Expressive Control and Emotion Perception:

The Impact of Expressive Suppression and Mimicry

on Sensitivity to Facial Expressions of Emotion

by

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Dissertation submitted in partial fulfillment of
the requirements for the degree of
Doctor of Philosophy in
the Department of Psychology and Neuroscience
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ABSTRACT

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Abstract

Recent studies have linked expressive suppression to impairments in interpersonal functioning, but the mechanism underlying this relationship has not been well articulated. One possibility is that the individual who engages in expressive suppression is impaired in perceiving the emotions of others, a critical ability in successful interpersonal functioning. In the current study, participants were presented with a series of photographs of facial expressions that were manipulated so that they appeared to “morph” from neutral into full emotion expressions. As they viewed these images, participants were instructed to identify the expression as quickly as possible, by selecting one of the six emotion labels (happiness, sadness, fear, anger, surprise, and disgust) on the screen. Prior to this task, participants were randomized to one of three groups: instructed to mimic the expressions on the screen, instructed to suppress all emotion expressions, or not given specific instructions on how to control expressions (the control group). The speed with which participants accurately identified emotional expressions (emotion sensitivity) was the primary variable of interest. Overall, participants in the suppression condition were found to be slower to accurately identify emotions, while no statistically-significant differences were found between the mimicry and no-instructions conditions. The decreased emotion sensitivity in the suppression group could not be accounted for by impulsive responding, decreased sensitivity at full expression, or perceived difficulty of task.

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Figure 1: Impact of Instructions on Emotion Sensitivity

Interest in the study of emotion has blossomed over the past quarter century with nearly 4000 journal articles addressing the topic published in the past ten years alone (PsycInfo, OVID, search 3.22.08). In general, researchers tend to identify six “basic” emotions (defined as having innate underlying neural substrates, innate and universal expressions, and are experientially distinctive) that are recognized cross-culturally: happiness, sadness, fear, anger, surprise, and disgust (Ekman, 1992; Ekman, Friesen, & Ellsworth, 1972), although agreement on this matter is far from universal (see Ortony & Turner, 1990; Russell, 1994; Russell, 1995). Arguments have been made against the inclusion of surprise as a basic emotion (Shaver, Schwartz, Kirson, & O'Connor, 1987), and alternately, for the inclusion of interest (Izard, 1994; Langsdorf, Izard, Rayias, & Hembree, 1983), pride (Tracy & Robins, 2007), embarrassment (Keltner, 1995; Tracy & Robins, 2008b), shame (Dougherty, Bartlett, & Izard, 1974; Keltner, 1995), and contempt (Buhlmann, Etcoff, & Wilhelm, 2006) in the catalog of basic emotions.

Functions of Emotion

While there may not be perfect agreement as to which emotions can be classified as "basic", those emotion researchers who have attempted these classifications have, for the most part, worked from an evolutionary model of emotion (Ekman, 1992; Izard, 1994). According to this view, emotions are intricate bio-behavioral systems which have developed as a result of natural selection and provide an adaptive advantage (Izard, 2007). Emotions are viewed as complex systems comprised of behavioral (i.e. expressive), cognitive, physiological, and experiential components (Gross & Levenson, 1993, 1997). Contemporary emotion theorists generally agree that emotions are necessary to human functioning (Ekman, 1992; Lazarus, 1991), assisting in the organization and direction of intrapersonal and interpersonal functions. From an evolutionary perspective, emotions have developed because they play a central role in signaling that some response to the environment is required and then guiding the selection and implementation of that response (Darwin 1872/1998; Ekman, 2003). On the most basic level, emotions are thought to encourage approach or avoidance reactions by the organism experiencing the emotion (Chen & Bargh, 1999; Davidson, Ekman, Saron, Senulis, & Friesen, 1990). For example, the subjective experience of fear is believed to be primarily avoidance-orienting (Alexopoulos & Ric, 2007), while the subjective experience of anger is believed to be primarily approach-orienting (Adams & Kleck, 2003; Harmon-Jones & Allen, 1998). Importantly, emotion functions not only on the individual experiencing the emotion, but also influences the behavior of others in the environment. Humans have multiple means of signaling to others that they are experiencing emotion (i.e. through language, body movement, and perhaps most importantly through facial expressions). These expressions of emotion, in turn, serve to elicit approach or avoidance reactions from others (Adams, Ambady, Macrae, & Kleck, 2006; Marsh, Ambady, & Kleck, 2005). Thus, emotions serve to motivate and guide behavioral responses to the environment, which then function to alter the environment by eliciting approach or avoidance reactions from others.

In order to confer an adaptive advantage, individuals must be able to successfully produce, identify, and interpret expressions of emotion. In this paper we examine emotion sensitivity, the speed with which individuals accurately recognize facial expressions, an ability that is crucial for social functioning. An overwhelming number of studies have shown that skill in decoding nonverbal cues is tied to effectiveness in interpersonal relationships (Hall, Rosenthal, Archer, DiMatteo, & Rogers, 1978; Rosenthal, Hall, Archer, DiMatteo, & Rogers, 1979; Rosenthal, Hall, DiMatteo, Rogers, & Archer, 1979).

The primary goal of this study is to examine the impact of experimentally-induced expressive suppression (ie. “show no emotion”) and mimicry (ie. “mimic the facial expression”) on emotion perception sensitivity. In the current study we examine the impact of expressive suppression and mimicry on overall emotion sensitivity, as well as the unique effects of these two strategies on each of the six basic emotions.

Emotion Perception

Processing of facial expressions of emotion can take place on a conscious or unconscious level. There is significant evidence that processing of emotional stimuli begins even before the devotion of significant attentional resources. Evidence from neuroimaging studies has shown that fearful facial expressions produce strong activation of the amygdala, even when the expressions are backward masked and thus not available for conscious processing (Whalen, Rauch, Etcoff, McInerney, Lee, & Jenike, 1998). In addition, some expressions may require less processing than others. For instance, in visual search tasks, angry faces are identified far more readily than happy faces (Fox, Lester, Russo, Bowles, Pichler, & Dutton, 2000; Öhman, Lundqvist, & Esteves, 2001). Some studies have demonstrated that emotion perception is not fully automatic in nature, however (Edelstei & Gillath, 2008; Fenske & Eastwood, 2003; Horstmann, Borgstedt, & Heumann, 2006). Attempts to selectively attend to emotional information have been shown to be disrupted under conditions of cognitive load (Edelstei & Gillath, 2008). In addition, emotional expressions have been repeatedly shown to be processed more slowly when "flanked" by incompatible emotions, suggesting that additional cognitive resources are necessary to identify an expression when conflicting information is present (Fenske & Eastwood, 2003; Horstmann et al., 2006). Thus, it seems that accurate identification of facial expressions of emotion involves both automatic and effort-based mechanisms.

Terminology

One factor that complicates a review of the emotion perception literature is the wide variety of terminology which is used. Some studies describe the process of emotion recognition, which usually indicates that the study has examined participants' ability to identify the emotion at full expression. Other studies use the terms emotion identification or identification accuracy to refer to this same process. A number of studies have also examined threshold sensitivity, which refers to the minimum degree of expression that is necessary in order to accurately identify the expression. The development of morphing technologies has allowed a third type of measurement which incorporates both speed and accuracy of responding. Emotion sensitivity, as it is used in this study, refers to the speed with which an individual can accurately identify an expression as it evolves from a neutral to a full expression. This procedure enhances ecological validity, as facial expressions are rarely static in vivo, and also allows for the parsing of accuracy at 100% expression from the speed of accurate identification.

Emotion Perception as a Set of Abilities

Although emotion perception is generally described as a single construct it may be more accurately described as a constellation of related abilities, rather than as a single unique ability. Thus, an individual who is highly sensitive to facial expressions of sadness may not be highly sensitive to other facial expressions, such as fear. Imaging studies have provided evidence of the activation of different brain structures during the processing and recognition of different emotions. For example, the insula and basal ganglia appear to be involved in the recognition of disgust, while the amygdala may play a larger role in the recognition of fear (Adolphs, 2002). Additionally, processing of fearful expressions has been shown to activate the right fusiform gyrus and left dorsolateral frontal cortex, and processing of angry faces activates the right gyrus cinguli and medial temporal gyrus of the left hemisphere (Sprengelmeyer, Rausch, Eysel, & Przuntek, 1998). Thus, it appears that there are distinct neural substrates for the processing of many of the basic emotions, a finding which provides further support for the distinctiveness of these emotions from one another.

Emotion Contagion, Mimicry, and Facial Feedback

One of the most intriguing aspects of emotion perception is the phenomenon of emotion contagion. In emotion contagion, the simple act of viewing a facial expression of emotion is sufficient to evoke an emotional reaction in the perceiver (Wild, Erb, & Bartels, 2001). Emotion contagion has been described as a three-stage process in which the perception of an emotional facial expression triggers facial mimicry, which in turn leads to afferent feedback from the facial musculature and associated neural structures, leading to the experience of emotion in the perceiver (Hatfield, Cacioppo, & Rapson, 1994). Thus, emotion contagion relies upon automatic facial mimicry and facial feedback in order to produce the experience of emotion in the perceiver.

