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A Communication Approach To Understanding Rapid Responses To Others: The Importance Of Flexibility Across Goal Conditions

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A COMMUNICATION APPROACH TO UNDERSTANDING RAPID RESPONSES TO OTHERS: THE IMPORTANCE OF FLEXIBILITY ACROSS GOAL CONDITIONS

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ABSTRACT

Two studies evaluated the communication approach to rapid display responses (RDRs) to others by 1) examining the influence of specific communicative goals on RDRs and, 2) identifying the social outcomes associated with correspondence between communicative goals and responses. Both studies showed that people in general can change the magnitude of their most rapid responses according to communication goals to either respond or suppress responses. For some stimulus-response pairs, the ability to flexibly deploy RDRs to align with goals is associated with positive social outcomes for those who are socially active. In Study 1, individual differences among socially active first-year college students' ability to flexibly deploy RDRs across communicative contexts predicted social adjustment. When the goal was to respond, those who were better at enhancing their smiling response to a smiling face reported better social adjustment compared to those who were not as successful at enhancing their smile. Study 2 showed that adults' ability to suppress fearful responses to angry displays was associated with better social adjustment in the wake of a stressful event. This ability was also associated with reduced depressive symptoms through its effect on social adjustment. As in Study 1, the relationship between RDR flexibility and social adjustment was especially strong for those who were socially active. These findings provide support for a communicative mechanism by which displays elicit RDRs and

suggest that the ability to modify rapid responses to match communicative goals has consequences for longer-term social adjustment and even mental wellbeing.

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Chapter One: Introduction

As social animals, humans are faced with the endless task of surveying the social environment and selecting and responding to information in a way that achieves social goals. Limited cognitive and behavioral resources necessitate quick and efficient processes for perceiving and responding to the world. Without these processes, constant bombardment of social stimuli would be overwhelming and influencing one's social surroundings nearly impossible (see Uleman, Saribay, & Gonzalez, 2008 for a review).

This class of automatic, rapid response processes includes nonconscious mimicry, or the tendency to match others' behaviors without conscious awareness or instruction (Dimberg, 1982; Dimberg, Thunberg, & Elmehed, 2000). Mimicry occurs among human adults, children and infants (see Chartrand, Maddux, & Lakin, 2005), and also among non-human primates (Davila, Menzler, & Zimmermann, 2008). Empirical evidence suggests that mimicry plays a role in a variety of adaptive social processes including empathy and emotional contagion (Bavelas, Black, Lemery, & Mullett, 1986; Decéty & Chaminade, 2003; Hatfield, Cacioppo, & Rapson, 1993, 1994; Iacoboni, 2005; Lakin & Chartrand, 2003; McIntosh, 2006; Scambler, Hepburn, Rutherford, Wehner, & Rogers, 2007; Sonnby-Borgström, 2002), helping and generosity (van Baaren, Holland, Kawakami, & van Knippenberg, 2004), embodied cognition (Barsalou, 1999; Thompson & Varela, 2001) and emotion display identification (Niedenthal, Brauer, Halberstadt, & Innes-Ker, 2001). The importance of mimicry is further highlighted by negative outcomes associated with its absence. Interpersonal interactions in which mimicry is not present are associated with reduced empathy and understanding between interaction partners (Stel, Vonk, & Smeets, 2006), and studies have shown mimicry deficits in individuals with an autism spectrum disorder, a pervasive developmental condition characterized by socioemotional dysfunction (McIntosh, Reichmann-Decker, Winkielman, & Wilbarger, 2006; Beall, Moody, McIntosh, Hepburn, & Reed, 2008).

Mimicry has been described as an automatic, reflexive response (Chartrand & Bargh, 1999) that was selected over the course of evolution because it facilitates social functioning (Lakin, Jefferis, Cheng, & Chartrand, 2003). Some researchers have argued that automatic matching behavior occurs because of a neural link between perception and action that bypasses other brain systems and may be mediated by the mirror neuron system (Niedenthal, Barsalou, Winkielman, Krauth-Gruber, & Ric, 2005). By this account mimicry is a process by which input evokes reflexive, matching output at the neural level for neurotypical individuals, and good things come to those who mimic their interaction partners.

However, matching behavior does not occur in all social situations even among neurotypical individuals without an autism spectrum disorder; in many cases interaction partners engage in systematic *non*-matching behavior. For example, Lanzetta and Englis (1989) observed facial matching—smiles in response to smiles, grimaces in response to grimaces—among individuals who perceived their interaction partner to be a collaborator, but non-matching—no response or sometimes even grimaces in response to smiles—when a partner was perceived as a competitor. In a more recent study of *rapid* responses, McIntosh (2006) showed that changing an observer's perception of a person changes her response to that person. Observers were more likely to match the smiles of targets perceived more favorably than targets perceived less favorably.

If mimicry is an automatic, reflex-like behavior that serves adaptive social functions, why do people not match observed faces in every situation and sometimes produce rapid *non*-matching responses to interaction partners? One possible explanation is that behavioral responses to others, even those that occur very rapidly, are communicative in nature and are produced or modified according to communication goals. For example if one's goal is to convey affiliation and intention to cooperate with a collaborator, another's smile begets a smile, but if one's goal is to be stoic in the face of your competitor's success, her smile may not elicit a behavioral response. When the communicative goal context changes, rapid responses—the message that is produced—also change. This communication approach has proved fruitful for understanding the nature, functions and effects of producing nonverbal displays in general (see Fridlund, 1994), showing that displays can be communicative tools that are used strategically to influence one's social surroundings. Here I use this approach to understand variation in how observers respond to a model across various contexts.

Two studies presented here evaluate the communication approach to rapid responses by first examining the influence of specific communicative goals on rapid responses and, second, identifying the social outcomes associated with correspondence between goals and response behavior. Both studies test 1) whether people in general can modulate responses in accordance with goals within two seconds of seeing a model, 2) whether individual differences in ability to modulate the earliest responses (within one second of seeing a model) in accordance with communication goals relate to variation in social outcomes, and 3) whether the association between modulation ability and social outcomes is strongest for people who are more socially active. In addition, Study 2 tests whether the ability to modulate rapid responses affects mental well-being (improvement in depressive symptoms in the wake of a stressful life event) through its effects on social functioning. I argue that this communicative approach provides new insights into the nature and functions of rapid responses to others.

Rapid Responses to Others as Communication

Emotion researchers have demonstrated that nonverbal displays, in general, are communicative in nature (Fernández-Dols & Ruiz-Belda, 1995; Fridlund, 1994; Kraut & Johnston, 1979). Mimicry and other rapid responses, as members of the broader category of nonverbal displays, may also serve communication functions (Bavelas, Black, Chovil, Lemery, & Mullett, 1988; Moody & McIntosh, 2011b), and their communicative nature may explain variation in how and under what circumstances they are produced. However, the implications of the communication approach to rapid responses have not yet been tested rigorously due in part to a heavy focus on rapid matching. Rapid *non*-matching responses, like a smile in response to a frown or remaining stoic in the face of a scowl, may be particularly helpful in understanding the communicative nature of rapid responses (Moody, McIntosh, Mann, & Weisser, 2007). Matching a friend's frown might convey psychological similarity by conveying, "I feel your pain," but smiling in response to your opponent's frown might say, "I'm glad I won," a message indicating *dis*similarity. I therefore use the term *rapid display responses* (RDRs) to describe this group of behaviors comprising both matching and non-matching responses. The term *mimicry* describes just one subset of RDRs.

