smiling at nearly a maximum level. This was accomplished by having the participants hold a wooden stick between their teeth and telling them to keep their lips away from the stick. In the other, sulky condition group, it was made impossible to tense the facial muscles associated with smiling, resulting in a sulky expression. In this group, participants held a wooden stick between their lips, with the lips protruded. The two conditions are illustrated in Figure 3.

Figure 3. Image of the happy (left) and the sulky (right) facial conditions. Reprinted with kind permission from Springer Science+Business Media: Journal of Nonverbal Behavior, Emotional empathy and facial feedback, 32, 2008, page 219, Per Andréasson and Ulf Dimberg.

After viewing each of the four humorous films, participants rated how funny they thought the film was. The participants kept the wooden sticks in their mouths all the time when watching and rating the four films, which required less than 3 min. None of the participants reported seeing through the cover story when interviewed after the fourth film. The participants were informed of the true purpose of the experiment after the interview.

Design

An analysis of variance was performed with Condition (happy or sulky) and Empathy (high or low) as between-subjects factors and Trial as a within-subjects factor. A priori *t*-tests were carried out and effect sizes were calculated to detect and estimate differences between groups. Effect sizes (*d*) of .20, .50, and .80 are interpreted as small, medium, and large effects, respectively (Cohen, 1988). The alpha level .05 was used for all statistical tests.

Results

There was no significant main effect of Condition ($F(1, 108) = 1.5$, $p = .23$, partial $\eta^2 = -.013$), as predicted in the first hypothesis. The mean values of the funniness ratings were 39.8 ($SD = 17.2$) for the happy condition and 43.6

(SD = 16.8) for the sulky condition. Interestingly, a significant interaction effect was detected between Empathy and Condition ($F(1, 108) = 5.5$, $p < .05$, partial $\eta^2 = 0.048$). This interaction effect consisted of the group with high emotional empathy, who had a weak tendency to react in line with the facial feedback hypothesis, and the group with low emotional empathy, who reacted contrary to the facial feedback hypothesis (see Figure 4). As predicted in the second hypothesis, people with high versus low emotional empathy rated the films as funnier when in the happy condition ($t(55) = 2.49$, $p < .01$, one-tailed), with the effect size at a medium level ($d = .66$). The third hypothesis was not confirmed, although there was a weak tendency for the group with high versus low emotional empathy to rate the films as less funny when they had a manipulated sulky facial expression ($t(53) = 0.86$, $p = .20$, one-tailed), with the effect size at a small level ($d = .23$).

The low-empathy group rated the films as significantly funnier when in the sulky rather than the happy condition ($t(54) = 2.80$, $p < .01$, two-tailed), with the effect size at a medium level ($d = –.75$). The high-empathy group had a weak tendency to rate the films as funnier when in the happy rather than the sulky condition ($t(54) = 0.73$, $p = .47$, two-tailed), with the effect size at a small level ($d = .20$).

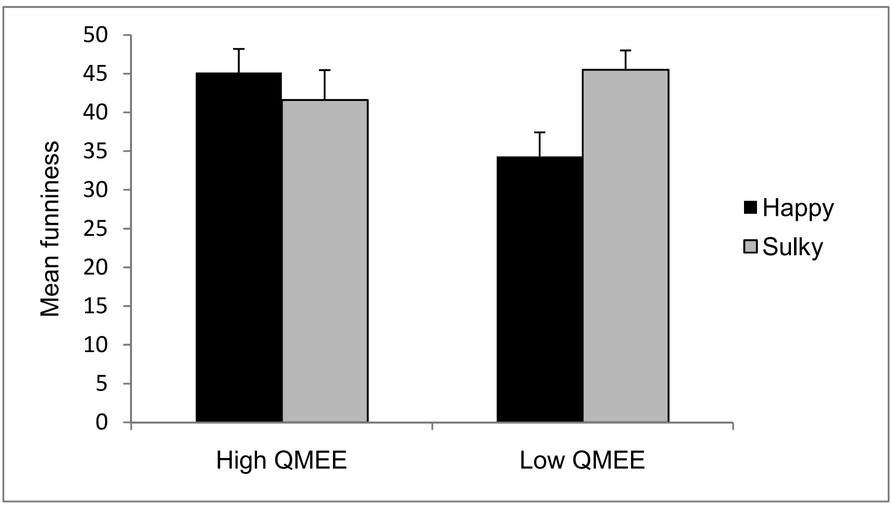

Figure 4. Mean funniness ratings (+SE) for the high- and low-QMEE groups for the happy and the sulky conditions.

Discussion

The humorous films were not rated as funnier by participants in the happy rather than the sulky condition, as predicted by the first hypothesis and suggested by the facial feedback hypothesis. However, there was a significant interaction effect between Empathy and Condition. This interaction effect consisted of the group with high emotional empathy, who had a weak tendency to react as predicted in the first hypothesis, and the group with low emotional empathy, who reacted significantly contrary to the first hypothesis. The second hypothesis, which predicted that the group with high versus low emotional empathy would rate the films as funnier when in the happy condition, was confirmed. Furthermore, the group with high versus low emotional empathy had a weak tendency to rate the films as less funny when in the sulky facial condition, as predicted in the third hypothesis. In summary, people with high emotional empathy had a weak tendency to react in line with the facial feedback hypothesis while people with low emotional empathy reacted contrary to the facial feedback hypothesis.

Experiment 1 indicated that people with high emotional empathy spontaneously reacted more distinctly with their facial muscles when shown emotional facial expressions. One could question whether people with high emotional empathy tended to smile more in general and were therefore more affected by facial feedback in Experiment 2. However, in the manipulated happy condition, it was nearly impossible to further strengthen the facial muscles involved in smiling, while in the sulky condition it was almost impossible to tense the muscles involved in smiling. Thus, the differences in the effects of the facial manipulations were not likely due to different levels of activity in the facial muscles between the two groups.

Surprisingly, as mentioned above, in the present experiment the group with low emotional empathy rated the films as significantly funnier when in the sulky rather than the happy manipulated facial condition. However, Sonnby-Borgström (2002) found differences between people with high versus low emotional empathy regarding self-reported feelings and spontaneous facial muscle activity. People with low empathy were found to smile more when reporting negative feelings, whereas people with high emotional empathy tended to smile less when reporting negative feelings. Even though it is not self-evident that these spontaneous facial reactions are comparable to manipulated facial expressions, as indicated in Experiment 2, it is noteworthy that people with low emotional empathy tended to smile when reporting negative feelings. Furthermore, Sonnby-Borgström (2002) and Sonnby-Borgström et al. (2003) found that people with low emotional empathy tended to smile when shown angry facial expressions, whereas people with high emotional empathy did not. Thus, several studies found that people with low emotional empathy tended to react contrary to what was expected and unlike people with high emotional empathy.