Automatic facial mimicry in response to viewing facial expressions of emotion is a well documented phenomenon (Dimberg, 1997; Lundqvist & Dimberg, 1995; Vaughan, & Lanzetta, 1980; Walbott, 1991). In several studies, Dimberg and colleagues demonstrated emotion-specific facial EMG changes within several hundred milliseconds following exposure to photos of emotionally expressive faces (Dimberg & Thunberg, 1998; Dimberg, Thunberg, & Elmehed, 2000; Lundqvist & Dimberg, 1995). In a study by Walbott (1991) participants who viewed photos from the Pictures of Facial Affect were later able to identify the emotion that they had been observing when presented with recordings of their own facial reactions, with a degree of accuracy significantly better than chance. The expressions produced in response to viewing facial expressions are similar in strength to those produced in reaction to acoustic stimuli (Bradley & Lang, 2000; Hietanen, Suraka, & Linnankoski, 1998). There is overwhelming evidence not only that viewing emotional facial expressions elicits facial expression in the viewer (Blairy, Herrera, & Hess, 1999; Dimberg & Thunberg, 1998; Dimberg et al., 2000; Hess & Blairy, 2001; Lundqvist & Dimberg, 1995; Sloan, Bradley, Dimoulas, & Lang, 2002; Weyers, Muhlberger, Hefele, & Pauli, 2006; Wild, et. al., 2001), but that viewing emotional facial expressions elicits changes in emotional state (Blairy, et al, 1999; Hess & Blairy, 2001; Laird, Alibozak, Davainis, Deignan, Fontanella, Hong, et al., 1994; Lundqvist & Dimberg, 1995; Wild et al., 2001). Furthermore, several studies have shown that the facial expressions elicited when viewing emotional faces are difficult to suppress (Dimberg, Thunberg, & Grunedal, 2002; Kappas, Bherer, & Thierault, 2000).

In order for emotion contagion to occur, it is essential not only that the perceiver mimic the perceived emotion expression, but also that the process of facial feedback occur. There are two empirically-supported variations of the facial feedback hypothesis, both of which hold that facial expression influences the experience of emotion in a positive feedback loop (McIntosh, 1996; Rutledge & Hupka, 1985). In the "weak" version (also referred to as the "maintaining" hypothesis) emotions which are already experienced are intensified by the proprioceptive feedback from the facial musculature during a facial expression. In the "strong" version (sometimes referred to as the "initiating" hypothesis) facial action alone is sufficient to produce an emotional response, where none existed. There is abundant evidence supporting the "weak" version of the facial feedback hypothesis (Bush, Barr, McHugo, & Lanzetta, 1989; Laird, 1974; Laird, 1984) in which facial expressions consistent with an emotion increase the subjective experience of that emotion. This result has been demonstrated for smiling/happiness

(Soussignan, 2002; Strack, Martin, & Stepper, 1988), disgust (Kraut, 1982), and anger (Rutledge & Hupka, 1985). More recently, evidence has mounted for the stronger version of the hypothesis (Duclos & Laird, 2001; Hess, Kappas, McHugo, Lanzetta, & Kleck, 1992; Levenson, Ekman, & Friesen, 1990). Some researchers have suggested that this increase in subjectively experienced emotion can be accounted for by situational demand, direction of attention onto the emotion, recognition of the emotional meaning of facial behavior, or by category accessibility (Laird, 1974; Strack et al., 1988). In order to examine the facial feedback hypothesis in its "purest" form (i.e. without interference from demand characteristics or other cognitive meddling, Strack and colleagues (1988) created a clever experiment in which they were able to ensure that participants activated muscles associated with smiling by instructing them to hold a pen in their mouth while judging cartoons, under the ruse that they were assessing various daily activities of the disabled. Participants in the facilitating condition rated the cartoons as funnier than did participants in an expression inhibiting condition, and did not deduce the real purpose of the facial manipulation. This study, along with others that have since refined this procedure (Soussignan, 2002), has provided further evidence that facial feedback occurs and is not solely due to demand characteristics or conscious awareness of facial expressions.

There is a smaller body of work supporting the "strong" version of the facial feedback hypothesis, in which facial expression is sufficient to elicit an emotional response in the absence of any emotional stimulus. Posing of facial expressions associated with happiness, surprise, fear, sadness, anger, and disgust have all been found to elicit the corresponding emotional experience (Duncan & Laird, 1977; Duclos, Laird, Schneider, Sexter, Stern, & Van Lighten, 1989; Laird, Cuniff, Sheehan, Shulman, & Strum, 1989). To date, however, it appears that this stronger version of the facial feedback hypothesis has not been subjected to the more rigorous and stringent that has been created to control for demand effects, suggesting a promising avenue for future research.

Consequences of Impaired Emotion Perception

Individuals use the facial expressions of others as important cues with which to regulate their own behavior (Salovey & Mayer, 1990), during attempts to regulate the emotions of others, and in order to assess the attitudes of others (Hess, Kappas, & Scherer, 1988). Difficulties in interpersonal functioning may be due, in part, to difficulties in perceiving emotion in others. The impact of this impairment likely differs depending upon the severity of the impairment as well as the type of emotion expression to be perceived. Emotions such as happiness, sadness, fear, and anger are associated with characteristic expressions and are thought to communicate specific cues to the perceiver. Perception of these expressions is likewise associated with specific recognition expressions (Kohler, Tuner, & Stolar, 2004). The consequences of missing or being slow to pick up on information transmitted by facial expressions are dependent upon the communication function of the emotion.

Impaired Perception of Happiness Expressions

The expression of happiness is generally accepted as a signal inviting the perceiver to approach or affiliate with the expresser. Characteristic expressions of happiness consist of the following: raised inner eyebrows, tightened lower eyelid, raised cheeks, upper lip raised, and lip corners turned upward (Kohler et al., 2004). Smiling, in particular, is associated with the expression of happiness, and recognition of happiness is related to increased attributions of attractiveness and kindness by the perceiver (Otta, Abrosio, & Hoshino, 1996). The facial expression corresponding with recognition of happy facial expressions consists of raised outer brow, eyelid tightening, and raised cheek

(Kohler et al., 2004). Impairment in recognizing expression of happiness may reduce opportunities to approach and affiliate with others and interfere with socially appropriate responding to affiliative cues. Impaired recognition of facial expressions of happiness has been associated with features of major depression, and is thought to underlie the impaired interpersonal functioning associated with this disorder (Surguladze, Young, Senior, Brebion, Travis, & Phillips, 2004).

Impaired Perception of Sadness Expressions

Characteristic expressions of sadness consist of furrowed eyebrows, opened mouth with raised upper lip, lip corners stretched and turned down, and chin pulled up (Chiba, 1985; Kohler, et al., 2004). These facial configurations are believed to elicit attentive, caregiving, and non-aggressive behaviors (Sternglanz, Gray, & Murakami, 1977). The facial expression corresponding with recognition of sad faces consists of lower brow and raised cheek (Kohler et al., 2004). Individuals who fail to accurately perceive expressions of sadness may fail to respond with attention and caregiving, or may engage in inappropriate aggressive behavior.

Impaired Perception of Fear Expressions

The experience of fear is thought to facilitate the detection of impending danger in the environment (Eysenck, 1992; LeDoux, 1996). Characteristic fear expressions consist of raised eyebrows, wide eyes, and stretched mouth (Kohler et al., 2004). The perception of fear in others has often been assumed to signify threat to the perceiver (Adolphs, Russel, & Tranel, 1999; Morris, Frith, Perret, Rowland, Young, Calder, et al., 1996) although recent evidence suggests that the fear expression may in fact serve as an affiliative stimulus, encouraging approach rather than avoidance in the perceiver (Marsh, Adams, & Kleck, 2005; Marsh et al., 2005). The facial expression corresponding with recognition of fearful faces consists of raised inner brow and wide eyes, raised upper lip and nostril dilation (Kohler, et al, 2004). This expression is consistent with increased attention to the surrounding environment. Whether fear signals an environmental threat or an affiliative approach signal, any impairment in detecting this signal on the part of the perceiver could have significant consequences.

Impaired Perception of Anger Expressions

Anger is widely accepted as an approach-oriented emotion (Adams & Kleck, 2003) insofar as the experience of anger motivates the individual to approach the emotion-inducing stimulus. Characteristic anger expressions consist of the following: lowered eyebrows, wide open eyes with tightened lower lid, stretched lip corners and lips exposing teeth (Kohler et al., 2004). The experience and expression of anger are associated with physiological changes marked by increased heart rate as well as greatly increased peripheral vascular functioning (Ekman, Levenson, & Friesen, 1983) and increases in diastolic blood pressure (Roberts & Weerts, 1982). The perception of anger in others, however, acts as a cue to potential danger. The facial expression corresponding with recognition of angry faces consists of lowered eyebrows, raised upper eyelids and depression of the lower lip (Kohler, et al., 2004). Impairment in the perception of anger may have significant and unfavorable consequences. Even a mild impairment in perceiving facial expressions of anger in others could be detrimental on an interpersonal level in that subtle signals of annoyance or frustration may go unnoticed.