In this section I consider the functional account of RDRs as communicative tools from which I derive three key implications. This approach draws on findings that nonverbal emotion displays in general (i.e., not necessarily rapid or a response to another person) communicate information to others through their association with particular sets of thoughts and actions (Frijda, 1986). Emotion displays convey messages about what the displayer is thinking and what she will likely do next (Buck, 1984). Because encoders and decoders (those producing and perceiving the displays, respectively; Buck, 1984) share knowledge—implicit or explicit—of the behavioral repertoire associated with a certain display, displays influence the thoughts and behaviors of others. If RDRs are also communicative, they should operate according to the same principles as emotion displays in general. RDRs should 1) be influenced by communicative context, and 2) produce positive social outcomes under conditions in which the display supports communicative goals. A third implication is that the effect of congruence between the communicative goal and the message conveyed by the display (goal-message congruence) should be especially pronounced in more social contexts compared to less social contexts.

Here I discuss these implications of the communicative approach with regard to RDRs, noting aspects for which there is suggestive evidence that RDRs are indeed communicative.

Implication 1. *RDRs should vary as a function of communicative context.* The first criterion for whether a behavior is communicative is that it is responsive to communicative context (e.g., Fridlund 1994). Evidence suggesting RDRs vary as a function of communicative context comes from studies in which manipulations related to communication produced differences in RDRs between experimental groups. Recall that manipulating responders' attitudes toward a model changed the degree to which they mimicked the models' smiles (McIntosh, 2006). If RDRs convey information to others, and rapid mimetic smiling increases with target favorability, perhaps matching in this case sends the message, "I'm happy that you're happy." No response or even non-matching responses (e.g., scowls; Likowski, Mühlberger, Seibt, Pauli, & Weyers, 2008) are more likely to be produced in reaction to disliked smiling targets. Scowling sends the message, "I'm unhappy that you're happy." Manipulating target favorability changes the responder's communicative goals, which in turn affects the message conveyed by the response.

Research also shows a modulating effect of audience on RDR production. If RDRs do not communicate information to observers, then whether someone is watching should have no impact on their production. However, consistent with research demonstrating audience effects on emotion displays in general (e.g., Kraut & Johnston, 1979; Ruiz-Belda, Fernández-Dols, Carrera, & Barchard, 2003) and displays produced in response to others' behavior (Bourgeois & Hess, 2008), Moody and McIntosh (2011b) found greater mimicry in more social versus less social contexts. Participants watched pictures of happy, angry, and neutral faces either alone or with another person. Those in the more social condition produced more frequent and stronger rapid matching responses to the emotional faces than those who watched the pictures alone. This finding supports the idea that RDRs are communicative signals that are produced when there is an audience to receive the message.

In addition to being responsive to attitudes and audience, RDRs vary according to other situational motivations. Moody and colleagues (2007) demonstrated the modulating effect of mood state on rapid facial responses to pictures of emotional faces. Participants in whom fear had been induced were more likely to produce fearful facial displays (raised brows) in response to angry faces compared to participants in a more neutral mood state. Importantly, mood state had no effect on responses to neutral faces, indicating that rapid reactions are responsive to the motivational context of the observer.

These studies demonstrate that RDRs vary by context, but because communicative goals were never manipulated directly, this variance could be explained by non-communicative differences across varying contexts such as emotional reactions or attentional differences. One interpretation of current data is that RDRs are markers of underlying subjective states rather than communicative signals. As an example, seeing a well-liked interaction partner smile may elicit happiness on the part of the observer that results in a smiling response as an outward expression of the internal state, whereas seeing a disliked interaction partner smile may elicit less happy sentiments and result in a reduced tendency to smile. Audience and mood effects could also be explained fully by differences in emotional state across conditions rather than differences in observers' communicative goals. A second possibility is that social context alters more basic processes that influence mimicry; for example, an audience may enhance attention to presented stimuli or strengthen a dominant matching response (cf. Moody & McIntosh, 2011b; Zajonc, 1968). Thus, observed sensitivity of RDRs to social context does not establish that they are playing a communicative role. More direct support of the RDRs-as-communication perspective would be a demonstration that manipulating communicative goals influences RDRs. The present study does this. Note that finding that communication goals influence RDRs does not mean that there are no other influences on RDRs (e.g., context influencing emotional state and thus facial movements that serve non-communicative instrumental functions, such as enhanced vision in fear). It is likely that multiple mechanisms operate concurrently to yield a rapid response (cf. Moody & McIntosh, 2011a). The present research tests whether communication is one function of rapid displays in response to another's display of emotion.

Another question yet to be addressed concerns timing of response modulation. If communication goals do modulate RDRs, how early does modulation occur—do communication goals influence *rapid* responses, or do the most rapid responses reflect emotional state? For example, if your boss who you secretly detest injures his finger, can your goal to keep your job trump any early nonverbal traces of schadenfreude, or do you first produce a micro-smile (see Ekman, 2003)? Many studies have measured responses by coding overt facial actions and gestures. However, this method fails to capture early, subtle responses and how they might be modulated according to social goals. The few studies that have looked at rapid response modulation (differences in responses occurring within just a few seconds of seeing an image or interaction partner; Dimberg, Thunberg, & Grunedal, 2002; Moody et al., 2007) have employed physiological measures of RDRs that allow for more precise assessment of early responses (i.e., RDRs) and how they unfold over time.

In the present research I use electromyography (EMG)—a temporally precise physiological measure of the magnitude with which muscles contract—to assess whether communicative goals in a given situation influence the magnitude and time course of the facial response that is produced within just two seconds of seeing a model's display.

Implication 2. *The ability to produce goal-congruent RDRs across communicative contexts should produce positive social outcomes.* A second implication of the RDRs-as-communication approach concerns outcomes associated with different responses under different communicative contexts. Unlike previous work on mimicry that has focused mainly on the benefits of matching, a communications approach to RDRs both emphasizes that matching is not universally good and also suggests when it may be dysfunctional. Matching should produce favorable outcomes only when doing so elicits thoughts and behaviors in an interaction partner that are in line with one's goals; matching in other situations might have maladaptive consequences. Furthermore, *not* mimicking in situations in which it might produce unfavorable consequences should be adaptive, like not mimicking a scowling romantic partner with whom you wish to reconcile. To this end, *flexible* responding—producing a response only when it is aligned with social goals in a given context—may be associated with positive social outcomes while uncontrolled responding may have negative costs. Because goals change from one moment to the next, individuals able to flexibly adapt their rapid responses to support their goals across various social contexts might fare better socially than those who are not as flexible.