In conclusion, emotional empathy is thought to be a critical and previously disregarded factor concerning individual differences in the effects of facial feedback.

Paper III

Experiment 3

Background

In Experiment 2, scores on the Questionnaire Measure of Emotional Empathy (QMEE) were used to divide a sample of participants at the median into one group with high and another with low emotional empathy. Experiment 3 aimed to investigate whether the differences found in Experiment 2 between people with high and low emotional empathy would be accentuated if participants with extraordinarily high and low scores on the QMEE were selected and compared. Would the weak tendency to react in line with the facial feedback hypothesis turn into a significant facial feedback effect for the group with extraordinarily high emotional empathy? Would the reaction in the opposite direction to that proposed by the facial feedback hypothesis still be evident and accentuated in the group with low emotional empathy? To further increase the power to detect differences between conditions, a within-subjects design was applied in Experiment 3. Consequently, the first hypothesis stated that the group with high emotional empathy would react in line with the facial feedback hypothesis and rate the films as funnier when they had a manipulated happy rather than a manipulated sulky facial expression. Furthermore, the second hypothesis stated that the group with low emotional empathy would rate the films as funnier when they had a manipulated sulky rather than a manipulated happy facial expression, contrary to the facial feedback hypothesis.

Method

From a large sample of students, 48 participants with extraordinarily high and 48 participants with extraordinarily low scores on a Swedish translation (Dimberg, 2010) of the QMEE (Mehrabian & Epstein, 1972) were selected. The 96 participants were aged 18–32 years with a mean age of 22 (SD = 2.4). In the group with high emotional empathy, the mean QMEE rating was 69 (SD = 15). In the group with low emotional empathy, the mean QMEE rating was 7 (SD = 17). Because females generally rate themselves higher on QMEE than do males, the selection of participants to the high and low groups was made separately for females and males. The method used in Experiment 3 resembles that used in Experiment 2 with one exception. All participants watched and rated the four humorous films twice, once with each of the two facial manipulations. The two facial manipulations in Experiment 3 were the same as those used in Experiment 2. Half of the participants started with the happy facial expression and half with the sulky facial expressions. Fourteen participants saw through the cover story and were replaced with other participants.

Design

An analysis of variance was performed with Condition (happy or sulky) and Trial as within-subjects factors and Empathy (high or low) as a between-subjects factor. To detect and estimate differences between conditions for the group with high versus low emotional empathy, *t*-tests were conducted.

Results

The results indicated a significant main effect of condition in the opposite direction to that suggested by the facial feedback hypothesis ($F(1, 94) = 4.45$, $p = .038$, partial $\eta^2 = -.045$). No other significant main or interaction effects were found in the analyses of variance. Furthermore, the group with high emotional empathy did not rate the films as funnier when in the happy rather than the sulky condition as predicted by the first hypothesis ($t(47) = -.34$, $p = .74$, $d = -.05$). However, as predicted by the second hypothesis, the group with low emotional empathy rated the films as funnier when in the sulky rather than the happy facial condition ($t(47) = 2.45$, $p = .018$, $d = .35$). The results are depicted in Figure 5.

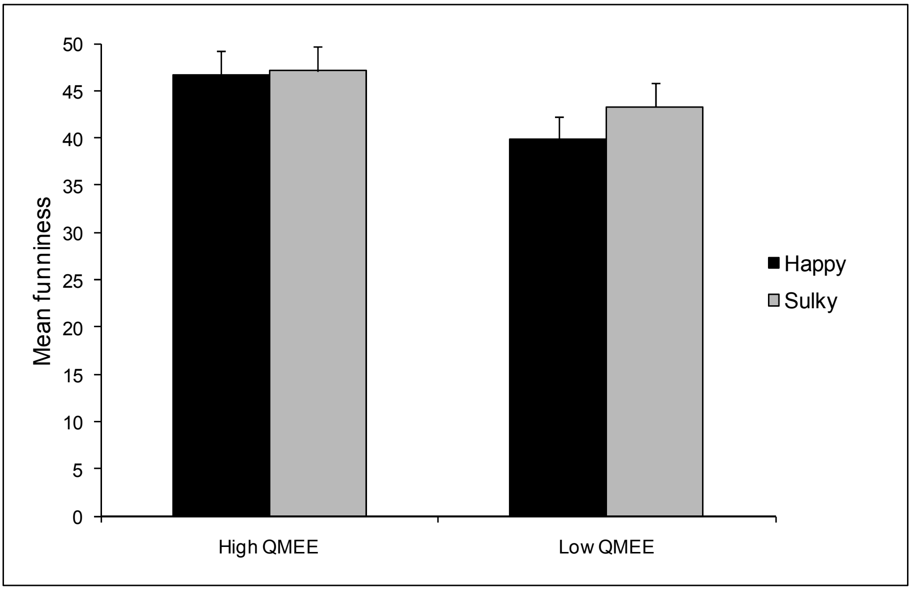

Figure 5. Mean funniness ratings (+SE) for the high- and low-QMEE groups for the happy and the sulky conditions.

Discussion

The group with high emotional empathy did not rate the films as funnier when in the happy rather than the sulky condition as predicted by the first hypothesis. The group with low emotional empathy rated the films as funnier when in the sulky rather than the happy facial condition as predicted by the second hypothesis. The results of Experiment 3 are in line with those of Experiment 2, in that people with low emotional empathy reacted contrary to the facial feedback hypothesis, while people with high emotional empathy did not react significantly. The group with high emotional empathy had a weak tendency to react in line with the facial feedback hypothesis in Experiment 2, but there was no such tendency in Experiment 3. Experiment 3 did not determine why people with low emotional empathy reacted contrary to what the facial feedback hypothesis predicts, but did confirm the results of Experiment 2.

Englis, Vaughan, and Lanzetta (1982) reported that facial expressions could function as conditioned stimuli able to evoke empathic and counter-empathic emotional responses. Thus, there may have been something in their emotional learning history that made people with low emotional empathy rate the humorous films as funnier when in the sulky rather than the happy facial condition. Furthermore, it has been suggested that emotional facial expressions serve an emotional self-regulatory function. In accordance with this, Ansfield (2007) found that people smiled when exposed to disgusting stimuli. Furthermore, people tended to smile more when exposed to stimuli causing high versus moderate degrees of disgust. These results were interpreted as supporting the hypothesis that positive emotional expressions serve an emotional self-regulatory function. In a review, Kunz, Prkachin, and Lautenbacher (2009) reported that the negative emotional state of pain was associated with raising the lips and forming a smile, and suggested that this might represent a self-regulatory process. Thus, one explanation as to why people with low emotional empathy rate humorous films as funnier when in the sulky rather than the happy facial condition could be that people with low emotional empathy use smiling primarily to up-regulate negative emotional experiences. When repeatedly coupled with negative emotional experiences, smiling may become a conditioned stimuli able to evoke negative emotional experiences.