Enhanced Emotion Sensitivity

While it may be easy to imagine the difficulties posed by impaired emotion sensitivity, the possible complications of enhanced emotion sensitivity are not quite as immediately obvious. Imagine, however, that you are highly sensitive to even the most minute expression of anger. The brief expression of annoyance on a friend's face, which would go unnoticed by anyone else, is perceived as a much stronger signal, and you react accordingly. This may be the case for individuals with borderline personality disorder, who have been shown to accurately identify expressions of anger at much lower thresholds than depressed or normal controls (Lynch, Rosenthal, Kosson, Cheavens, Lejuez, & Blair, 2006). There is abundant research suggesting that humans are imperfect at controlling emotional expressions (Dimberg et al., 2002; Kappas et al., 2000), and these "leaky" expressions, which may not be noticed by others, could be perceived by the individual with heightened emotional sensitivity. While the ability to selectively attend to and discriminate slight variations in low threshold emotion expressions may prove useful at the poker table, most research on enhanced emotion sensitivity has shown emotion-specific enhancement that is unintentional on the part of the perceiver (Niedenthal & Setterlund, 1994).

There are far fewer studies that have examined situations under which emotion perception is enhanced, it is nonetheless worthwhile to note that a handful of studies have been conducted which have found enhanced emotion sensitivity in certain populations.

Individual Differences in Emotion Recognition Sensitivity

There is evidence that individuals differ in their abilities to identify emotional expressions (Rozin, Taylor, Ross, Bennett, & Hejmadi, 2005) and that these individual differences in emotion perception threshold are relatively stable over time (Martin, Berry, Dobranski, & Horne, 1996). Individual differences in the ability to accurately identify emotional expressions have been linked to factors such as gender (McClure, 2000), age (Calder, Keane, Manly, Sprengelmeyer, Scott, Nimmo-Smith, et al., 2003; Montagne, Kessels, De Haan, & Perrett, 2007; Orgeta & Phillips, 2008), cultural differences (Elfenbein & Ambady, 2003; Matsumoto & Ekman, 1989), and psychopathology (Lynch et al., 2006; Montagne, Schutters, Westenberg, van Honk, Kessels, & de Haan, 2006; Wagner, Roemer, Orsillo, & Litz, 2003).

Gender Differences in Emotion Perception

There is substantial evidence of significant gender differences in the speed and accuracy with which individuals identify facial expressions of emotion (Hall & Matsumoto, 2004; Hampson, van Anders, & Mullin, 2006; Montagne, Kessels, Frigerio, De Haan, & Perrrett, 2005; Thayer & Johnson, 2000), which suggests that on average women are more accurate in recognizing facial expressions than are men. Studies have found evidence for increased accuracy of emotion recognition in women for both positively and negatively valenced emotions (Hampson et al., 2006; Hall & Matsumoto, 2004). Several studies, however, has found that males were superior in recognizing anger (Wagner, MacDonald, & Manstead, 1986; McAndrew, 1986), although in at least one study this finding was limited to identification of anger in male faces (Rotter & Rotter, 1988). A recent meta-analytic review concluded that there is a significant female advantage at facial expression processing from infancy through adolescence (McClure, 2000). Gender differences are complicated, however, by the finding that both men and women are faster at identifying angry expressions on male faces and happy expressions on female faces (Becker, Kenrick, Neuberg, Blackwell, & Smith, 2007). Furthermore, there is evidence that opposite-sex faces require less processing time for both men and women than do same-sex faces (Hofmann, Suvak, & Litz, 2006). In the current study, gender effects are examined and treated as a primary covariate.

Age and Emotion Perception

Several studies have found differences in emotion recognition sensitivity between younger and older adults (Montagne et al., 2007; Orgeta & Phillips, 2008). Orgeta and Phillips (2008) found age-related deficits in the perception of all six "primary" emotions, whereby older individuals (ages 61 and over) demonstrated decreased sensitivity compared to their younger counterparts. Other studies have found age-related deficits in recognition of anger and fear (Calder, et al., 2003), happiness and sadness (Montagne et al., 2007) but not disgust or surprise. Because all of the participants in the current study fall within the young adult age-range, it is not necessary to control for age effects, although findings may be limited to this segment of the population.

Cultural Differences and Emotion Perception

Cultural differences may also influence the accuracy with which individuals perceive emotional expressions (Matsumoto, Kasri, & Kooken, 1999; Thibault, Bourgeois, & Hess, 2006). One principle underlying the argument for the existence of "basic" emotions is that the expressions of these emotions are universally recognized (Matsumoto, 1992). While there is some evidence that this is the case, for example, studies have found that facial expressions of pride generalizes across cultures (Tracy & Robins, 2008b), including cultures that have been relatively isolated (Ekman & Friesen, 1971), other studies have shown that one's cultural background may influence the rated intensity of emotion expression (Matsumoto & Ekman, 1989; Matsumoto et al., 1999) as well as the accuracy with which one judges expression (Matsumoto, 2002). Recent research by Thibault and colleagues (2006) suggests that these differences may be due to increased effort by perceivers when attempting to decode the emotional expression of in-group members. More recently, Elfenbein & Ambady (2003) demonstrated that individuals, regardless of race or ethnicity, are faster and more accurate in judging facial expressions of emotion displayed by members of the society in which they live than members of other societies. These results suggest that cultural contact, rather than underlying biological or ethnic ties, is responsible for the cultural differences that have been observed in emotion recognition.

Psychopathology and Emotion Perception

Difficulty expressing emotion and/or identifying emotion expressions have been documented within numerous clinical populations, including borderline personality disorder (Bland, Williams, Scharer, & Manning, 2004; Levine, Marziali, & Hood, 1997; Renneberg, Heyn, Gebhard, & Bachmann, 2005), post-traumatic stress disorder (Santa Maria, 2002; Wagner et al., 2003), and social anxiety (Melfsen, Osterlow, & Florin, 2000; Montagne et al., 2006). Certain disorders have been linked to impaired recognition of facial expressions for specific emotions. For example, obsessive-compulsive disorder has been linked to impaired identification of facial expressions of disgust (Corcoran, Woody, & Tolin, 2008). Social anxiety disorder has been linked to impaired identification of anger and disgust (Montagne et al., 2006).

Psychopathology is not always related to impairment in processing of emotion, however. In some populations, researchers have found significantly heightened processing of certain emotions. For example, individuals with high levels of trait anxiety have been found to have improved identification of facial expressions of fear (Surcinelli, Codispoti, Montebarocci, Rossi, & Baldaro, 2006). Additionally, individuals with paranoid schizophrenia have been shown to be more accurate in identifying emotions than individuals with other forms of schizophrenia, depressed participants, and those with no psychiatric disorder (Davis & Gibson, 2000). Research is mixed with regard to borderline personality disorder. In one study, borderline individuals were less accurate than controls at recognizing facial expressions of anger, fear, and disgust (Levine et al., 1997), while another study found that borderline individuals were more accurate in identifying facial expressions of fear at full expression (Wagner & Linehan, 1999). A third study found that individuals with borderline personality disorder displayed greater sensitivity (that is, they were faster to accurately identify) facial expressions of anger and happiness (Lynch et al., 2006). This lower threshold for emotion identification may play a role in the emotional dysregulation that is characteristic of borderline personality disorder. Clearly, both impaired and selectively heightened sensitivity to facial expressions of emotion carry risks for appropriate emotional responding. This study may help to shed light on some of the problems related to interpersonal functioning in these disorders.

Factors Affecting Emotion Perception Sensitivity

In addition to individual variations in emotion sensitivity, differences in emotion sensitivity may be seen within the same individual over time. Factors that have been shown to affect emotion recognition sensitivity include cognitive load (Patterson & Stockbridge, 1998; Tracy & Robins, 2008a), mood congruence (Niedenthal, Brauer, Halberstadt, & Innes-Ker, 2001; Niedenthal, Halberstadt, Margolin, & Innes-Ker, 2000), and the use of certain medications (Coupland, Singh, Sustrik, Ting, & Blair, 2003; Zangara, Blair, & Curran, 2002). Additionally, it is possible that emotion recognition sensitivity may be better conceptualized as a group of related abilities, rather than as a unitary ability, in that individuals may display varied sensitivities to different emotions (Adolphs, 2002; Sprengelmeyer et al., 1998).

Cognitive Load

One factor that may impact emotion recognition is cognitive load (Patterson & Stockbridge, 1998). Surprisingly few studies have investigated this, however. In one set of studies, Tracy and Robins (2008a) found that participants who were asked to view and later recall a seven-digit number were slightly less accurate in identifying several emotions at full expression, than participants not subject to this cognitive load. This result is difficult to interpret, however, given that those in the cognitive load condition had only 1,500 ms to view and respond to the expression, while those not subject to the cognitive load were given 8,000 ms to view and respond. Furthermore, the differences did not prove to be particularly robust and the only emotion consistently affected was surprise. Nonetheless, the potential impact of cognitive load cannot be discounted.

Mood Congruence

There is some evidence that processing of emotion expressions is impacted by the current mood state of the perceiver (Niedenthal et al., 2000; Schiffenbauer, 1974). These studies build upon research which has demonstrated that individuals tend to perceive emotion-congruent stimuli more efficiently than emotion-incongruent stimuli (Niedenthal & Setterlund, 1994). Several studies by Niedenthal and colleagues (Niedenthal et al., 2001; Niedenthal et al., 2000; Niedenthal & Setterlund, 1994) have found that participants in an experimentally-induced mood state (happiness or sadness) perceived enduring evidence of a happy or sad mood state in a facial expression as it morphed from full expression to a neutral expression. Others have found, though, that sensitivity to changes in facial expression is related to current affective state, but mediated by the degree to which individuals tend to emphasize feelings of pleasure or displeasure in their self-report of emotional experience (Barrett & Niedenthal, 2004). In other words, individuals are more likely to perceive expressions that are congruent with their own affect, but only if they are specifically focused on their own internal feeling state.