I argue that if RDRs function as communicative tools, RDR flexibility—producing goal-congruent RDRs and suppressing goal-incongruent RDRs—should help procure positive social outcomes in a particular instance and, over time, may help individuals gain and sustain social capital.

Indeed, research on display control in general (not necessarily rapid) indicates that goal-congruent responding is associated with good outcomes, while goal-incongruent responding is associated with negative outcomes: people who suppress displays when they may be beneficial and display emotions that are goal-incongruent may suffer negative consequences (e.g., Kennedy-Moore & Watson, 2001; Sperberg & Stabb, 1998). Bonanno and colleagues (Bonanno, Papa, Lalande, Westphal, & Coifman, 2004) demonstrated that individuals who are more *flexible*—able to enhance and suppress overt, visible displays according to communicative goals—experience more positive outcomes. Students who began college in New York City just prior to the terrorist attacks of September 11th completed a laboratory task in which they watched positive and negative emotional images on a computer screen under three conditions. For some images they were told that a camera was on them and they were to communicate their emotion in response to the images such that a person in a nearby room could guess what they were feeling. For other images they were told the camera was on but they were to suppress their responses such that the person could not guess what they were feeling. In the third condition they were told that the camera was off and they were to respond to the images as they would normally. Two measures of flexibility were calculated by subtracting the degree of emotion expressed in the non-communicative condition (camera off) from the degree of emotion expressed in each of the communicative goal conditions (communicate or suppress). Both flexibility measures were inversely related to distress reported at the end of students' second year of college, controlling for psychological distress reported around the time of the laboratory session. Thus, individual differences in response flexibility, or goal-congruent response production and suppression, are related to outcomes, with more flexible individuals experiencing more positive outcomes.

One possible mechanism through which response display flexibility promoted positive outcomes in the study of New York City college students is the effect displays had on others—a *social* mechanism. When interacting with people, flexible individuals produced displays in a way that was consistent with communicative goals, thereby exerting goal-congruent influences on the thoughts and behaviors of the people around them. Humans strive to cultivate strong social bonds with others (Baumeister & Leary, 1995; Brewer, 1991), and rapid communicative flexibility across many and varied daily social interactions may be an important contributor to achieving one's goal of initiating and sustaining harmonious relationships. This social capital may, in the long run, promote well-being and buffer flexible individuals from experiencing psychological distress and developing mental health disorders for which social support is a protective factor, like depression (see Cohen, Gottlieb, & Underwood, 2000). I argue that a social mechanism is especially likely to be engaged in the case of responses to other people. Thus, the ability to flexibly produce responses to others according to communicative goals should be associated with positive *social* outcomes, and this association should mediate the relationship between flexibility and other outcomes such as mental well-being.

Because timing is so critical for processing and responding in social interactions (Crown, Feldstein, Jasnow, Beebe, & Jaffe, 2002), individual differences in very early response modulation may be most predictive of outcomes if the effect of response flexibility is operating through a social mechanism. Some studies have found that group differences in the timing of responses are associated with variation in social functioning. McIntosh and colleagues (2006) used EMG to show that adults with an autism spectrum disorder were able to overtly imitate facial displays when instructed to so but did not produce fast, spontaneous responses to faces in the same way as matched controls. Similarly, Oberman, Winkielman, & Ramachandran (2009) found that early, spontaneous responses to emotional faces as measured by EMG were delayed 160 ms on average for children with an autism spectrum disorder compared to neurotypical children's responses. Thus, early variation in responses may be critical for predicting outcomes associated with RDR flexibility. For typically developing individuals, those who demonstrate early goal-congruent modulation (occurring within just one second of seeing a model) may be most successful at coordinating social interactions compared to individuals who are less successful at modulating early responses.

Implication 3. *The association between RDR flexibility and social outcomes should be strongest for people who are more socially active.* A third implication of the RDRs-as-communication approach is that if RDRs do indeed influence social outcomes through a communicative process, the predicted relationship between RDR flexibility and social success should be modulated by the degree to which individuals are interacting with others. In other words, RDR flexibility should support relationship establishment and maintenance for those people who have opportunities to communicate to and influence others—those who are highly socially active—compared to those who are less active.

Present Research

Here I used facial EMG to measure response magnitude across two communication goal conditions—response enhancement and suppression—to test the three implications of RDRs-as-communication. First, I tested whether explicit communication goals influence the magnitude of RDRs. Second, I used an individual difference approach to test whether differences in how people deploy RDRs across different goal contexts predict variation in communication-related, social outcomes. To date, studies demonstrating RDR modulation across different social contexts have not assessed outcomes associated with flexibility. I therefore used a within-persons design, similar to the paradigm used to measure flexibility in general display production (Bonanno et al., 2004), to look at early response modulation across two goal conditions—respond and suppress responses to emotional faces. I controlled for differences in expressivity independent of goal context by including an uninstructed condition in which participants viewed emotional faces without a communication goal. I used physiological measures (EMG) to assess RDR flexibility and how it might relate to social support and social activity across first-year students' transition to college (Study 1) and in the wake of stressful life events (Study 2). Social support may, in turn, promote well-being and buffer flexible individuals from developing mental health disorders for which social support is a protective factor, like depression (see Cohen, Gottlieb, & Underwood, 2000). Study 2 examined the effect of RDR flexibility on depressive symptoms through its effect on social support.

Predictions. Testable predictions were derived from the three implications of RDRs-as-communication. First, a communication framework predicts differences in RDRs when the communicative goal is to show responses versus to suppress them. I expected the overall magnitude of responses to be greater in the respond condition compared to other conditions. Second, goal-congruent RDRs should produce more positive social outcomes and goal-incongruent RDRs should produce less positive social outcomes. I predicted that individual differences in RDR flexibility, defined as goal-congruent response production and suppression, would be associated with variation in social outcomes such that highly flexible people would experience more positive social outcomes compared to less flexible people, especially for those individuals engaged in social activity. Thus, I predicted a direct association between RDR flexibility and improvements in social support that is moderated by degree of social activity (Studies 1 and 2) and, because mental health is closely tied to social functioning, an indirect association with improvement in depressive symptoms via a direct effect on social support (Study 2).