Another explanation is that people with high and low emotional empathy differ in how their facial configuration sends feedback to the brain. One last possibility is that, while the facial configuration sends information in the same way in people with high versus low emotional empathy, it is interpreted differently in their brains.

However, facial condition had no main effect in the direction suggested by the facial feedback hypothesis in either Experiment 2 or 3. This indicates that although Strack et al. (1988) reported facial feedback effects in line with the facial feedback hypothesis with the use of fairly similar facial manipulations, there may be subtle differences in the facial manipulations that might explain the divergent results.

The conclusion from Experiment 2 still holds for Experiment 3: emotional empathy is thought to be a critical and previously disregarded factor concerning individual differences in the effects of facial feedback. Furthermore, it could be concluded that the facial manipulations used in Experiments 2 and 3 may not effectively induce facial feedback, in line with the facial feedback hypothesis, although Strack et al. (1988) reported facial feedback effects with the use of fairly similar facial manipulations.

Experiment 4

Background

The results of Experiments 2 and 3 do not correspond to the findings of Strack et al. (1988), who used fairly similar facial manipulations and reported facial feedback effects in line with the facial feedback hypothesis. To investigate whether the results of Experiments 2 and 3 could be generalized to other facial manipulations also known to have facial feedback effects, the two facial manipulations used in Experiments 2 and 3 were replaced with two different facial manipulations in Experiment 4.

A number of earlier EMG studies have demonstrated an association between positive emotional reactions with increased activity in the zygomaticus major muscle, involved in smiling reactions, and negative emotional reactions to increased activity in the corrugator supercilii muscle, used in frowning reactions (e.g., Dimberg, 1982, 1988, 1990, 1997b). Accordingly, several earlier studies have reported facial feedback effects in line with the facial feedback hypothesis when using a smiling, happy condition, versus a frowning, angry condition, as facial manipulations (Dimberg & Söderkvist, 2009; Duncan & Laird, 1977, 1980; Flack, 2006; Flack et al., 1999; Laird, 1974; Rhodewalt & Comer, 1979). Thus, in Experiment 4, participants were instructed to elevate their cheeks, in the happy condition, or wrinkle their eyebrows, in the angry condition, while viewing the same humorous films as used in Experiments 2 and 3 and rating how funny they were.

Based on the facial feedback hypothesis and earlier studies (e.g., Dimberg & Söderkvist, 2009; Laird, 1974), it was predicted that the films would be rated as funnier when viewers were in the happy condition (smiling) rather than the angry condition (frowning). Furthermore, it was predicted that this effect would be more distinct in the group with high emotional empathy. Another investigated question was whether people with low empathy would still react, as in Experiments 2 and 3, in the opposite direction to that proposed by the facial feedback hypothesis, and rate the humorous films as less funny when in the happy versus the sulky facial condition.

Method

Eighty-eight students at Uppsala University participated in Experiment 4, 43 males and 45 females aged 19–29 years with a mean age of 22 (*SD* = 2.0). Scores on the QMEE were used to divide the participants at the median into one group with high and another with low emotional empathy. The 44 individuals in the group with high emotional empathy had a mean QMEE score of 52 (*SD* = 17), while the 44 individuals in the group with low emotional empathy had a mean score of 22 (*SD* = 24). The division into high and low groups at the median was made separately for males and females.

In the happy condition, the corners of the mouth were lifted, activating facial muscles associated with smiling. In an angry condition, participants were asked to frown, activating facial muscles associated with an angry facial expression.

As a cover story, participants were told that the purpose of the experiment was to measure physiological responses while they were watching a few short films and that the level of skin moisture was going to be measured. Furthermore, electrodes were attached to two fingers on the left hand, in line with the prospect of that skin moisture were going to be measured. Ten participants saw through the cover story and were excluded from the experiment.

Design

An analysis of variance was performed with Empathy (high or low) as a between-subjects factor and Condition (happy or angry) and Trial as within-subjects factors. To estimate differences between conditions for the group with high and low emotional empathy, *t*-tests were conducted.

Results

A significant main effect of Condition in the direction suggested by the facial feedback hypothesis was detected in the analysis of variance ($F(1, 87) = 14.19$, $p < .001$, partial $\eta^2 = 0.14$). No other significant main or interaction effects in the analyses of variance were present. As illustrated in Figure 6, *t*-tests revealed that the high-empathy group rated the humorous films as funnier when in the happy rather than the angry condition ($t(43) = 2.08$, $p = .043$), with an effect size at a small level ($d = .31$). Moreover, as illustrated in Figure 6, this was also true for the group with low emotional empathy ($t(43) = 3.28$, $p = .002$), with the effect size at a medium level ($d = .50$).

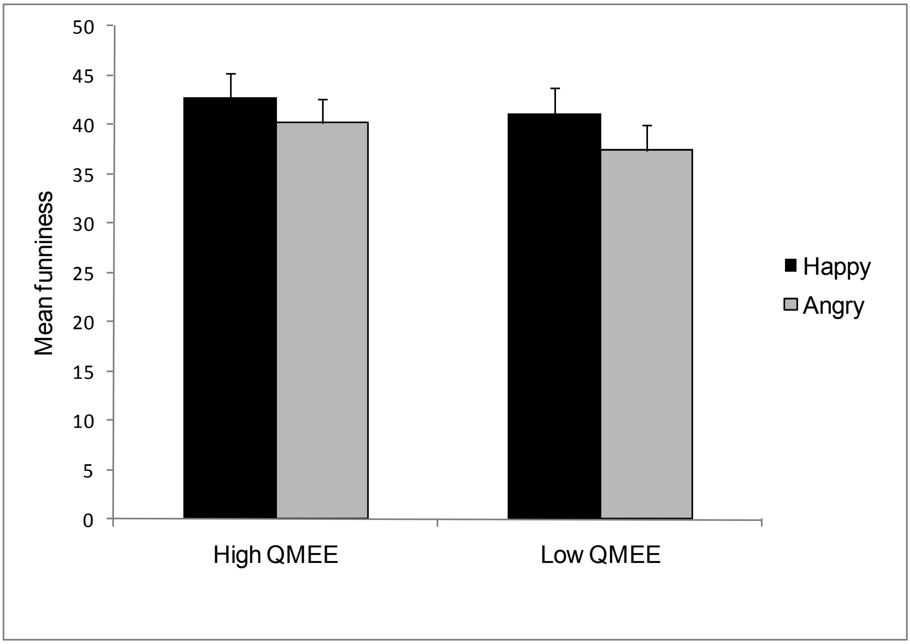

Figure 6. Mean funniness ratings (+SE) for the high- and low-QMEE groups for the happy and the angry conditions.

Discussion

In Experiment 4, there were no differences between the groups with high and low emotional empathy. Both groups reacted in line with what the facial feedback hypothesis predicted, rating the stimulus films as funnier when in the happy rather than the angry facial condition. This is in sharp contrast to the results of Experiments 2 and 3, where people with high emotional empathy did not react significantly and people with low emotional empathy reacted contrary to the predictions of the facial feedback hypothesis.