Medication and Perception

Certain prescription medications have been linked to selective impairments in the identification of certain emotions. Diazepam, more commonly referred to as Valium, has been shown to selectively impair the recognition of anger (Blair & Curran, 1999), fear (Zangara et al. 2002), surprise and disgust (Coupland et al., 2003). Similarly, alcohol has been shown to selectively reduce sensitivity to facial expressions of anger (Borrill, Rosen, & Summerfield, 1987). While alcohol use was not assessed in this study, respondents were asked about their use of prescription medications. None of the participants reported using diazepam or any other class of benzodiazepine.

Management of Expressive Behavior

Why might there be individual differences in sensitivity to emotional expressions? One answer may lie in the management of expressive behavior by the individual that occurs at the same time that an individual is attempting to process the emotional expression of an interaction partner. Expression and perception of expression occur simultaneously, but are often studied independently. Extensive studies have been conducted which examine the theoretical, methodological, and mechanistic issues underlying emotion perception (Adams & Kleck, 2003; Kohler, et al., 2004; Mufson & Nowicki, 1991; Rosenberg & Ekman, 1995) as well as expressive control (Butler, et.al., 2002; DePaulo & Kirkendol, 1988; DePaulo, Kirkendol, Tang, & O'Brien, 1988; Gross & John, 2003; Gross and Levenson, 1993; 1997). This study builds upon research in the areas of emotion perception, specifically *sensitivity to facial expressions of emotion*, and expressive control, in particular, attempts to control the facial expression of emotion, either by *expressive suppression* or *mimicry.*

Expressive Suppression

Expressive suppression involves deliberate efforts to control the outward expression of experienced emotion. It involves actively reducing or eliminating emotionally expressive behavior. Individuals may engage in expressive suppression for a variety of reasons, for example in order to mask socially inappropriate affect, to avoid unwanted attention, or in an attempt to stifle emotional experience. Furthermore, expressive suppression may be attempted in response to both positive and negative emotions. Studies of expressive suppression have centered on experiential, physiological, and social consequences (Butler, Egloff, Wilhelm, Smith, Erickson, and Gross & John, 2003; Gross and Levenson, 1993; 1997; Notarius and Levenson, 1979).

Previous research has shown that expressive suppression decreases behavioral expression (Gross & John, 2003; Gross & Levenson, 1993; 1997), but either fails to decrease or paradoxically increases emotion experience (Butler et.al., 2002; Gross & John 2003; Gross & Levenson, 1993; 1997), and has unintended physiological (Gross & Levenson, 1993; 1997; Notarius and Levenson, 1979) and cognitive (Egloff, Schmukle, Burns, & Schwerdtfeger, 2006; Richards & Gross, 2000) side effects. For example, the use of expressive suppression as an emotion regulation strategy leads to memory impairment for the period of time during which suppression occurs (Egloff et al., 2006). This unintended cognitive side-effect has been demonstrated in studies using instructed suppression (Richards & Gross, 2000; Richards, Butler, & Gross, 2003) as well as studies of spontaneous emotion regulation (Egloff et al., 2006).

While some amount of expressive suppression appears to be healthy and necessary for successful social interaction, excessive reliance on expressive suppression as an emotion regulation strategy is related to a number of psychological disorders, including posttraumatic stress (Roemer, Litz, Orsillo, and Wagner, 2001; Wastell, 2002), eating disorders (Geller, Cockell, Hewitt, Goldner, and Flett, 2000; Piran and Cormier, 2005; Waller, Babbs, Milligan, Meyer, Ohanian, and Leung, 2003; Zaitsoff, Geller, and Srikameswaran, 2002), and depressive symptomatology (Gross & John, 2003; Kopper & Epperson, 1996). In particular, the suppression of anger appears to be problematic

(Geller et al., 2000; Kopper & Epperson, 1996; Piran & Cormier, 2005; Waller et al., 2003; Whiteside & Abramowitz, 2004; Zaitsoff et al., 2002).

Recent studies examining the impact of expressive suppression on interpersonal functioning have found short-term and long-term effects. In the short-term, expressive suppression has been shown to increase physiological responding in individuals interacting with suppressors (Butler et.al., 2003) and to decrease liking of and rapport with suppressors, as well as to decrease willingness to form a friendship (Butler et.al., 2003). Emotion expression serves social functions (Fridlund, 1994) and has been shown to play a central role in establishing relationships (Keltner and Kring, 1998), as well as interpersonal coordination (Laurenceau, Barrett, and Pietromonaco, 1998). Chronic expressive suppression style may interfere with social functioning. For example, emotion expression is linked to social closeness (Reis & Shaver, 1988) while in at least one longitudinal study expressive suppression has been shown to impair the development of social closeness (Mcgonigal & Gross, in press). The mechanisms underlying the relationship between expressive suppression and impaired social functioning have not been well articulated. One possibility is that the individual who engages in expressive suppression is impaired in perceiving the emotions of others, a critical ability in successful interpersonal functioning.

Mimicry

As previously noted, automatic facial mimicry in response to viewing facial expressions of emotion is a well documented phenomenon (Dimberg, 1997; Lundqvist & Dimberg, 1995; Vaughan, & Lanzetta, 1980; Walbott, 1991) which plays a catalytic role in emotion contagion (Wild et al., 2001). Rapid, spontaneous facial mimicry has been shown to occur in response to live interaction (McIntosh, 2006), to still photographs (Walbott, 1991), and to dynamic expressions of emotion (Yoshikawa & Sato, 2006), even for relatively weak levels of expression (Hess & Blairy, 2001). Spontaneous mimicry has been demonstrated for expressions of happiness, sadness, fear, anger, surprise, and disgust (Hess & Blairy, 2001; Moody, McIntosh, & Mann, 2007; Vrana & Gross, 2004). Spontaneous mimicry of emotional expressions is not an exclusively Western phenomenon, as it has been observed in Japanese participants as well (Tamura & Kameda, 2006)

Several studies have demonstrated a link between intensity of automatic mimicry in response to expressive faces and empathy (Sonnby-Borgstrom, 2002; Sonnby-Borgstrom, Jonsson, & Svensson, 2003). In addition, in one study individuals who scored low on measures of empathy, tended to respond inversely to expressive faces (ie. smiling at an angry face; Sonnby-Borgstrom, 2002). Diminshed levels of spontaneous facial mimicry have been found in a number of patient populations, including pre-adolescent boys with oppositional defiant disorder (De Wied, van Boxtel, & Zaalberg, 2006), adolescents and adults with autism spectrum disorders (McIntosh, Reichmann-Decker, & Winkielman, 2006), and dysphoric adults (Sloan et al., 2002).

Mimicry is thought to play a crucial role in interpersonal functioning. Successfully mimicking the expressive behavior of interaction partners has been shown to facilitate affiliation and rapport (Bernieri, 1988; Lakin & Chartrand, 2003). The underlying mechanism by which this occurs, however, is not well understood.

The Current Study

In the current study, participants have been randomly assigned to one of three instructional conditions. In the suppression condition, participants were explicitly instructed not to display any emotional facial expression while completing the task. This condition was expected to be both cognitively taxing and to eliminate any source of facial feedback information which may be useful to the participant in identifying facial expressions of emotion. In the mimic condition, participants were explicitly instructed to mimic the expressions of the faces that they were observing, and to increase the magnitude of their own expressions as the facial expressions on the screen became more intense. This condition was expected to be cognitively taxing, but did not eliminate the possibility of facial feedback. The third condition was a no-instruction control, which was not expected to be as cognitively taxing as the other two conditions, and in which participants' management of their own facial expressions would not be influenced.

Memory deficits have been associated with both experimentally-induced enhancement and suppression of emotion, suggesting that both conscious mimicry and suppression require cognitive resources (Bonanno, Papa, Lalande, Westphal, & Coifman, 2004). Given the cognitively taxing nature of these behavioral regulation techniques, it is possible that engaging in both mimicry and suppression will negatively impact simultaneous attempts to quickly and accurately identify emotion expressions. If, on the other hand, the use of mimicry proves to be advantageous in increasing sensitivity to facial expressions of emotion, this may help to explain the advantage that individuals who spontaneously mimic expressions have in social situations.

While both the expressive suppression and mimicry conditions are associated with high cognitive load, only those in the mimicry condition will be producing observable facial expressions. The inclusion of both an instructed suppression and a mimicry condition within this study allows us to tease apart the impact of the cognitive load from the presence or absence of facial expression itself. If both conditions lead to impairment in emotion perception, then it is likely that the associated cognitive load is responsible. If, however, suppression but not mimicry leads to perception impairment, then this would provide support for the importance of the role of facial expression itself in facilitating emotion perception.

Hypotheses

Main Effects of Condition.