This communication model makes different predictions from those which would be expected by other approaches not focused on communication. Facial mimicry research has focused almost exclusively on matching as the path through which RDRs promote favorable outcomes such as increased liking and rapport between interaction partners. However, some evidence suggests that displaying matching, but goal-incongruent displays may sometimes have unwanted consequences. For instance, anger expressed between interaction partners is associated with decreased social support. Lane and Hobfoll (1992) showed that chronically ill patients who expressed anger induced anger in close others, thereby depleting precious social resources and making patients more vulnerable to future stress. If matching produces a display that is incongruent with one's goals, then matching behavior in that context would be maladaptive compared to no response or a non-matching, goal-congruent response. For instance, research has demonstrated that smiling in the face of adverse circumstances predicts psychological adjustment (Keltner & Bonanno, 1997; Papa & Bonanno, 2008). One way in which researchers have hypothesized that Duchenne (genuine) smile production promotes well-being is that these smiles elicit positive emotions in others and, consequently, positive social interactions (also see Cohen, Gottlieb, & Underwood, 2000). These findings suggest by extension that in the context of rapid responses to others' displays, those people who are unable to suppress displays of goal-*in*congruent responses might sometimes experience deleterious social consequences, but those who can actually produce goal-congruent responses (i.e., responding and suppressing responses when appropriate) are more likely to build and maintain social resources. Thus, in contrast with perspectives that uniformly link matching with positive outcomes (e.g., Chartrand & Bargh, 1999) and display suppression with negative outcomes (e.g., Moore, Zoellner, & Mollenholt, 2008), a communication framework predicts favorable consequences associated with RDR flexibility across situations that vary in terms of communication goals.

Chapter Two: Study 1

If RDRs are communicative, then they should differ across communicative goal conditions. If this communication is functional, then RDR flexibility should enhance social outcomes related to effective goal-congruent communication, such as cultivating new friendships. Study 1 tested these implications in a sample of women transitioning to college. First-year students often report experiencing at least some increase in distress as a result of starting college (Gerdes & Mallinckrodt, 1994), therefore I expected some variability in social adjustment across the first year. In the fall term of their first year of college, participants completed a laboratory task in which they enhanced responses to some pictures of emotional faces and suppressed responses to others. Facial EMG was used to measure the magnitude of responses to derive measures of RDR flexibility. Social adjustment was assessed by measuring change in social support from college friends across the first year; participants completed questionnaire measures of social support at the end of the fall term and again in the spring at the end of the academic year.

If the mechanism by which RDR flexibility affects outcomes is indeed a social, communicative process, the predicted relationship between RDR flexibility and social success should be modulated by the degree to which individuals are social active. In other words, RDR flexibility should support healthy communication and relationships for those people who are interacting with others. Study 1 tested this implication using one index of social activity: number of Facebook friends added during a 45-day period in the fall term.

Specific Hypotheses

Consistent with the communication framework, I predicted that RDRs would be modulated across goal condition and would be stronger in the respond condition compared to other conditions (Hypothesis 1), individuals high in RDR flexibility would experience larger increases in social support across the first year of college compared to those low in RDR flexibility (Hypothesis 2), and social activity would moderate the relationship between RDR flexibility and change in social support such that the relationship should be especially strong for individuals who are more socially active (Hypothesis 3).

Study 1 Method

Participants. Forty-nine first-year college women were recruited from introductory psychology courses at the University of Denver to participate in a longitudinal study with data collection occurring at three time-points (T1-T3). Only women were recruited to reduce variability due to gender differences in responding to emotional stimuli. Data from two participants (4%) were excluded due to equipment malfunction, and 12 participants (24%) failed to complete either T2 or T3, leaving a total of 36 participants (M = 18.15, SD = .50). Participants were compensated with course credit for completing T1 (laboratory session completed within one month of the beginning of the fall term) and T2 (questionnaires completed at the end of the fall term), and $10 for completing T3 (questionnaires completed at the end of the spring term). Ethnic composition of the sample was representative of the University of Denver undergraduate population: 30 (86%) Caucasian and 6 (14%) non-Caucasian.

Of these 36 participants, 20 consented to providing Facebook data (see Measures). No additional compensation was provided for participating in this component. Participant treatment was consistent with American Psychological Association (APA) ethical guidelines (American Psychological Association, 2002) and all questionnaires and procedures were approved by the University of Denver Institutional Review Board (IRB).

Stimuli. Participants viewed on a computer monitor a series of 74 digitized photographs. Eight happy faces, eight angry faces, and eight fearful faces were selected from the NimStim stimuli set (Tottenham, Borscheid, Ellertsen, Marcus, & Nelson, 2002). These photos were digitally cropped so that only the face of the model is visible, and equal numbers of male and female models were presented from each emotion class. The modified photos have been used successfully in this lab in the past to elicit rapid responses without instruction (Moody et al., 2007; Moody & McIntosh, 2011b). In addition to the 24 face stimuli, 10 non-social positive (e.g., birthday cake), 10 non-social negative (e.g., a gun), 10 affectively neutral (e.g., a lamp), 10 social and positive (e.g., laughing children), and 10 social and negative (e.g., a mutilated body) photos were selected from the International Affective Pictures System (IAPS). Responses to non-facial stimuli are not reported here because the primary focus of this study was to investigate rapid responses to others.

Procedures.

T1. Participants were scheduled for an individual laboratory session within six weeks of the beginning of the fall term. On the day of the lab session, the participant was greeted by a trained research assistant who explained the lab session, T2 and T3 procedures and answered all questions. After consenting to these components of the study, facial EMG sensors used to measure RDRs were applied, and the participant then completed the RDR flexibility task.

The participant was seated approximately .5 m from the computer monitor and instructed to remain still in the seat for the following task. First, the participant was instructed to pay attention (uninstructed condition) to the series of pictures as they appeared one at a time on the screen. All 74 photographs were presented in two blocks: NimStim faces and IAPS pictures. Stimuli were presented randomly within each block and block order was randomized across participants. Each stimulus was preceded by a short orienting tone and a 500 ms grey screen. Stimulus duration was 3 s followed by a 1000-1500 ms variable ISI during which the screen was white. Next, the participant read and heard these instructions (respond/suppress condition): "For the previous set of pictures, you simply watched and paid attention. However, oftentimes people respond to emotional pictures with their faces. For each picture, there are many possible ways to respond. In some situations, you may want others to see your natural facial response. In other situations, you may not want others to see your facial response at all. For the next set of pictures, if you see a GREEN screen appear, make sure others CAN see your natural facial response to the picture that follows. If you see a RED screen appear, make sure others CAN'T see your natural facial response to the picture that follows. Remember, green means go; make sure others CAN see your response. Red means stop; make sure others CAN'T see your response." The participant completed a short practice block comprised of one happy face preceded by a green screen, one angry face preceded by a red screen, one social and negative IAPS picture preceded by a green screen, and one social and positive IAPS picture preceded by a red screen. The participant was given the opportunity to ask the research assistant questions about the task, then completed the respond/suppress conditions comprising two blocks of stimuli: the same 24 faces from the previous condition and 40 IAPS pictures (those from the uninstructed condition minus the 10 neutral pictures). Stimuli were presented randomly within each block and block order was randomized across participants. The color of the screen indicating whether to respond or suppress facial responses to a given stimulus was randomized. Half were preceded by green and half were preceded by red. EMG data were collected continuously for the duration of the task (approximately 17 minutes).

After a short break, participants completed other tasks and questionnaires not reported here. Once all components of the lab session were completed, participants were thanked and reminded of the procedures for T2 and T3.