The major difference between Experiment 4 and the other two experiments, Experiments 2 and 3, was in the facial manipulation. In Experiment 4, the participants lifted the corners of their mouths in the happy condition or lowered their eyebrows in the angry condition. In Experiments 2 and 3, participants held a wooden stick either between their teeth, for the happy condition, or between their lips, for the sulky condition (see Figure 3). The happy condition in Experiment 4 resembled the happy condition in Experiments 2 and 3 in that it involved contracting the zygomaticus major muscle used in smiling. On the other hand, the angry condition in Experiment 4 involved the corrugator supercilii muscle in the upper face in a frowning facial expression, whereas the sulky expression in Experiments 2 and 3 was a facial expression involving the mouth (see Figure 3).

A number of earlier facial feedback studies (e.g., Dimberg & Söderkvist, 2009; Duncan & Laird, 1977, 1980; Flack, 2006; Flack et al., 1999; Laird, 1974; Rhodewalt & Comer, 1979) found support for the facial feedback hypothesis, using facial manipulations involving frowning (i.e., contracting the corrugator supercilii muscle) versus smiling (i.e., contracting the zygomaticus major muscle).

The involvement of the corrugator supercilii muscle in negative emotional reactions is well documented. Increased activity in the corrugator supercilii muscle has been reported both when imaging sad and angry situations (e.g., Schwartz et al., 1976) and during exposure to pictures of angry facial expressions (e.g., Dimberg, 1990). Furthermore, activity in the corrugator supercilii muscle has been reported to modulate central emotion circuitries in the brain, and this has been interpreted as supporting the facial feedback hypothesis (Hennenlotter et al., 2009). Further supporting the importance of the corrugator supercilii muscle in facial feedback effects, Larsen, Kasimatis, and Frey (1992) found that contraction of corrugator supercilii muscle versus non-contraction of the corrugator supercilii muscle gives rise to facial feedback effects in line with the facial feedback hypothesis.

Altogether, Experiments 2–4, and the other empirical evidence mentioned above, indicate that the corrugator supercilii muscle is essential in producing facial feedback effects in line with the facial feedback hypothesis and that this is true for people with low and with high emotional empathy, as demonstrated in Experiment 4.

In light of the results of Experiments 2 and 3, it is concluded that emotional empathy is a critical and previously disregarded factor concerning individual differences in the effects of facial feedback in the case of *some*, but not all, facial manipulations.

General discussion

Main findings

Experiment 1 found that people with high emotional empathy spontaneously mimicked emotional facial expressions while people with low emotional empathy lacked this mimicking reaction. Furthermore, people with high versus low emotional empathy rated pictures of angry faces as angrier and happy faces as happier.

Experiment 2 revealed that people with low emotional empathy reacted contrary to the facial feedback hypothesis when their facial muscles were manipulated into the happy versus the sulky facial expression, while people with high emotional empathy did not react significantly. Experiment 3 replicated the findings of Experiment 2 in people with extraordinarily high or low levels of emotional empathy.

Experiment 4 found that people with high as well as people with low emotional empathy reacted in line with the facial feedback hypothesis when a smile and a frown were used as facial manipulations. The results of Experiment 4 supported the facial feedback hypothesis.

Discussion

As mentioned in the introduction, Hatfield et al. (2009) suggested mimicking and facial feedback to result in emotional empathic reactions via emotional contagion. The process suggested by Hatfield et al. (2009) starts with mimicking the emotional facial expressions of another, which in turn sends facial feedback from one's own facial configuration, leading to emotional contagion. Experiment 1 explored the first stage of this process and found that people with high emotional empathy mimicked emotional facial expressions, whereas people with low emotional empathy did not.

It is possible that people with high emotional empathy, through feedback from their facial configuration, may pick up and be contaminated by emotional messages sent from others via emotional facial expressions. On the other hand, if people with low emotional empathy do not mimic emotional facial expressions, they will not be contaminated by others' emotions through feedback from their own facial configuration.

Experiments 2–4 explored the second stage of the process suggested by Hatfield et al. (2009), namely, whether facial configuration functions as a feedback system and modulates the emotional experience. More specifically, Experiments 2–4 investigated whether the presumed modulating effects of facial configuration differ between people with high versus low emotional empathy.

The results of Experiments 2–4 revealed different reaction patterns for people with high versus low emotional empathy. In Experiments 2 and 3, where the facial manipulations were happy or sulky facial expressions, the group with high emotional empathy did not react significantly, whereas the group with low emotional empathy reacted contrary to the facial feedback hypothesis. On the other hand, when the facial manipulations were smiling or frowning, people with high and with low emotional empathy reacted as predicted by the facial feedback hypothesis. This thesis did not determine why people with high versus low emotional empathy reacted differently from each other in some facial manipulations but not in others. However, one could note that the facial manipulations used in Experiments 2 and 3 involved only the mouth, whereas the facial manipulations used in Experiment 4 involved both the mouth and the muscles of the upper face involved in frowning. The upper facial muscles are known to be primarily controlled bilaterally whereas the lower facial muscles are known to be primarily controlled contralaterally (controlled by the opposite side) in the human brain (e.g., Fridlund, 1994). Thus, this may be one clue to understand why people with high versus low emotional empathy reacted in different ways when the facial manipulations of Experiment 2 and 3 were used but not when the facial manipulations of experiment 4 were used.

Limitations and future directions

As mentioned in the introduction, it is not likely that facial reactions when exposed to emotional facial expressions could be explained solely in terms of imitating facial expressions. Probably there is one component of imitating and one component of positive/negative emotional reaction involved. For a more detailed discussion of this subject, see Lundqvist and Dimberg (1995) and Lundquist (1995). Therefore it would be interesting to compare the facial reactions of people with high versus low emotional empathy when using other positive/negative emotional stimuli, not depicting facial expressions. Dimberg (1986) used pictures of snakes/spiders as negative stimuli and pictures of flowers/mushrooms as positive stimuli. The negative stimuli were found to increase the activity in the corrugator muscle region, whereas positive stimuli increased the activity in the zygomatic region. Thus, it would be interesting to measure facial reaction patterns in people with high versus low emotional empathy when exposed to other positive and negative stimuli than facial expressions. This would shed some light over the question if people with high versus low emotional empathy differ regarding the imitating component or if it is rather the amplitude of the emotional reaction that differs between the groups.

The emotional stimuli in Experiment 1 were pictures of angry and happy facial expressions and it is not self evident that the higher facial reactivity for the people with high versus low emotional empathy could be generalized to emotional stimuli expressing other emotions. This issue calls for future studies.