Compared to participants who are not instructed to control their own facial expressions, we expected participants who were instructed to suppress to show decreased perceptive sensitivity. That is, we expected them to be slower to accurately identify emotional facial expressions. Participants who are instructed to mimic facial expressions may show decreased perceptive sensitivity (if cognitive load is the dominating factor) or increased perceptive sensitivity (if facial feedback is the dominating factor.)

Main Effects of Emotion

Main effects for emotion were examined in order to identify whether there were differences in participants' abilities to quickly and accurately identify happiness, sadness, fear, anger, surprise, and disgust.

Interaction between Condition and Emotion

Group X emotion interactions were examined in order to determine whether there was one emotion that was responsible for any observed differences in emotion perception sensitivity across conditions.

Gender Differences

While some studies have failed to identify gender differences in the recognition of facial expressions of emotion (Oyuela-Vargas & Pardo-Velez, 2003), numerous others have demonstrated that on average, women decode facial expressions of emotion more accurately than men (Hall, 1978; McClure, 2000; see Hall, 1984 for a review), with the exception of anger, which men may accurately identify more quickly (Wagner et al., 1986; McAndrew, 1986; but see also Hess, Blairy, & Kleck, 1997). We anticipated a significant gender effect such that female participants would be faster in accurately identifying expressions of happiness, sadness, and fear, while male participants would be faster in accurately identifying expressions of anger. If statistically significant gender differences are found, gender will be treated as a covariate.

Impact of Instructions on Expression

Suppression instructions will lead to a decrease, but not elimination of facial expression (see Gross & Levenson, 1993; 1997) and mimicry instructions will lead to an increase in facial expressions of all six target emotions as demonstrated by facial affect coding of videotaped expression during the experiment.

Method

Participants

Participants were 96 male (41%) and female undergraduate students recruited through the Duke University Psychology subject pool and through the Duke Social Science Research Institute subject pool. Participants received either 1.5 hours of participation credit or $15 for their involvement in the study. After removal of outliers and data from participants who did not follow instructions (see Results section), data from 90 participants remained for data analyses. The demographics for this sample were as follows: 36 male (40%) and 54 female participants. The average age of participants was 19.94 years (SD=2.21). With regard to race/ethnicity, 56 participants (62%) identified themselves as Caucasian, 17 as Asian/Asian-American, 9 as Black/African-American, 6 as Hispanic/Latino, and 2 as multi-racial.

Measures

Demographic Information. A short self-report questionnaire was administered in order to obtain age, gender, and race/ethnicity.

The *Multimorph Facial Affect Recognition Task* (Blair, Colledge, & Murray, 2001*)* is a tool for assessing the speed and accuracy with which one identifies an emotion expression. The morphing technique developed by Perrett and colleagues (Perrett, May, and Yoshikawa, 1994) allows the participant to view as a neutral facial expression gradually develops into a distinct emotion expression. The photographic stimuli are taken from the cross-culturally validated Pictures of Facial Affect Series (Ekman and Friesen, 1978). This set of photographs consists of six distinct emotion expressions (happiness, sadness, fear, anger, surprise, and disgust), each portrayed by three male and three female actors (see Figure 1.). Each trial begins with a neutral face, which gradually morphs through 39 stages of 450 ms each into one of the six prototypic emotional expressions. Prior to completing this task, all participants received the following instructions:

> *You will be presented with a series of faces. These faces are initially neutral, that is, they have a blank expression. However, the faces will slowly change over many stages, to reveal one of the six target emotions listed on the screen. For each face, you will have to determine which expression is displayed as soon as possible in as few stages as possible, without merely guessing. So remember, the aim is to say which emotion is being shown as soon as you recognize it by choosing one of the six emotions: fear, sadness, disgust, surprise, happiness, or anger. Once you have given an answer, you can change your mind when you want to, and as often as you wish right up until the end of the expression. Finally, for each face, you will also be asked to give a final answer.*

The principal measure of performance is the mean number of stages required to achieve correct classifications of emotion. In addition, the first stage at which any response was made as well as performance accuracy for expressions at 100 % expression was measured. The first stage at which any response was made was used to distinguish emotional sensitivity from response bias or impulsivity, which might lead some individuals to respond earlier or later without actually being able to identify the facial affect. Performance accuracy at 100 % expression was used to distinguish sensitivity to facial affect information from overall facial affect recognition ability.

Procedure

Upon arrival at the lab, participants began by providing written informed consent. Participants were then seated in a comfortable chair in front of a computer and received instructions (on-screen and verbally) for the study. Participants completed a number of questionnaires on the computer, including a measure of basic demographics.

Following the completion of study questionnaires, participants were provided with an overview of the use of the biophysiological equipment used in this study and given an opportunity to ask any questions that they might have. Physiological recording devices were connected in the following order: galvanic skin response sensors were placed on two fingers of the non-dominant hand, electrocardiogram (ECG) sensors were places on the chest, and a respiration band was placed around the chest. Finally, pairs of miniature 4mm Ag-Cl electrodes were placed at three sites on the face, corresponding to the musculature of the corrugator (muscle associated with the knitting of the eyebrows), zygomatic major (muscle that lifts the cheek in smiling), and levator labii (muscle that raises the upper lip in disgust expressions). Participants sat quietly for three minutes while a baseline measurement of all physiological recordings was taken. [1]

Next, participants reviewed the instructions for the Multimorph task (above) with the experimenter. Immediately following the instructions for the Multimorph task, participants were randomly assigned to one of three conditions (suppress, mimic, or no-

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[1] The physiological data collected will not be analyzed and presented as part of this paper. Nonetheless, information regarding the use of the equipment and placement of electrodes is included here because of the potential implications which these procedures may have for the primary variables of interest in this study.

instruction) for the duration of the experiment, and received instructions specific to their experimental group. Participants were informed that they would be video-recorded for the remainder of the experiment in order to ensure that they complied with instructions.

Suppression Instructions. Individuals randomized to the suppression condition received the following instructions:

> *As you complete the next set of tasks, we would like you to suppress all facial expressions. That is, we would like for you to control your expressions so that someone looking at you would have no idea how you are feeling. We will be video-recording throughout to ensure that you comply with these instructions.*

Mimic Instructions. Individuals randomized to the mimic condition received the following instructions.

> *As you complete the next set of tasks, we would like you to mimic the expressions of the faces that you see on the screen. Try to match the expression as closely as possible, so that as the face on the screen becomes more expressive, your expression becomes more expressive as well. We will be video-recording throughout to ensure that you comply with these instructions.*

Control Instructions. In order to limit any unnecessary differences between groups, participants in the no-instructions control condition received a second set of instructions as well. These instructions were as follows:

As you complete the next set of tasks, we would like you to pay attention. We will be video-recording throughout to ensure that you comply with these instructions.

Once the participant was prepared to begin, video-recording commenced as a check to ensure compliance with experimental instructions. Each participant was presented with 6 trials for each of the 6 target emotions, for a total of 36 trials. The order of emotion presentation for each of the 36 Multimorph trials was counterbalanced to account for order effects. Each Multimorph presentation began with a neutral facial expression and then transformed over 39 progressive stages. For each emotion, the expression morphed from neutral to 100% expression in increments of 2.5%. The stimuli were presented as continuous sequences in which the emotion transformed over 20 seconds. The full 20s progression was always presented, regardless of the stage at which the participant first identified the emotion. Participants responded by using a mouse to click on one of the six on-screen buttons marked with the names of the six target emotions. Participants were able to change their response as often as they liked during the progression of the expression by clicking on the emotion labels. When the expression reached 100%, the full-expression image remained static on the screen and participants were instructed to give a final answer. Once the participant selected a final answer, the image disappeared and a new trial began.

The entire sequence of Multimorph presentation lasted approximately twelve minutes. Following completion of the Multimorph task, participants answered several questions regarding their perceived difficulty of the task, the amount of effort which they expended, and their perceived success in suppressing/mimicking expressions. Participants were then debriefed and had the opportunity to ask questions and were paid or credited for their participation.

Data Analytic Plan

This is a mixed design with one between-subjects independent variable (experimental group) and one within-subjects independent variable (emotion). The between-subjects variable is a categorical variable consisting of three groups (suppress, mimic, no instruction). The within-subjects variable is a repeated measure comprised of six emotions (happiness, sadness, anger, fear, surprise, and disgust), each presented six times to every participant, for a total of 36 trials. This leads to one aggregate dependent variable (sensitivity to expression) which can be parsed into six distinct categories (corresponding to each of the six emotions.) The primary covariate examined was gender. A more detailed analytic plan is outlined below.

Data analysis consisted of six steps. First, video-recordings were reviewed in order to ensure that participants attended to stimuli and attempted to comply with experimental instructions. Second, distributions of the dependent variables (earliest stage at which each emotion was correctly classified) were examined for normality of distribution (skewness and kurtosis.) Third, independent samples *t* tests were conducted in order to examine possible gender effects. Fourth, a 3 (group) X 6 (emotion) repeated measures mixed analysis of covariance (ANCOVA), controlling for gender effects, was conducted in order to examine the impact of instruction condition on emotion sensitivity.