Before leaving, participants were asked about their interest in allowing researchers access to their Facebook profile page for research purposes. The procedure was explained and participants provided consent and their Facebook username. Immediately following the laboratory session, participants enrolled in the Facebook component of the study were sent a friend request from the Facebook profile associated with the lab. All participants sent a friend request accepted it, thus allowing researchers associated with the lab to view their Facebook profile page and record Facebook activity data.

The laboratory session lasted approximately 45 minutes.

T2. Within two weeks of the end of the fall term, participants completed questionnaires on their home computer including measures of social support.

T3. Within two weeks of the end of the spring term, participants again completed questionnaires on their home computer including measures of social support and personality traits.

Measures.

RDRs. EMG was used to record muscle activity over three facial muscles on the left side of the face: zygomaticus major (raises the corners of mouth), corrugator supercilii (contracts the brow), and medial frontalis (raises the brow). Activity over zygomaticus has been shown to occur during the experience of positive emotions (Cacioppo, Petty, Losch, & Kim, 1986); activity over the corrugator muscle has been shown to be a marker of negative emotions such as anger (Cacioppo et al., 1986); activity over frontalis has been shown to indicate fear (Darwin, 1998; Moody et al., 2007). Electrode site preparation and placement followed standard procedures (Tassinary, Cacioppo, & Geen, 1989). First, the skin over each muscle was cleaned with rubbing alcohol and gently abraded with NuPrep Gel®. Next, two electrodes were placed over each muscle group approximately 1.25 cm apart and parallel to the length of the muscle. Electrodes were Biopac 4 mm Ag-AgCl, cup style electrodes that measured muscle activity continuously at a sampling rate of 2000 Hz with a 10 Hz to 500 Hz band pass filter and a 60 Hz notch filter using a Biopac signal amplifier.

To begin the data cleaning and reduction process, each participant's EMG file was first inspected visually for noise and artifacts. The waveforms associated with each stimulus presentation were inspected by a research assistant blind to stimulus type to look for artifacts (e.g., changes in muscle activation during the baseline period prior to stimulus onset). Those trials for which artifacts were detected were deleted and thus excluded from analyses. No participant had more than 10% of the total number of trials deleted due to artifacts.

Activity of each muscle was calculated for the 500 ms baseline period before the orienting tone and for each 100 ms window during stimulus presentation by taking the integral for each time window using Analysis Lab EMG data reduction software. To reduce the influence of extreme values, the integral values were then log10 transformed (e.g., Winkielman & Cacioppo, 2001). Next, the value corresponding to the 500 ms baseline period was subtracted from the level of activity during the stimulus presentation for each trial and each muscle to calculate stimulus-induced change from baseline.

Scores for each 100 ms window were then averaged in two ways. The first average was computed for the purpose of *within*-persons analyses of variance (ANOVAs) to test whether magnitude of participants' responses differed across conditions (Hypothesis 1). Scores for each 100 ms window from 300[1] to 2000 ms post stimulus onset were averaged for each of the three conditions (uninstructed trials, respond trials and suppress trials) within each of the three stimulus classes (happy faces, angry faces and fearful faces) for each muscle (zygomaticus, corrugator and frontalis). This results in nine magnitude scores calculated for each participant for each of the three muscles.

The second average was computed for the purpose of using variance in responses *across* individuals to predict outcomes (Hypotheses 2 and 3). Consistent with previous findings of differences between groups in very early responses (< 1000 ms; e.g., McIntosh et al., 2006; Oberman, Winkielman, & Ramachandran, 2009), I predicted that variability in very early responses would be related to variability in outcomes. I therefore selected a shorter window—300 to 1000 ms post stimulus onset—to test whether individual differences in RDR flexibility in terms of magnitude predict change in social support. Nine magnitude scores (3 conditions × 3 classes of facial displays) were calculated for each participant for each of the three muscles.

Social support. Participants completed the 40-item Interpersonal Support Evaluation List (ISEL; Cohen & Hoberman, 1983) at T2 and T3. Instead of measuring the structure of one's social network (e.g., "How many friends do you have?"), the 10-item subscales of the ISEL assess four facets of social functionality: (1) belonging or companionship support; (2) appraisal, which is emotional support or someone to talk to about problems; (3) self-esteem in terms of positive comparison statements when comparing the self to others; and (4) instrumental support, or the availability of tangible material aid (Cohen, Kamarck, & Mermelstein, 1983). Participants responded to each item using a scale ranging from 0 (*definitely false*) to 3 (*definitely true*). Sample items from each subscale include "I often meet or talk with family or friends" (belonging or companionship), "There is someone I could turn to for advice about making career plans or changing my job" (appraisal), "Most of my friends are more successful at making changes in their lives than I am" (self-esteem, reverse scored), and "If I were sick and needed someone to take me to the doctor, I would have trouble finding someone" (instrumental support, reverse scored). To target change in social support at college, instructions at T2 and T3 read, “Please answer the following questions with regard to your friends and other people you know at DU (and not your non-DU friends or family members).” Scores were summed for a total score and for each subscale. This measure has sufficient internal consistency (alphas in previous work range from .88 to .90 for the total scale; in the current sample, α = .85 at T2 and .87 at T3) and it has been used extensively to measure perceptions of social support and social coping mechanisms (Cohen, Gottlieb, & Underwood, 2000).

Social activity. The degree to which each participant was socially active was measured by calculating the number of friends added to her Facebook profile from October 1st to November 15th of her first term at college. Despite obvious differences between offline social behavior and online social behavior mediated by social networking websites, research has demonstrated correspondence between offline, face-to-face behavior and online behavior (e.g., Weisbuch, Ivcevic, & Ambady, 2009). In terms of befriending behavior, a recent study found that people who were high in shyness, a trait associated with having fewer friends in the offline world (Jones & Carpenter, 1986), added fewer friends on Facebook than people who were less shy (Orr, Sisic, Ross, Simmering, Arseneault, & Orr, 2009). One explanation for this finding is that shy people are less socially active offline, leaving them with fewer online contacts to befriend on Facebook. This explanation is supported by Facebook users’ reports that the majority of Facebook friends were first offline acquaintances and friends who were later added as an online friend (Ellison, Steinfield, & Lampe, 2007). This offline-to-online process suggests that the number of Facebook friends participants added is a reasonable approximation of their offline social activity.