The participants in Experiment 1 were exposed to pictures of strong emotional expressions from Ekman and Friesen's Pictures of facial affect (1976a) and people with high versus low emotional empathy were found to differ in facial reaction patterns as well as ratings of the experience of the presented pictures. Mild emotional facial expressions may have higher ecological validity. Therefore, it would be valuable to investigate if the differences between people with high versus low emotional empathy would still be present when mild emotional facial expressions are used.

Another intriguing question is if the difference between people with high versus low emotional empathy, in facial reaction patterns to static facial expressions, can be generalized to dynamic facial expressions. Kilts, Egan, Gideon, Ely and Hoffman (2003) found different patterns of brain activity in response to dynamic versus static happy and angry facial expressions. Moreover, Biele and Grabowska (2006) found intensity ratings to be higher to dynamic versus static angry and happy faces. Furthermore, dynamic happy faces compared to static happy faces were rated more intense by males as well as females whereas dynamic angry faces compared to static angry faces only were rated as more intense only by females.

As noted in the introduction, Dimberg et al. (2000) found unconscious exposure to happy and angry faces to evoke corresponding facial reactions in the facial muscles. To explore the question whether it is conscious or unconscious processes that differ between people with high versus low emotional empathy, one interesting future study would be to compare the facial reactions to unconscious exposure to happy and angry faces. The exposure time Dimberg et al. (2000) was 30 ms. Sonnby-Borgström (2002) and Sonnby-Borgström et al. (2003) compared facial reactions in people with low versus high emotional empathy when exposed to pictures of happy and angry faces 17 ms. At this short exposure time no mimicking reaction was detected neither for the high nor the low empathy group. The 17 ms long exposure may have been too short to evoke any facial reaction. Therefore, it may be fruitful to use an exposure of 30 ms in the same experimental setting as in Experiment 1 in the present thesis. In addition, it would be interesting to use positive and negative stimuli other than facial expressions when applying a subliminal exposure time of 30 ms. This would shed some light on the question if unconscious facial reactions should be interpreted as imitating reactions, emotional reactions, or both, and if people with high versus low emotional empathy differ in regard of these reactions.

The facial manipulations used in Experiments 2 and 3 produced no significant facial feedback effects in line with the facial feedback hypothesis, although Strack et al. (1988) reported facial feedback effects when using fairly similar facial manipulations. These conflicting results may be explained by subtle differences in the facial manipulations used, though this matter calls for further investigation.

Furthermore, it would be valuable to explore why emotional empathy played a determining role for the facial feedback effect of the happy and sulky facial manipulations used in Experiments 2 and 3, but not for the smiling and frowning facial manipulations used in Experiment 4. One way to follow up the results of Experiments 2–4 would be to design studies comparing combinations of the four facial manipulations used in Experiment 2–4 yet not compared in the same experiment. For example, the sulky facial expression in Experiment 1 could be compared with the angry facial expression in Experiment 4. This would shed some light on the question under which facial manipulation or manipulations people with high versus low emotional empathy reacts in different ways. Another approach to this question would be to compare each one of the four facial manipulations with a neutral condition. One could propose that a condition with no facial manipulation would be a neutral condition. However, in such facial condition there would be no control of the facial muscles and it would not be possible to draw any conclusion from this condition. One possible solution to this problem may be to use botulinum toxin induced denervation of the facial muscles in a neutral facial condition. Botulinum toxin induced denervation have been used for the corrugator muscle in a facial feedback study by Hennenlotter et al. (2009) and it may be possible to use botulinum toxin induced denervation in other facial muscles as well.

Another way to explore this subject would be via imaging studies of the brain. It might be possible to identify differences in activation patterns in the brain between people with high versus low emotional empathy when the facial muscles are manipulated into happy or sulky facial expressions, as in Experiments 2 and 3. Furthermore, the same activation patterns might be found in people with high versus low emotional empathy when happy and angry facial manipulations are applied, as in Experiment 4.

Closing words

In conclusion, the studies included in the present thesis indicate that mimicking and feedback from the facial muscles may be involved in emotional contagion and thereby influence emotional empathic reactions. Thus, differences in emotional empathy may be partly accounted for by different propensities to mimic emotional facial expressions and different emotional effects of feedback from the facial muscles.

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References

Adelmann, P. K., & Zajonc, R. B. (1989). Facial efference and experience of emotion. *Annual Review of Psychology*, 40, 249–280.

Andrew, R. J. (1963). Evolution of facial expressions. *Science*, 142, 1034–1041.

Ansfield, M. E. (2007). Smiling when distressed: When a smile is a frown turned upside down. *Personality and Social Psychology Bulletin*, 33, 763–775.

Bard, P. (1928). A diencephalic mechanism for the expression of rage with special reference to the central nervous system. *American Journal of Physiology*, 84, 490–513.

Baron-Cohen, S., & Wheelwright, S. (2004). The Empathy Quotient (EQ): An investigation of adults with Asperger Syndrome and high-functioning autism, and normal sex differences. *Journal of Autism and Developmental Disorders*, 34, 163–175.

Batson, C. D. (2009). These things called empathy: Eight related but distinct phenomena. In J. Decety & W. Ickes (Eds.), *The social neuroscience of empathy* (pp. 3–15). London: The MIT Press.

Biele, C., & Grabowska, A. (2006). Sex differences in perception of emotion intensity in dynamic and static facial expressions. *Experimental Brain Research*, 171, 1–6.

Blair, R. J. R., Morris, J. S., Frith, C. D., Perrett, D. I., & Dolan, R. J. (1999). Dissociable neural responses to facial expressions of sadness and anger. *Brain*, 122, 883–893.

Blakemore, S-J., & Frith, C. (2005). The role of motor contagion in the prediction of action. *Neuropsychologia*, 43, 260–267.

Blaney, P. H. (1986). Affect and memory: A review. *Psychological Bulletin*, 99, 229–246.

Breiter, H. C., Etcoff, N. L., Whalen, P. J., Kennedy, W. A., Rauch, S. L., Buckner, R. L., Strauss, M. M., Hyman, S. E., & Rosen, B. R. (1996). Response and habituation of the human amygdala during visual processing of facial expression. *Neuron*, 17, 875–887.

Buck, R. (1980). Nonverbal behavior and the theory of emotion: The facial feedback hypothesis. *Journal of Personality and Social Psychology*, 38, 811–824.

Buck, R. (1984). *The communication of emotion*. New York: Guilford.

Buck, R., & Ginsburg, B. (1997). Communicative genes and the evolution of empathy. In W. Ickes (Ed.), *Empathic accuracy* (pp. 17–43). New York: The Guilford Press.

Cacioppo, J. T., Berntson, G. G., Larsen, J. T., Poehlmann., & Ito, T. A. (2000). The Psychophysiology of emotion. In M. Lewis & M. Haviland-Jones (Eds.), *Handbook of Emotions* (2nd ed., pp. 173–191). New York: The Guilford Press.