Fifth, planned between-groups comparisons were conducted using independent samples *t* tests to examine between-group differences in sensitivity for specific emotions. Finally, post hoc ANOVAs and independent samples *t* tests were employed to examine the potential impact of impulsive responding, differences in emotion sensitivity at full expression, and perceived difficulty of instructional task

Results

Review of Video-Recordings

Previous research has shown that there are limits to the voluntary control of facial expression (Kappas et al. , 2000) therefore participants in the suppression condition who produced some facial expressions and those in the mimic condition who produced facial expressions inconsistent with instructions were not removed from analyses unless they repeatedly failed to comply with experimental instructions. After reviewing video-recordings, a total of four participants were removed from analyses due to failure to comply with experimental instructions (two participants failed to attend to the stimuli during presentation; two participants in the instructed mimicry group did not attempt to mimic expressions). Removal of these four participants from further analyses left data from 92 participants for further analyses.

Normality of Distribution

Prior to conducting primary data analyses, the dependent variable (sensitivity to emotion expression, as measured by earliest correct classification of emotion) was examined to ensure normality of distribution. Two extreme outliers were identified. These two participants (one in the no instructions condition and the other in the suppression condition) appear to have failed to comply with instructions. On each of the 36 trials, these participants did not attempt to identify the emotional expression until the expression had reached 100%. As a result, these two participants were excluded from further analyses, leaving 90 participants (18 female and 12 male per condition). Skewness and kurtosis were examined and found to be within acceptable limits.

Gender as Covariate

Because previous research has indicated that females are quicker to accurately recognize facial expressions of emotion than are males (Hall, 1978; McClure, 2000), participant sex was examined in order to determine whether there were systematic differences in responding. Independent samples *t* tests were conducted and a statistically significant difference was found between males and females [$t(88) = -2.345$, $p < .05$], on the primary dependent variable. Collapsing across all six emotions, female participants were found to respond slightly more quickly and accurately ($M = 24.44$, $SD = 3.28$) than male participants ($M = 26.06$, $SD = 3.39$), $t(88) = -2.32$, $p < .05$, $d = 0.5$. Upon further examination, this difference in average sensitivity appeared to be the result of increased sensitivity by female participants to expressions of disgust [$t(88) = -2.57$, $p < .05$, $d = 0.5$] and sadness [$t(88) = -3.12$, $p < .01$, $d = 0.7$] compared to male participants. While not statistically significant, there was a trend for increased sensitivity to expressions of anger ($p = .06$), fear ($p = .09$), and surprise ($p = .09$), among female participants as well. As a result, gender was dummy coded and treated as a covariate for subsequent analyses.

Differences in Earliest Correct Response to Facial Affect

A 3 (group) X 6 (emotion) X 2 (sex) repeated-measures mixed analysis of covariance (ANCOVA) was conducted to examine the effects of instruction condition on emotion perception sensitivity (the earliest stage to correctly identify facial expressions of emotion). This analysis revealed a significant multivariate main effect, $F(3,86) = 6.71$, $p < .001$, partial $\eta^2 = .97$ There were also significant main effects for both group, $F(2,86) = 7.17$, p<.001, partial $\eta^2 = .93$, and sex, $F(1,86) = 5.79$, $p < .05$. The Group X Sex interaction was not significant. Between-groups comparisons revealed a significant difference across all emotions between participants in the suppression group (*M* = 26.77, *SD*=3.53) and participants in the no-instruction group (*M* = 24.70, *SD*=3.15), *t*(58) = 2.39, *p*<.05, *d* = 0.6, as well as between participants in the suppression group and participants in the mimic group (*M* = 23.80, *SD* =2.87), *t*(58) = 3.57, *p*<.01, *d* = 0.9. A between-groups comparison of the mimic and no-instructions group was not significant when collapsing all emotions.

Our hypotheses suggested that participants in the suppress and mimic groups would be slower to accurately identify facial expressions than would participants in the no-instruction group. This hypothesis was partially supported. As predicted, participants who were instructed to suppress expressions were slower to accurately identify facial expressions of emotion (*M* = 26.77, *SD* = 3.53) than were participants who were not so instructed. Interestingly, however, participants who were instructed to mimic expressions were actually faster to accurately identify expressions (*M* = 23.80, *SD* = 2.87) than were participants in the no-instructions condition (M = 24.70, *SD* = 3.153), although this difference failed to reach statistical significance.

Next, planned between-groups comparisons were conducted using independent samples *t* tests to examine between-group differences in sensitivity for specific emotions. Procedures outlined by Rosenthal and Rubin (1982) were used to test the relative magnitude of effects. We did not have specific hypotheses as to which emotions would be most impacted by instructions. Sensitivity to anger varied significantly between the suppression (*M* = 28.20, *SD* = 5.28) and mimic (*M* = 24.97, *SD* = 5.59) groups, *t*(58)=2.31, *p*<.05, *d* = 0.6, and between the suppression and no-instructions groups (*M* = 25.03, *SD* = 4.91), *t*(58) = 2.41, *p*<.05, *d* = 0.6. Sensitivity to <u>sadness</u> varied significantly between the suppression (*M* = 29.63, *SD* = 5.31) and mimic groups (*M* = 26.33, *SD* = 4.63), *t*(58) = 2.57, *p*<.05, *d* = 0.7, and between the suppression and no-instructions (*M* = 27.23, *SD* = 4.95) groups, *t*(58) = 2.41, *p*<.05, *d* = 0.6. Sensitivity to <u>surprise</u> varied significantly between the suppression (*M* = 26.93, *SD* = 5.81) and mimic groups (*M* = 23.93, *SD* = 4.25), *t*(58) = 2.28, *p*<.05, *d* = 0.6 and between the suppression and no-instructions (*M* = 24.20, *SD* = 4.28) groups, *t*(58) = 2.08, *p*<.05, *d* = .05. Sensitivity to <u>happiness</u> varied significantly between the suppression (*M* = 19.27, *SD* = 5.21) and mimic groups (*M* = 15.20, *SD* = 4.50), *t*(58) = 3.24, *p*<.05, *d* = 0.9 and between the suppression and no-instructions (*M* = 16.83, *SD* = 4.59) groups, *t*(58) = 1.92, *p*<.05, *d* = 0.5. Sensitivity to <u>fear</u> varied significantly between the suppression (*M* = 31.00, *SD* = 3.74) and mimic groups (*M* = 28.67, *SD* = 3.45), *t*(58) = 2.50, *p*<.05, *d* = 0.7 but the difference did not reach statistical significance between the suppression and no-instructions (*M* = 29.80, *SD* = 3.46) groups, *t*(58) = 1.29 *p* = .20. There were no statistically significant differences in sensitivity to <u>disgust</u> between conditions. The average number of stages until a correct response for each emotion by condition is shown in figure 1.

Collapsing all three conditions, happiness was accurately identified the most quickly (*M* = 17.10, *SD* = 5.01), followed by surprise (*M* = 25.02, *SD* = 4.97), anger (*M* = 26.07, *SD* = 5.42), disgust (*M* = 26.99, *SD* = 5.34), sadness (*M* = 27.73. *SD* = 5.11), and fear (*M* = 29.82, *SD* = 3.65). This pattern of findings held when examining each instruction condition separately, with the exception that participants in the suppression condition were slightly faster to identify disgust (M = 28.00, SD = 4.96) than anger (M = 28.20, SD = 5.28).

Differences in Earliest Incorrect Response

In order to control for the possibility that heightened sensitivity to emotion expression is associated with a tendency to respond impulsively (quickly but with more errors), the impact of earliest incorrect response on between-group differences was examined. A 3(group) X 6 (emotion) repeated measures ANOVA was conducted on the first stage of inaccurate response across trials. A significant multivariate main effect was found $F(5,83) = 132.01$, $p<.001$, partial $\eta^2=.89$, but no significant interaction was found ($p>.05$). There was a significant main effect for emotion $F(5,87) = 59.36$, $p<.001$, partial $\eta^2=.41$, but not for group, $F(2,87) = 2.77$, $p>05$. Thus, differences in sensitivity to facial expressions between groups were not associated with differential early inaccurate responding.

Differences in Earliest Incorrect Response by Emotion

Because significant between-groups differences were found in the earliest stage at which anger, surprise, sadness, happiness, and fear were correctly classified, post hoc independent samples t tests were conducted to examine differences in incorrect classification of these emotions during trials in which a different emotion was displayed. In other words, the tendency to identify an emotion when it was not in fact present was examined. No differences were found between the suppression group and the mimicry group in the earliest stage at which any emotion was incorrectly classified (all ps>.05).

Comparison of the suppression and no-instructions conditions revealed one significant difference in the incorrect classification of emotion. The suppression group (M = 29.47, SD = 10.39) differed from the no-instruction group (M = 22.90, SD = 12.28) in the earliest stage at which anger was incorrectly classified in non-anger trials, $t(58) = 2.24$, $p=.03$. Given that participants in the no-instructions group were quicker to incorrectly classify anger in non-anger trials, it is possible that the greater sensitivity to anger demonstrated by the no-instructions group compared to the suppression group could be accounted for by the tendency to identify anger more impulsively. However, the absence of differences between the suppression and mimicry groups in the earliest stage at which anger was incorrectly identified suggests that impulsivity in identifying anger is not responsible for this difference.