Study 1 Results

Hypothesis 1. Are RDRs modulated across communication goal conditions? A Condition (3: uninstructed, respond, suppress) × Stimulus Type (3: happy faces, angry faces, fearful faces) × Muscle (3: zygomaticus, corrugator, frontalis) repeated measures ANOVA with average muscle activation from 300 to 2000 post stimulus onset as the dependent variable revealed a significant main effect of Condition, $F(2, 62) = 33.48$, $p < .0001$, partial $\eta^2 = .52$. Post-hoc comparisons indicated more muscle activation on respond trials ($M = .05$, $SD = .07$) than uninstructed trials ($M = -.02$, $SD = .02$), $t(34) = 6.87$, $p < .0001$, and more muscle activation on just watch trials than suppress trials ($M = -.05$, $SD = .05$), $t(34) = 3.00$, $p = .005$. This effect was qualified by a significant three-way interaction, $F(8, 248) = 28.20$, $p < .0001$, $\eta^2 = .48$. Thus, at least one muscle varied in activation magnitude as a function of condition and stimulus type (see Appendix B, Figure 1). Within stimulus, each individual muscle oftentimes differed in magnitude across condition (see Appendix A, Table 1). The largest differences within expression were 1) enhancement of zygomaticus to happy faces during the Respond condition, 2) suppression of zygomaticus to anger faces during the Suppress condition, and enhancement of corrugator to anger faces during the Respond condition, and 3) enhancement of frontalis to fearful faces during the Respond condition.

Hypothesis 2. Does RDR flexibility predict change in social support? To address whether RDR flexibility predicted changes in social support, I tested whether RDR flexibility—responses in the respond and suppress conditions—predicted social support at T3 while controlling for social support at T2 and responses in the uninstructed condition. RDR flexibility was measured two ways: magnitude of muscle activation on respond trials from 300 to 1000 ms and magnitude of muscle activation on suppress trials from 300 to 1000 ms. I conducted three sets (one per face stimulus type) of two regression analyses (one per flexibility index) to test whether flexibility predicted social support at T3. Each regression included seven predictors entered step-wise in three blocks: T2 social support (Block 1), the responses from each of the three muscles elicited by the stimulus in the uninstructed condition (Block 2), and the responses from each of the three muscles elicited in the goal condition (Block 3).

For happy faces, the magnitude of zygomaticus response in the respond condition was the only significant predictor of T3 social support besides T2 social support, but in the direction opposite of what I predicted, $\beta = -.26$, $p = .03$. When instructed to enhance, those with stronger cheek contractions reported less social support at T3 controlling for social support at T2 than those with weaker cheek contractions. of the variables in the suppress condition were significant predictors of T3 social support after controlling for T2 social support (ps > .05).

For angry faces, none of the variables were significant predictors of T3 social support after controlling for T2 social support (ps > .05).

For fearful faces, none of the variables were significant predictors of T3 social support after controlling for T2 social support (ps > .05).

These regressions were repeated for the subsample of participants who provided social activity data (N = 20). No variables were significant predictors of T3 social support after controlling for T2 social support (*p*s > .05).

Hypothesis 3. Does social activity moderate the effect of RDR flexibility on social support? To address the question of whether the relationship between zygomaticus activation magnitude in response to happy faces in the respond condition and T3 social support is moderated by social activity, I regressed T3 social support onto T2 social support, zygomaticus magnitude in the uninstructed condition, zygomaticus magnitude in the enhance condition, and social activity. I also included the interaction term (zygomaticus activation magnitude in response to happy faces in the respond condition × social activity) to determine whether social activity moderates the relationship between zygomaticus activation magnitude in response to happy faces and T3 social support. The interaction term was significant, $\beta = .16$, $p = .04$ (see Appendix A, Table 2). Figure 2 (Appendix B) depicts the nature of the interaction. Those who added many Facebook friends *and* demonstrated stronger cheek contractions in response to smiling faces in the respond condition (i.e., those who were more flexible) reported greater increases in social support over the school year than those who added many friends but demonstrated weaker check contractions. Those who added fewer Facebook friends reported the same amount of change in social support regardless of flexibility evident in cheek contraction strength.

Study 1 Discussion

Study 1 found evidence for all three implications, thus providing preliminary support for the RDRs-as-communication framework. Using a within-persons design, RDRs were modified by the communication goals to respond and suppress responses. Individual differences in flexibly with which RDRs were deployed across communicative contexts predicted social adjustment across students' first year of college. Specifically, among students who were most socially active, those who were better at enhancing their smiling response to a smiling face when the goal was to respond reported experiencing better social adjustment. The moderation by degree of social activity is critical; the association between RDR flexibility and social adjustment was strongest and positive only for those who were highly active. This highlights the social nature of the mechanism by which RDR flexibility may give rise to social outcomes.

A major limitation of Study 1 is the small, homogenous nature of the sample. Furthermore, if RDR flexibility influences social outcomes, flexibility may also have consequences for non-social outcomes that draw on social resources, but outcomes beyond social adjustment were not measured in Study 1. Study 2 was designed to address these limitations by testing for replication of the effects in Study 1 in a larger sample of women *and* men ranging in age from 21 to 60 years. Study 2 also looked at the indirect effects of RDR flexibility on mental health outcomes through direct effects on social support.

Chapter Three: Study 2

Study 1 supported the hypotheses that RDRs differ across communicative goal conditions and that individual differences in RDR flexibility are associated with variation in social outcomes for people who are socially active. Study 2 evaluated these effects in a larger, more diverse sample of people during a period in which eliciting social support may be particularly important: coping with stressful life events (SLEs) that sometimes result in negative mental health outcomes such as depression. Several mental health problems, including depression, are associated with social disconnection (e.g., Baumeister & Leary, 1995), therefore social support is a key component in models of depression (e.g., Coyne, 1976). By facilitating communication, RDR flexibility may buffer individuals at risk for developing negative mental health outcomes by promoting social support. Specifically, social support may mediate the relationship between RDR flexibility and depression such that people who are able to modulate their RDRs to elicit favorable responses from others are more likely to experience high social support that may in turn reduce their symptoms of depression following exposure to SLEs. Given the high prevalence of depression and its cost to society (Kessler et al., 2003), it is important to understand whether and how RDR flexibility contributes to resilience.

Study 2 examined RDR flexibility and its associated outcomes in a sample of individuals who recently experienced one or more SLEs. As part of a larger study on stress, participants who had been exposed to an SLE completed the laboratory task described in Study 1 and questionnaires assessing social support and depressive symptoms within six weeks of experiencing a discrete SLE. Six months after the laboratory session participants again completed measures of social support and depression symptoms.

Specific Hypotheses

Consistent with the communication framework, I expected to replicate Study 1 findings. I predicted RDRs would vary in strength according to communicative goal condition (Hypothesis 1), individuals high in RDR flexibility would experience larger increases in social support across the six months following the laboratory session compared to those low in RDR flexibility (Hypothesis 2), and social activity would moderate the relationship between RDR flexibility and change in social support such that the relationship should be especially strong for individuals who are more socially active (Hypothesis 3). Extending Study 1, I predicted an indirect association between RDR flexibility on depression that is mediated by social support (Hypothesis 4).

Study 2 Method

Participants. Eighty-three participants (51 women) between the ages of 21 and 60 years old (M = 43.16, SD = 10.41) were recruited from the Denver community to take part in a larger longitudinal study on emotion and life events with data collection occurring at two time-points (T1 and T2). Recruitment took place through online classified advertisements (Craigslist.org) and by posting flyers in public places including college campuses and churches. Compensation was $55 for completing T1 (questionnaires and laboratory session) and $20 for T2 (questionnaires completed from home). Participant treatment was consistent with APA ethical guidelines (American Psychological Association, 2002) and all questionnaires and procedures were approved by the University of Denver IRB.