Cannon, W. B. (1927). The James–Lange theory of emotions: A critical examination and an alternative theory. *American Journal of Psychology*, 39, 106–124.

Chlopan, B. E., McCain, M. L., Carbonell, J. L., & Hagen, R. L. (1985). Empathy: Review of available measures. *Journal of Personality and Social Psychology*, 48, 635–653.
Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: L. Erlbaum Associates.
Cornelius, R. R. (1996). *The science of emotion: Research and tradition in the psychology of emotion*. Upper Saddle River, NJ: Prentice Hall.
Cosmides, L., & Tooby, J. (2000). Evolutionary psychology and the emotions. In M. Lewis & M. Haviland-Jones (Eds.), *Handbook of Emotions* (2nd ed., pp. 91–115). New York: The Guilford Press.
Cosmides, L., & Tooby, J. (2008). Evolutionary psychology of the emotions and their relationship to internal regulatory variables. In M. Lewis & M. Haviland-Jones (Eds.), *Handbook of Emotions* (3rd ed., pp. 114–137). New York: The Guilford Press.
Darwin, C. (1872/1965). *The expression of emotion in man and animals*. Chicago: University of Chicago Press (Original work published 1872).
Davis, J. I., Senghas, A., & Ochsner, K. N. (2009). How does facial feedback modulate emotional experience? *Journal of Research in Personality*, 43, 822–829.
Davis, M. H. (1980). A multidimensional approach to individual differences in empathy. *Catalog of Selected Documents in Psychology*, 10, 85.
Davis, M. H. (1983). Measuring individual differences in empathy: Evidence for a multidimensional approach. *Journal of Personality and Social Psychology*, 44, 113–126.
Davis, M. H. (1996). *Empathy. A social psychological approach*. Boulder, CO: Westview Press.
Dawkins, R. (1989). *The selfish gene*. Oxford: Oxford University Press.
Decety, J., & Jackson, P. L. (2004). The functional architecture of human empathy. *Behavioral and Cognitive Neuroscience Reviews*, 3, 71–100.
de Waal, F. B. M. (2008). Putting the altruism back into altruism: The evolution of empathy. *The Annual Review of Psychology*, 59, 279–300.
Dimberg, U. (1982). Facial reactions to facial expressions. *Psychophysiology*, 19, 643–647.
Dimberg, U. (1983). Emotional conditioning to facial stimuli: A psychobiological analysis. Acta Universitatis Upsaliensis, *Abstracts of Uppsala dissertations from the faculty of Social Sciences*, 29. Uppsala: Almqvist & Wiksell.
Dimberg, U. (1986). Facial reactions to fear-relevant and fear-irrelevant stimuli. *Biological Psychology*, 23, 153–161.
Dimberg, U. (1988). Facial electromyography and the experience of emotion. *Journal of Psychophysiology*, 3, 277–282.
Dimberg, U. (1990). Facial electromyography and emotional reaction. *Psychophysiology*, 27, 481–494.
Dimberg, U. (1997a). Facial EMG: Indicator of rapid emotional reactions [Abstract]. *International Journal of Psychophysiology*, 25, 52–53.
Dimberg, U. (1997b). Psychophysiological reactions to facial expressions. In U. Segerstråhle and P. Molnar (Eds.), *Nonverbal communication: Where nature meets culture* (pp. 47–60). Mahwah, NJ: Lawrence Erlbaum Associates.
Dimberg, U. (2010*). A Swedish translation of the Questionnaire Measure of Emotional Empathy (QMEE)*. Unpublished manuscript.
Dimberg, U. & Petterson, M. (2000). Facial reactions to happy and angry facial expressions: Evidence for right hemisphere dominance. *Psychophysiology*, 37, 693–696.

Dimberg, U., & Söderkvist, S. (2009). *The voluntary facial action technique: A method to test the facial feedback hypothesis*. Manuscript submitted for publication, Uppsala University, Sweden.

Dimberg, U., Thunberg, M., & Elmehed, K. (2000). Unconscious facial reactions to emotional facial expressions. *Psychological Science*, 11, 86–89.

Duncan, J. W., & Laird, J. D. (1977). Cross-modality consistencies in individual differences in self-attribution. *Journal of Personality*, 45, 191–206.

Duncan, J. W., & Laird, J. D. (1980). Positive and reverse placebo effects as a function of differences in cues used in self-perception. *Journal of Personality and Social Psychology*, 39, 1024–1036.

Dymond, R. F. (1949). A scale for the measurement of empathic ability. *Journal of Consulting Psychology*, 13, 127–133.

Eisenberg, N., & Lennon, R. (1983). Sex differences in empathy and related capacities. *Psychological Bulletin*, 94, 100–131.

Ekman, P. (1973). Cross-cultural studies of facial expressions. In P. Ekman (Ed.), *Darwin and facial expression: a century of research in review* (pp. 169–222). New York: Academic Press.

Ekman, P. (1984). Expression and the nature of emotion. In K. R. Scherer & P. Ekman (Eds.), *Approaches to emotion* (pp. 319–343). Hillsdale, NJ: Erlbaum.

Ekman, P. (1992). An argument for basic emotions. *Cognition and Emotion*, 6, 169–200.

Ekman, P., & Friesen, W. V. (1976a). *Pictures of facial affect*. Palo Alto, CA: Consulting Psychologists Press.

Ekman, P., & Friesen, W. V. (1976b). Measuring facial movement. *Journal of Environmental Psychology and Nonverbal Behavior*, 1, 56–75.

Ekman, P., Friesen, W. V., & Ancoli, S. (1980). Facial signs of emotional experience. *Journal of Personality and Social Psychology*, 39, 1125—1134.

Ekman, P., Levenson, R., & Friesen, W. V. (1983). Autonomic nervous system activity distinguishes among emotions. *Science*, 221, 1208–1210.

Ekman, P., & Oster, H. (1979). Facial expressions of emotion. *Annual Review of Psychology*, 30, 527–554.

Ekman, P., & Oster, H. (1982). Review of research, 1970–1980. In P. Ekman (Ed.), *Emotion in the human face* (2nd ed., pp. 147–173). New York: Cambridge University Press.

Englis, B. G., Vaughn, K. B., & Lanzetta, J. T. (1982). Conditioning of counter-emphatic emotional responses. *Journal of Experimental Social Psychology*, 18, 375–391.

Field, T. M., Woodson, R., Greenberg, R. & Cohen, D. (1982). Discrimination and imitation of facial expression by neonates. *Science*, 179–181.

Flack, W. F. (2006). Peripheral feedback effects of facial expressions, bodily postures, and vocal expressions on emotional feelings. *Cognition and Emotion*, 20, 177–195.

Flack, W. F., Laird, J. D., & Cavallaro, L. A. (1999). Separate and combined effects of facial expressions and bodily postures on emotional feelings. *European Journal of Social Psychology*, 29, 203–217.