Differences in Accuracy of Response at Full Expression

In order to determine whether decreased sensitivity to expressions within the suppression group is related to decreased accuracy in identifying emotions at full expression, a 3 (group) X 6 (emotion) repeated measures ANOVA was conducted. Differences in identifying emotion expressions accurately at 100% expression were examined. A significant multivariate main effect was found, $F(5,83) = 91.25$, $p < .001$, partial η^2=.85, but no significant interaction was found, $F(10, 168) = .569$, p=.837, partial η^2=.03. There was a significant main effect for emotion, $F(5, 435) = 42.85$, p<.05, partial η^2=.33, but not for group, $F(2, 87) = 3.16$, p>.05, partial η^2=.07. Thus, there were no observed differences in the ability to accurately identify emotions at full expression.

Impact of Perceived Difficulty of Task

In order to examine the impact of task difficulty upon group differences in emotion sensitivity, several manipulation checks were conducted. Following the emotion perception task, participants in the suppression and mimicry conditions were asked to use a scale of 0 to 10 to rate the difficulty of suppressing or mimicking expressions, their perceived success, and the amount of effort that they expended in doing so. Participants in the suppression condition perceived their task as less difficult (M = 3.35) than did participants in the mimicry condition (M = 5.52), and perceived themselves as more successful in achieving suppression (M = 6.98) than those in the mimicry condition did in mimicking expression (M = 5.24). Both of these comparisons were statistically significant [$F(1,58) = 15.61$, $p = .001$; $F(1,58) = 9.18$, $p=0.004$]. Participants in the mimicry condition reported trying harder (M = 6.76) to mimic expressions, than did suppression participants in trying to suppress expression (M =5.78), although this difference was not statistically significant [$F(1,58) = 2.40$, $p=.127$]. Overall, it appears that participants in the mimicry condition found their task to be more difficult and rated themselves as less successful in mastering it than did participants in the suppression condition. Thus, it does not appear that deficits in emotion perception within the suppression group can be attributed to completing a more difficult task.

Discussion

The first half of the primary study hypothesis, that participants who were instructed to suppress would show decreased emotion sensitivity compared to participants who were not instructed to control their own facial expressions, was confirmed. Participants who were instructed to suppress were significantly less sensitive overall compared to both participants who were not instructed to control their own facial expression and to participants who were instructed to mimic. This finding of decreased overall emotion sensitivity was a result of decreased sensitivity to expressions of happiness, sadness, fear, anger, and surprise, but not disgust.

We expected mimicry instructions to influence perceptive sensitivity, although it was unclear whether participants who were instructed to mimic facial expressions would show increased or decreased emotion sensitivity. We anticipated that if cognitive load was the dominating factor, mimicry instructions would be associated with decreased sensitivity, similar to that seen in the suppression condition, but that if facial feedback was the dominating factor, that mimicry instructions would be associated with increased sensitivity. The results support the latter hypothesis. Compared to participants in the suppression condition, participants in the mimicry condition demonstrated greater overall sensitivity to emotional expressions. This finding does not suggest that there is no cognitive load associated with mimicry; in fact, our results suggest the opposite. Participants in the mimicry condition reported greater difficulty in completing their task than those in the suppression condition and considered themselves less successful. This indicates that the mimicry condition was in fact associated with a cognitive load, but that the facilitative effects of the mimicry were sufficient to overcome this. The finding that mimicry is associated with increased cognitive load provides further support for the notion that the decreased emotion sensitivity in suppression is not simply the result of cognitive load, but is related to the failure to produce potentially-facilitative emotional expressions. In other words, suppression of emotional expressions appears to decrease emotion sensitivity by interrupting the facial feedback process.

Although participants in the mimicry condition were faster to accurately identify emotional expressions on average than those in the no-instructions condition, this finding failed to reach statistical significance. One possible explanation for this is that at least some of the individuals in the no-instructions condition were spontaneously mimicking the facial stimuli, a phenomenon which has been well-documented (Dimberg, 1997; Lundqvist & Dimberg, 1995; Vaughan, & Lanzetta, 1980; Walbott, 1991). These individuals would have the advantage of utilizing facial feedback information without the cognitive load associated with the conscious attempt to mimic expressions. Results suggest that even low levels of facial mimicry may increase emotion sensitivity, as mimicry increased accurate identification well before full expression was achieved. Individuals likely vary in the degree to which they spontaneously mimic expressions, which may help to explain the large standard deviation associated with the no-instructions control group. It will be interesting, in the future, to examine the relationship between spontaneous mimicry and emotion sensitivity.

Several analyses were conducted in order to ensure that the between-groups differences identified in this study could not be better accounted for by other factors.

Accuracy of response at full expression was examined for each emotion and no significant between-groups differences were found. Thus, suppression does not appear to interfere with the ability to identify intense emotional expressions, but rather, to affect the speed and accuracy of identification at lower levels of intensity. In day-to-day life, this impairment in emotion sensitivity could be problematic for suppressors, as humans display a wide variety of expressions at varying intensities other than full expression and these expressions are often rapidly changing. As a result, individuals who suppress their own expressions may fail to pick up on important or useful sources of emotional information.

In order to further ensure that the observed between-groups differences were truly accounted for by differences in emotion sensitivity, the impact of earliest incorrect response on between-group differences was examined in order to ensure that sensitivity to emotion expression was not associated with a tendency to respond impulsively (quickly but with more errors). No between-groups differences were found in the number of early incorrect responses, indicating that impulsive responding did not play a role in the between-groups differences observed.

Gender differences in emotion sensitivity that have been identified in other studies (Hall, 1978; McClure, 2000) were also identified in this study. Female participants demonstrated increased emotion sensitivity compared to male participants for most of the emotions (although this finding was not statistically significant, but a trend, in many cases). One possible explanation for this difference is that females tend to use mimicry to a greater extent than males. It is possible that social display rules which indicate gender-appropriate emotional displays are at work here. This would help to explain previous findings that males are superior in recognizing anger (McAndrew, 1986; Wagner et al., 1986), and that both men and women are faster at identifying angry expressions on male faces and happy expressions on female faces (Becker et al., 2007), given that in contemporary Western society, it is considered more acceptable for a male to display anger than for a female to do so. Nonetheless, because facial expressions were controlled by instructions in two of the three conditions, it seems that there are additional factors at work with regard to gender differences in emotion sensitivity. One possibility is that heightened emotion sensitivity in females is an effect of previous learning, related to previous experience in attending to emotional stimuli. Another intriguing possibility is suggested by a recent study which found that testosterone levels correlate with both facial mimicry in response to dynamic facial expressions of angry and happy faces and with empathy (Hermans, Putnam, & van Honk, 2006). This research found that administration of testosterone to healthy female participants resulted in decreased facial mimicry and empathic behavior. Thus, it may be that underlying biological mechanisms are responsible for differences in both facial mimicry and emotion sensitivity.

The results of the current study provide evidence of a possible mechanism underlying the observed relationship between suppression and interpersonal difficulties. Butler and colleagues (2003) found that when one member of an interaction dyad was instructed to suppress facial expressions during a discussion of an emotional film clip, the interaction partner experienced increased physiological responding, and reported less liking of and rapport with this individual, compared to interactions in which neither partner was instructed to suppress. In addition, participants interacting with a suppressor reported that they were less willing to form a friendship with the individual. Decreased liking, rapport, and willingness to form a friendship are clear and significant interpersonal effects. The results of the present study may help to explain these effects. As the suppressor is interacting with the partner, they are resisting the impulse to produce facial expressions, which in turn decreases their own emotion sensitivity. As a result, they are less sensitive to the emotional expressions of the interaction partner and presumably, less able to respond in emotionally appropriate ways. Of course, there are other factors at play here as well, not the least of which is the likely confusion of the interaction partner at the lack of emotional expression by the suppressor in a context that calls for expression. Impaired emotion sensitivity during suppression may not be the only factor impacting the social relationships of suppressors, but it is nonetheless important.

These potential impairments in emotion perception may be particularly relevant for those individuals who habitually inhibit emotional expression under circumstances involving strong experienced emotion. Habitual use of these strategies may be related to a number of negative outcomes, including the development of psychopathology. Police officers and other emergency personnel (Wastell, 2002), military personnel, and doctors/therapists are among the professionals who are expected to routinely control their own emotional expressions under high emotion while gathering information about the emotional experience and intentions of the people with whom they interact. Given that the use of suppression to control emotional expressions while interacting with others has the undesirable effect of reducing emotion sensitivity, it may be useful for these individuals to learn alternate methods of regulating emotion. Of course, some degree of expressive control is necessary in daily life, but the resulting impairment in emotion sensitivity and interpersonal functioning make suppression a poor choice for use in situations where swift, accurate emotion identification is important.

Limitations and Future Directions

Despite our best efforts to control as many potential sources of error variance as possible, there remain several important limitations to the current study. The first, and perhaps most obvious, is the use of a convenience sample of college undergraduates. While the current study included both male and female participants and 38% of the sample self-identified as non-white, this sample nonetheless represents a small segment of the population with regard to both age and education. Previous studies have found that older adults tend to display decreased emotion sensitivity compared to younger adults Montagne et al., 2007; Orgeta & Phillips, 2008). Although there is no specific reason to believe that the current findings would be limited to young adults, it is unclear whether this is the case. In addition, there is no data, to my knowledge, on the impact of education or socioeconomic status on emotion sensitivity. The current sample includes students in their first, second, third, or fourth year of college. Socioeconomic status was not assessed in the current sample, although given their status as undergraduate students, we know that all participants have access to adequate housing, food, and healthcare in an environment that is commensurate with higher than average socioeconomic status. Again, there is no specific reason to believe that education or socioeconomic status plays any role in emotion sensitivity, but the findings are nonetheless limited to this segment of the population.