To qualify for the study, participants were required to have experienced a SLE within the past six weeks. SLEs are events with a clearly defined starting point (rather than a relatively chronic stressor) that had a significant and negative impact on the participant's life. Common SLEs in this sample were sudden unemployment, change in living status (e.g., home foreclosure), long-distance move, illness, injury, or death of a loved one, exposure to crime, and divorce or the end of a romantic relationship. Exclusionary criteria included current drug or alcohol abuse and involvement in a pending legal case. Ethnic composition of the sample was mixed: 6% self-identified as African-American, 2% Asian American, 72% European American, 5% Latino, 11% of multiple ethnic backgrounds, and 4% other or unknown.

Procedures.

T1. After participants were determined to qualify for the study, they were scheduled for an individual laboratory session. Before arrival, participants provided consent and completed questionnaires on their home computer including questionnaires assessing exposure to SLEs, social support, social activity and current depressive symptoms (see Measures). Other self-report data were collected that are not a part of this study. The questionnaire portion of T1 took approximately one hour.

On the day of the T1 lab session, the participant was greeted by a trained research assistant who explained the lab session, T2 procedures, and answered all questions. The participant then consented to participating in the T1 lab session and T2. To maximize privacy and minimize distractions during data collection, the research assistant left the participant alone in the experimental room but was available for questions via intercom. The participant then completed a number of cognitive tasks not related to this study. After a short break the participant was connected to physiological data collection instruments including facial EMG sensors. The participant then completed the RDR flexibility task described in Study 1. After another short break, participants completed more cognitive tasks not reported here. When finished, participants were thanked and compensated. Lab sessions lasted 3.5 hours on average.

T2. Six months after the laboratory session participants completed questionnaires on their home computer including questions assessing perceptions of social support, current depressive symptoms and social activity defined here as the degree to which help and advice was sought from others (see Measures).

Measures.

RDRs. Facial EMG data were collected and scored in the same way described in Study 1.

Social support. As in Study 1, participants completed the ISEL at T1 and T2 (α = .88 and .88, respectively, in the current sample).

Depressive symptoms. Current depressive symptoms were measured using the 21-item Beck Depression Inventory (BDI; Beck & Steer, 1984). Each item consists of four grouped statements; for example, the first item ranges from “I do not feel sad” to “I am so sad or unhappy that I can’t stand it.” Participants were instructed to select the statement that best describes how they have felt in the past week. One question that pertains to suicidal thoughts was excluded due to IRB concerns, leaving a total of 20 items. Each item was scored on a zero to three scale and the total BDI score was calculated by summing the scores from each item. The BDI has been shown to have adequate internal consistency (Beck & Steer, 1984; $\alpha = .87$ in the current sample) and has been widely used in research to measure current depressive symptoms (e.g., Brands et al., 2007; O'Donnell, Wardle, Dantzer, & Steptoe, 2006; Pearlstein et al., 2006). BDI scores were elevated in this stressed sample (*M*s = 11.62 and 10.74, *SD*s = 9.41 and 9.72 at T1 and T2, respectively).

Social activity. A single item measured degree of social activity specific to the experience of the SLE. During the time since their SLE, at T2 participants were asked to respond to the statement, "I've been trying to get help or advice from people about what to do," on a scale of 1 (*I have not been doing this at all*) to 4 (*I have been doing this a lot*; $M = 3.00$, $SD = .89$).

Study 2 Results

There were no gender effects, therefore gender was not included as a predictor in the analyses presented here.

Hypothesis 1. Are RDRs modulated across communicative goal conditions? A Condition (3: uninstructed, respond, suppress) × Stimulus Type (3: happy faces, angry faces, fearful faces) × Muscle (3: zygomaticus, corrugator, frontalis) repeated measures ANOVA with average muscle activation magnitude 300 to 2000 ms post stimulus onset as the dependent variable revealed a significant main effect of condition, $F(2, 62) =$

33.48, $p < .0001$, partial $\eta^2 = .52$. Post-hoc comparisons indicated more muscle activation on respond trials ($M = .05$, $SD = .07$) than uninstructed trials ($M = -.02$, $SD = .02$), $t(34) = 6.87$, $p < .0001$, and more muscle activation on just watch trials than suppress trials ($M = -.05$, $SD = .05$), $t(34) = 3.00$, $p = .005$. This effect was qualified by a significant three-way interaction, $F(8, 248) = 28.20$, $p < .0001$, $\eta^2 = .48$. Thus, at least one muscle varied in activation magnitude as a function of condition and stimulus type (see Appendix B, Figure 3). Within stimulus, each individual muscle oftentimes differed in magnitude across condition (see Appendix A, Table 3). Matching the pattern seen in Study 1, the largest differences within expression were 1) enhancement of zygomaticus to happy faces during the Respond condition, 2) suppression of zygomaticus to anger faces during the Suppress condition, and enhancement of corrugator to anger faces during the Respond condition, and 3) enhancement of frontalis to fearful faces during the Respond condition.

Hypothesis 2. Does RDR flexibility predict change in social support? As in Study 1, I conducted three sets—one per stimulus type—of two regression analyses to test whether RDR flexibility (measured two ways: muscle activation on respond trials and muscle activation on suppress trials) predicted social support at T2. Each regression included seven predictors entered step-wise in three blocks: T1 social support (Block 1), the response from each of the three muscles elicited by the stimulus in the uninstructed condition (Block 2), and the response from each of the three muscles elicited in the goal condition (Block 3).

For responses to happy faces, none of the variables predicted T2 social support after controlling for T1 social support, *p*s > .05.

For responses to angry faces, greater frontalis activation in the suppress condition predicted poorer social support at T2, $\beta = -.27$, $p = .01$. When instructed to suppress, those who raised their brow more (i.e., those who were less flexible) within a second of seeing an angry face reported less social support at T2 than those who raised their brow more (i.e., those who were more flexible; see Appendix A, Table 4).

For responses to fearful faces, none of the variables predicted T2 social support after controlling for social support at T1, *p*s > .05.

Hypothesis 3. Does social activity moderate the effect of RDR flexibility on social support? To address the question of whether the relationship between frontalis activation magnitude in response to angry faces in the suppress condition and T2 social support is moderated by social activity, I regressed T2 social support onto T1 social support, frontalis magnitude in the uninstructed condition, frontalis magnitude in the suppress condition, and social activity. I also included the interaction term (frontalis activation magnitude in response to angry faces in the suppress condition × social activity) to determine whether social activity moderates the relationship between frontalis activation magnitude in suppress to angry faces and T2 social support. The interaction term was significant, $\beta = .18$, $p = .04$. Figure 4 (Appendix B) depicts the nature of the interaction. Those who were high in support seeking *and* produced weaker frontalis contractions in response to angry faces in the suppress condition (i.e., those who were more flexible) reported larger increases in social support from T1 to T2 than those were high in support seeking but produced stronger frontalis contractions (i.e., those who were less flexible). Those who were lower in support seeking reported the same amount of change in social support regardless of frontalis contraction strength across conditions.