Fontaine, J. R. J., Scherer, K. R., Roesch, E. B., & Ellsworth, P. E. (2007). The world of emotions is not two-dimensional. *Psychological Science*, 18, 1050–1057.

Fridlund, A. J. (1994). *Human facial expressions: An evolutionary view*. New York: Academic Press.

Fridlund, A. J., & Cacioppo, J. T. (1986). Guidelines for human electromyographic research. *Psychophysiology*, 23, 567–589.

Gellhorn, E. (1964). Motion and emotion: The role of proprioception in the physiology and pathology of the emotions. *Psychological Review*, 71, 457–472.

Gray, J. A. (1975). *Elements of a two-process theory of learning*. London: Academic Press.

Hatfield, E., Rapson, R. L., & Le, Y. L. (2009). Emotional contagion and empathy. In J. Decety & W. Ickes (Eds.), *The social neuroscience of empathy.* (pp. 19–42). London: Mit Press Ltd.

Hennenlotter, A., Dresel, C., Castrop, F., Ceballos Baumann, A. O., Wohlschläger, A. M., & Haslinger, B. (2009). The link between facial feedback and neural activity within central circuitries of emotion—New insights from botulinum toxin–induced denervation of frown muscles. *Cerebral Cortex*, 19, 537–542.

Hjortsjö, C. H. (1970). *Man's face and mimic language*. Lund, Sweden: Studentlitteratur.

Hodges, S. D., & Wegner, D. M. (1997). Automatic and Controlled Empathy. In W. Ickes (Ed.), *Empathic accuracy* (pp. 311–339). New York: The Guilford Press.

Hoffman, M. (2008). Empathy and prosocial behavior. In M. Lewis, J. Haviland-Jones, & L. Feldman Barrett (Eds.), *Handbook of emotions* (3rd ed., pp. 440–455). New York: The Guildford Press.

Hogan, R. (1969). Development of an empathy scale. *Journal of Consulting and Clinical Psychology*, 33, 307–316.

Hsee, C. K., Hatfield, E., Carlson, J. G., & Chemtob, C. (1990). The effect of power on susceptibility to emotional contagion. *Cognition and Emotion*, 4, 327–340.

Iacoboni, M. (2005). Understanding others: Imitation, language, empathy. In S. Hurley & N. Chater (Eds.), *Perspectives on imitation: From cognitive neuroscience to social science* (pp. 77–99). Cambridge, MA: M.I.T. Press

Izard, C. E. (1971*). The face of emotion*. New York: Appleton-Century-Crofts.

Izard, C. E. (1991). *The psychology of emotions*. New York: Plenum Press.

Izard, C. E. (1992). Basic emotions, relations among emotions, and emotion–cognition relations. *Psychological Review*, 99, 561–565.

Jackson, P. L., Melzoff, A. N., & Decety, J. (2005). How do we perceive others? A window into the neural processes involved in empathy. *NeuroImage*, 24, 771–779.

James, W. (1884). What is an emotion? *Mind*, 9, 188–205.

Jolliffe, D., & Farrington, D.P. (2006). Development and validation of the Basic Empathy Scale. *Journal of Adolescence*, 29, 589–611.

Keillor, J. M., Barrett, A. M., Crucian, G. P., Kortenkamp, S. A., & Heilman, K. M. (2002). Emotional experience and perception in the absence of facial feedback. *Journal of the International Neuropsychological Society*, 8, 130–135.

Kilts, C. D., Egan, G., Gideon, D. A., Ely, T. D., & Hoffman, J. M. (2003). Dissociable neural pathways are involved in the recognition of emotion in static and dynamic facial expressions. *Neuroimage*, 18, 156–168.

Kunz, M., Prkachin, K., Lautenbacher, S. (2009). The smile of pain. *PAIN*, 145, 273–275.

Laird, J. D. (1974). Self-attribution of emotion: The effects of expressive behavior on the quality of emotional experience. *Journal of Personality and Social Psychology*, 29, 475–486.

Laird, J. (1984). The real role of facial response in the experience of emotion: A reply to Tourangeau and Ellsworth, and others. *Journal of Personality and Social Psychology*, 47, 909–917.

Lang, P. J. (1968). Fear reduction and fear behavior: Problems in treating a construct. In J. M. Shlien (Ed.), *Research in psychotherapy* (Vol. III, pp. 90–102). Washington DC: American Psychological Association.

Langford, D. J., Crager, S. E., Shehzad, Z., Smith, S. B., Sotocinal, S. G., Levenstadt, J. S., et al. (2006). Social modulation of pain as evidence for empathy in mice. *Science,* 312, 1967–1970.
Larsen, J. T., Berntson, G. G., Poehlmann, K. M., Ito. T. A., & Cacioppo, J. T. (2008). The psychophysiology of emotion. In M. Lewis & J. M. Haviland-Jones (Eds.), *Handbook of emotions* (3rd ed., pp. 180–195). New York: Guilford Press.
Larsen, R. J., Kasimatis, M., & Frey, K. (1992). Facilitating the furrowed brow: An unobtrusive test of the facial feedback hypothesis applied to unpleasant affect. *Cognition and Emotion*, 6, 321–338.
Lazarus, R. (1982). Thoughts on the relations between emotion and cognition. *American Psychologist*, 37, 1019–1024.
LeDoux, J. E. (2000). Emotion circuits in the brain. *Annual Review of Neuroscience*, 23, 155–184.
LeDoux, J. E. & Phelps, E. A. (2000). Emotional networks in the brain. In M. Lewis & J. M. Haviland-Jones (Eds.), *Handbook of emotions* (2nd ed.). New York: Guilford Press.
Levenson, R. W. (1992). Autonomic nervous system differences among emotions. *Psychological Science*, 3, 23–27.
Levenson, R. W., Ekman, P., & Friesen, W. V. (1990). Voluntary facial action generates emotion-specific autonomic nervous system activity. *Psychophysiology*, 27, 363–384.
Levenson, R. B., & Ruef, A. M. (1992). Empathy: A physiological substrate. *Journal of Personality and Social Psychology*, 63, 234–246.
Lundqvist, L. –O, & Dimberg, U. (1995). Facial expressions are contagious. *Journal of Psychophysiology*, 9, 203–211.
Lundqvist, L. –O. (1995). Facial EMG reactions to facial expressions: A case of facial emotional contagion? *Scandinavian Journal of Psychology*, 36, 130–141.
MacDonald, A. (2003). I feel your pain (and joy): New theories about empathy. *Brain Work*, 13, 1–3.
Matsumoto, D. (1987). The role of facial response in the experience of emotion: More methodological problems and a meta-analysis. *Journal of Personality and Social Psychology*, 52, 769–774.
Matsumoto, D., Keltner, D., Shiota, M. N., O'Sullivan, M., & Frank, M. (2008). Facial expressions of emotion. In M. Lewis & J. M. Haviland-Jones (Eds.), *Handbook of emotions* (3rd ed., pp. 211–234). New York: Guilford Press.
McIntosh, D. N. (1996). Facial feedback hypothesis: Evidence, implications, and directions. *Motivation and Emotion*, 20, 121–147.
Mehrabian, A. (1977). Individual differences in stimulus screening and arousability. *Journal of Personality*, 45, 237–250.
Mehrabian, A., & Epstein, N. (1972). A measure of emotional empathy. *Journal of Personality*, 40, 525–543.
Mehrabian, A., Young, A. L., & Sato, S. (1988). Emotional empathy and associated individual differences. *Current Psychology: Research & Reviews*, 7, 221–240.
Meltzhoff, A. N., & Moore, M. K. (1977). Imitation of facial and manual gestures by human neonates. *Science*, 198, 75–78.
Myers, D. G. (2001). *Psychology* (6th ed.). New York: Worth Publishers.
Nummenmaa, L., Hirvonen, J., Parkkola, R., & Hietanen, J. K. (2008). Is emotional contagion special? An fMRI study on neural systems for affective and cognitive empathy. *NeuroImage*, 43, 571–580.
Öhman, A. (1986). Face the beast and fear the face: Animal and social fears as prototypes for evolutionary analyses of emotion. *Psychophysiology*, 23, 123–45.