A second limitation to the current study is the failure to control current mood state. As noted earlier, several studies have demonstrated that individuals may be biased toward attending to emotional information that is consistent with their own current mood state. (Niedenthal et al., 2000; Schiffenbauer, 1974). Although mood state was not manipulated in this study, all participants did have a period of three minutes during baseline measurement of physiology in which they were asked to sit quietly while measurements were taken. While this does not ensure that participants were in the same mood state at the beginning of the task, the time devoted to the consent process, to completing demographic information, and to this baseline period does ensure that participants were not exposed to any intense emotional stimulus in the period immediately prior to the task. Moreover, there is no reason to believe that participants varied significantly in their current mood state by condition in any systematic way, although we cannot know this for certain, as it was not assessed. Similarly, participants were not asked to identify any past or current psychiatric diagnoses, despite the fact that several disorders have been linked to differences in emotion sensitivity. However, because participants were randomly assigned to the three conditions, and data was screened for extreme outliers on the dependent variable, it seems unlikely that the presence of individual psychopathology could be responsible for the current findings.

As is often the case with experimental research, it was necessary in this study to sacrifice some degree of ecological validity in order to control the quality of the emotional stimuli presented. In real life, individuals do not present neutral emotional expressions to others which increase evenly and gradually over the course of twenty seconds until they reach full expression. Expressions may be much briefer, much lower in intensity, and/or more rapidly changing. This does not negate the importance of the current findings, however, but rather emphasizes it, as it highlights the importance of accurate emotion identification at lower levels of expression. Nonetheless, it would very interesting to examine whether the current findings would be reproduced in interaction dyads, in a design similar to that used in the study conducted by Butler and colleagues (2003). It may be that in vivo, the effects of suppression on emotion sensitivity are even more pronounced, because an interaction partner who is not receiving emotional feedback is unlikely to continue to intensify their own expression to maximum intensity as was the case with the stimuli presented in the current study. In fact, given the evidence on emotion contagion reviewed earlier, it is possible that an individual interacting with a suppressor will actually begin to display less facial expression of emotion, providing the suppressor with less information to work with in a self-perpetuating cycle. This is an exciting area for future investigation.

Another possible limitation of the current study is related to the use of facial electrodes. Some theorists have argued that the effects attributed to facial feedback are due to enhanced attention to the movement of the face and associated mediating cognitions (Laird, 1974; Strack et al., 1988). It is certainly likely that placement of electrodes on the face of research participants heightens the amount of attention paid to the expressions being produced and to movement of the face in general. How might this have influenced results? Participants in the suppression and mimicry groups were given explicit instructions on how to control their facial movements and their attention was explicitly directed to attend to this information. Only the no-instructions control group was not specifically instructed in how to control their facial expressions. It seems likely that the effect of the placement of facial electrodes would be to reduce rather than increase the movement of the facial musculature, as the sensations produced would be potentially distracting and many participants expressed concern about the possibility that these small electrodes would come off during the task. If the use of facial electrodes did influence the participants in the no-instruction control group by decreasing facial movement, our review of the literature and present findings suggest that this should have produced an impairment in emotion sensitivity. It may be that without the use of the facial electrodes, the differences between the suppression and no-instructions groups would have been even larger. It would be interesting to replicate this study without the use of facial electrodes to determine if this is indeed the case.

In order to eliminate practice effects and to reduce participants' ability to predict the upcoming stimulus, the stimuli presented to participants were presented in random order. Each of the six emotions was presented six times in counterbalanced order. Each of the six presentations of an emotion was presented using a different actor, but in all cases there were three female and three male faces per emotion. Thus, a participant would have seen one actor present more than one emotion, but would never have seen the same actor present the same emotion twice. In addition, in order to ensure that participants were not able to identify an emotion by process of elimination (i.e. "this must be surprise, because I've seen this actor express the other five emotions already"), stimuli were selected from a total of four male and four female actors. Although it would have been difficult for participants to track the number and type of stimuli presented (especially because they were not told how many presentations to expect), this was done to ensure that this could not occur. With this said, it would be interesting to attempt a replication of these findings in a within-subjects design. This of course further complicates the issue of practice effects, but this might be managed by varying the order of instructions. It would be interesting to examine the impact of suppression and mimicry in a within-subjects design as this would provide further support for the current findings.

One further promising area for future research is an examination of the effects of habitual suppression on emotion sensitivity. There are a number of intriguing possibilities here. It is possible that chronic suppressors learn to cope with reduced emotion sensitivity by attending to other sources of information. Alternately, chronic suppressors may be even less attuned to emotional information of an interaction partner than are individuals who are suppressing expressions because they are instructed to do so. Future studies could examine differences between self-motivated and instructed suppression and mimicry to determine whether there are differences in the degree to which habitual and instructed expressive control affect emotion sensitivity.

In summary, the present study found compelling evidence that the suppression of facial expressions significantly decreases emotion sensitivity to facial expressions of emotion. Mimicry of emotional expressions is associated with increased cognitive load but not with impairment in emotion sensitivity, providing further support for the conclusion that the impairment associated with suppression is not due to cognitive load, but rather to the failure to produce emotional expressions. These findings are consistent with the facial feedback hypothesis, and further suggest that individuals rely upon their own facial expressions to help them understand not only their own emotional experience, but also the emotional experience of others.

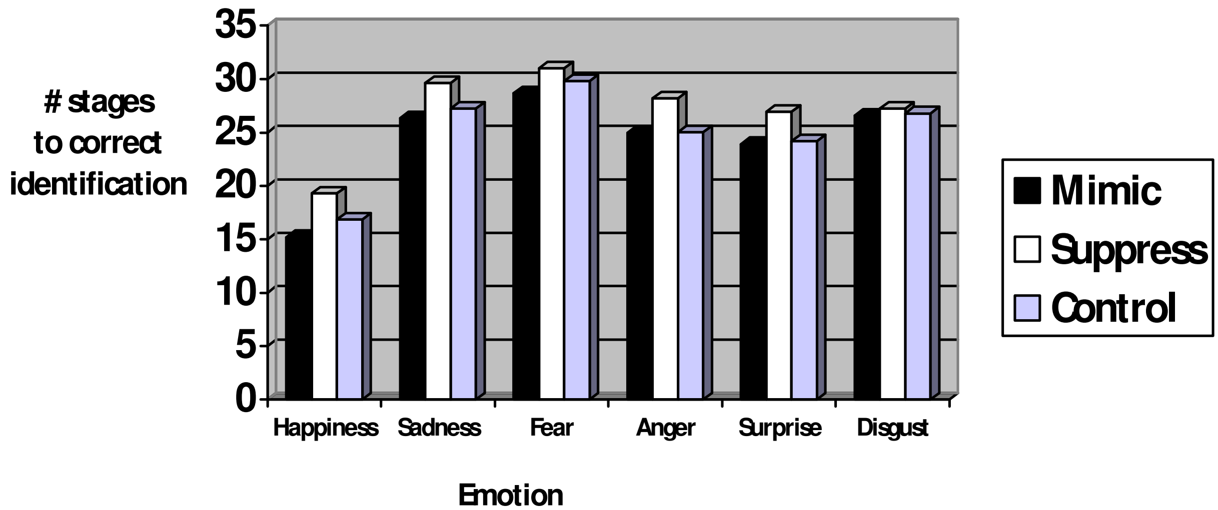

Figure 1: Impact of Instructions on Emotion Sensitivity

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Biography

Kristin Grace Schneider was born on September 8, 1977 in Boston, Massachusetts to Susan C. Alvey and Paul Robert Schneider. Kristin has one sibling, a younger brother named Jonathan. Kristin attended Brown University and received her bachelor's degree in Art-Semiotics in May of 1999. She received her Master's degree in Psychology from Duke University in December 2005. She is currently enrolled in the doctoral program in the Department of Psychology and Neuroscience at Duke University and will graduate with a Ph.D. in clinical psychology in September 2008. During her time at Duke, Kristin worked with Dr. Thomas Lynch at the Duke Cognitive Behavioral Research and Treatment Program. She published her first empirical study, "A mediational model of trait negative affectivity, dispositional thought suppression, and intrusive thoughts following a laboratory stressor" with Dr. Lynch in Behavior Research and Therapy in 2007. She has been a member of the Association for the Advancement of Behavioral and Cognitive Therapies (ABCT) for six years and has presented data in poster sessions and symposia at every annual meeting in the past five years. Most recently, Kristin presented this dissertation research as part of a research panel at the 2007 annual meeting of the International Society for Improvement in the Teaching of Dialectical Behavior Therapy (ISITDBT). Kristin has been a student affiliate of the American Psychological Society and a member of the American Psychological Association of Graduate Students since 1999. Kristin received a Duke University Vertical Integration fellowship in 2006 and received the Aleane Webb Dissertation Award in 2007. Kristin is currently completing her clinical internship at the Miami VA Medical Center and has accepted a post-doctoral fellowship in Empirically-Supported Treatments for post-traumatic stress disorder at the San Diego VA.