Panksepp, J. (2007). Neurologizing the psychology of affects: How appraisal-based constructivism and basic emotion theory can coexist. *Perspectives in Psychological Science*, 2, 281–296.
Plutchik, R. (1991). *The emotions: facts, theories, and a new model* (Rev. ed.). Lanham, MD: University Press of America.
Plutchik, R. (2002). *Emotions and life perspectives from psychology, biology and evolution*. Washington, DC: American Psychological Association.
Preston, D., & de Waal, F.B.M., (2002). Empathy: Its ultimate and proximate bases. *Behavioral and Brain Sciences*, 25, 1–72.
Rhodewalt, F., & Comer, R. (1979). Induced-compliance attitude change: Once more with feeling. *Journal of Experimental Social Psychology*, 15, 35–47.
Rizzolatti, G., & Craighero, L. (2004). The mirror-neuron system. *Annual Review of Neuroscience*, 27, 169–192.
Rolls, E. T. (1990). A theory of emotion, and its application to understanding the neural basis of emotion. *Cognition & Emotion*, 4, 161–190.
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.
Russell, J. A., & Carroll, J. M. (1999). On the bipolarity of positive and negative affect. *Psychological Bulletin*, 125, 3–30.
Schachter, S. (1966). The interaction of cognitive and physiological determinants of emotional state. In C. D. Spielberger (Ed.), *Anxiety and behavior*. New York: Academic Press.
Schwartz, G. E., Fair, P. L., Salt, P., Mandel, M. R., & Klerman, G. L. (1976). Facial muscle patterning to affective imagery in depressed and nondepressed subjects. *Science*, 192, 489–491.
Shamay-Tsoory, S. G., Aharon-Peretz, J., & Perry, D. (2009). Two systems for empathy: A double dissociation between emotional and cognitive empathy in inferior frontal gyrus versus ventromedial prefrontal lesions. *Brain*, 132, 617–627.
Seligman, M. E. P. (1970). On the generality of the laws of learning. *Psychological Review*, 2, 307–320.
Seligman, M. E. P. (1971). Phobias and preparedness. *Behavior Therapy*, 2, 307–320.
Seligman, M. E. P., & Hager, J. E. (1972). *Biological boundaries of learning*. New York: Appleton-Century-Crofts.
Sonnby-Borgström, M. (2002). Automatic mimicry reactions as related to differences in emotional empathy. *Scandinavian Journal of Psychology*, 43, 433–443.
Sonnby-Borgström, M., Jönsson, P., & Svensson, O. (2003). Emotional empathy as related to mimicry reactions at different levels of information processing. *Journal of Nonverbal Behavior*, 27, 3–23.
Soussignan, R. (2002). Duchenne smile, emotional experience, and autonomic reactivity: A test of the facial feedback hypothesis. *Emotion*, 2, 52–74.
Stel, M., van den Heuvel, C., & Smeets, R. C. (2008). Facial feedback mechanism in autistic spectrum disorders. *Journal of Autism and Developmental Disorders*, 38, 1250–1258.
Stotland, E. (1969). Exploratory investigations of empathy. In L. Berkowitz (Ed.), *Advances in experimental social psychology* (Vol. 4, pp. 271–314). New York: Academic Press.
Strack, F., Martin, L. L., & Stepper, S. (1988). Inhibiting and facilitating conditions of the human smile: A nonobtrusive test of the facial feedback hypothesis. *Journal of Personality and Social Psychology*, 54, 768–777.

Tomkins, S. S. (1962). *Affect, imagery, consciousness: Vol. 1. The positive affects*. New York: Springer.
Tomkins, S. S. (1963). *Affect, imagery, consciousness: Vol. 2. The negative affects*. New York: Springer.
Tomkins, S. S. (1980). Affect as amplification: some modifications in theory. In R. Plutchik & H. Kellerman (Eds.), *Emotion: theory, research and experience* (pp. 141–164). New York: Academic.
Tomkins, S. S. (1991). *Affect, imagery, consciousness: Vol. 3. The negative affects anger and fear*. New York: Springer.
Tourangeau, R., & Ellsworth, P. C. (1979). The role of facial response in the experience of emotion. *Journal of Personality and Social Psychology*, 37, 1519–1531.
Watson, D., Wiese, D., Vaidya, J., & Tellegen, A. (1999). The two general activation systems of affect: Structural findings, evolutionary considerations, and psychobiological evidence. *Journal of Personality and Social Psychology, 76*, 820–838.
Whalen, P. J., Rauch, S. L., Etcoff, N. L., McInerney, S. C., Lee, M. B., Jenike, M. A. (1998). Masked presentations of emotional facial expressions modulate amygdala activity without explicit knowledge. *The Journal of Neuroscience*, 18, 411–418.
Wiesenfeld, A. R., Whitman, P. B., & Malatesta, C. Z. (1984). Individual differences among adult women in sensitivity to infants: Evidence in support of an empathy concept. *Journal of Personality and Social Psychology*, 46, 118–124.
Wispé, L. (1986). The distinction between sympathy and empathy: To call forth a concept, a word is needed, *Journal of Personality and Social Psychology*, 50, 314–321.
Zajonc, R. B. (1980). Feeling and thinking: Preferences need no inferences. *American Psychologist*, 35, 151–175.
Zajonc, R. B., Murphy, S. T., & McIntosh, D. N. (1993). Brain temperature and subjective emotional experience. In M. Lewis & J. M. Haviland (Eds.), *Handbook of emotions* (pp. 209–220). New York: Guilford.

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