Hypothesis 4. Does change in social support mediate the relationship between RDR flexibility and change in depressive symptoms? I used the series of analyses recommended by Baron and Kenny (1986) to assess the relationships among RDR flexibility, depression and social support. In testing Hypothesis 2 I identified an indicator of RDR flexibility that predicts the hypothesized mediator: frontalis magnitude in the suppress condition predicts change in social support. Next, I tested whether RDR flexibility (measured two ways) predicts depressive symptoms. Finally, I tested whether the association between RDR flexibility and depressive symptoms was reduced (partial mediation) or eliminated (full mediation) when social support was included as a predictor of depression.

Does RDR modulation across goal conditions predict change in depressive symptoms? To assess the relationship between RDR flexibility and depressive symptoms, I conducted three sets—one per face stimulus type—of two regression analyses (one per flexibility index) to test whether RDR modulation predicted depressive symptoms at T2. Each regression included seven predictors entered step-wise in three blocks: T1 depression (Block 1), the response from each of the three muscles elicited by the stimulus in the uninstructed condition (Block 2), and the response from each of the three muscles elicited in the goal condition (Block 3).

For responses to happy faces, none of the variables predicted T2 depression symptoms after controlling for depression at T1, *p*s > .05.

For responses to angry faces, higher corrugator magnitude in the uninstructed condition predicted more depression at T2, β = .23, *p* = .03 (Appendix A, Table 5, Model 1). When given no response instructions, those who knitted their brow more were more depressed at T2 than those who knitted their brow less. Higher zygomaticus magnitude in the respond condition also predicted more depression at T2, β = .32, *p* < .01. Furthermore, more frontalis activation in the suppress condition predicted more depression at T2, β = .33, *p* < .01. When instructed to suppress, those who raised their brow more (i.e., those who were less flexible) were more depressed at T2 than those who raised their brow less (Appendix A, Table 5, Model 2).

For responses to fearful faces, none of the variables predicted T2 depressive symptoms after controlling for depressive symptoms at T1, *p*s > .05.

Does change in social support mediate the relationship between RDR flexibility and change in depressive symptoms? Magnitude of frontalis response to angry faces in the suppress condition predicted both change in social support and change in depressive symptoms at T2, meeting two of the three conditions necessary for mediation (Baron & Kenny, 1986). I ran a final regression to test the association between frontalis activation in response to angry faces in the suppress condition and T2 depressive symptoms with T2 social support minus T1 social support included as a predictor. Higher frontalis activation in the suppress condition (less flexibility) predicted more depression at T2, β = .27, *p* = .03; a Sobel test revealed a significant reduction in the association when social functioning is included in the model, $S = 1.50$, $p = .04$. Thus, change in social support partially mediated the relationship between magnitude of frontalis activation in the suppress condition in response to angry faces and change in depressive symptoms.

Study 2 Discussion

Study 2 replicated and extended the findings of Study 1, showing that RDRs are sensitive to communicative goal context and that individual differences in RDR flexibility are associated with variation in social outcomes for people who are socially active. Specifically, when the goal was to suppress responses, those who were better at suppressing fearful responses to angry faces reported experiencing better social support compared to those who were not as good at suppressing this response. As in Study 1, this association between RDR flexibility and social support was especially strong for those who were highly engaged in social activity. Furthermore, RDR flexibility was associated with depressive symptoms such that those who were more flexible reported greater improvements in depressive symptoms in the wake of a stressful event, and this relationship was due in part to the direct effect of RDR flexibility on social support.

Thus, RDRs are responsive to communicative goals, and the flexibility with which they are produced across different communicative contexts predicts both the social and mental wellbeing of the person producing them.

Chapter Four: General Discussion

Two studies provided support for the communication approach to rapid displays produced in response to others. Both studies showed that people in general can change the magnitude of their most rapid responses according to communication goals to either respond or suppress responses. For some stimulus-response pairs, the ability to modulate the magnitude of response to align with goals is associated with positive social outcomes for those who are socially active. In Study 1, individual differences among first-year college students' ability to flexibly deploy RDRs across communicative contexts predicted social adjustment for socially active students. Specifically, when the goal was to respond, those who were better at enhancing their smiling response to a smiling face reported better social adjustment compared to those who were not as successful at enhancing their smile. In Study 2, adults' ability to suppress fearful responses to angry displays was associated with better social adjustment in the wake of a stressful event. This ability was also associated with reduced depressive symptoms through its effect on social adjustment. As in Study 1, the relationship between RDR flexibility and social adjustment was especially strong for those who were socially active. Taken together, these findings suggest that individual differences in the way people produce RDRs across communicative contexts can, over time, influence one's social adaptation, and this effect has consequences for one's mental health.

The Communicative Nature and Functions of RDRs: Familiar Themes and New Insights

Differences across the two studies in terms of stimulus-response specificity provide valuable insight into and support for the communicative nature of RDRs. In Study 1, variation in enhancing one's smile in response to happy faces predicted social adjustment while in Study 2, *not* responding with a fearful display to angry faces predicted social adjustment. This stimulus-response specificity may be due to the unique communicative context of each sample. For college students making new friends, the ability to enhance a smile may be most relevant to the process of establishing solid friendships across the first year of college. For adults who have recently experienced a stressful event, being able to suppress one's fearful response to a social threat may be most relevant to the process of maintaining existing relationships during the period of recovery. Thus, I suggest that the relevance of the response display in a given context affects the degree to which the ability to quickly modulate that display will be associated with social outcomes. I made no predictions about which stimulus-response pairs would be most relevant to the social goals of the population from which participants were drawn for each study, but future research could test specific hypotheses about which stimulus-response pairs will matter most given the specific context of a population and should, therefore, predict individual differences in outcomes.

The findings presented here contribute to a more comprehensive understanding of the functions of RDRs. The *intra*personal functions of RDRs are well-established: they influence the person producing them, like enhancing one's ability to identify emotion displays produced by a model (Niedenthal, Brauer, Halberstadt, & Innes-Ker, 2001), and promoting empathy for that individual (Sonnby-Borgström, 2002). Theories (e.g., Lakin & Chartrand, 2003) suggest that RDRs also operate *inter*personally, influencing individuals observing their production. Ekman and colleagues' (see Ekman, 2003, for a review) work on micro-expressions has demonstrated the capacity of rapid, subtle displays (although *response* displays were not evaluated) to influence observers. As an example, compared to individuals who are being truthful about their emotional experience, individuals who are trying to mask their feelings oftentimes produce subtle facial actions corresponding to their genuine feelings (e.g., Ekman, Friesen, & O'Sullivan, 1988). Observers are able to pick up on these subtle cues to determine whether someone is lying or being truthful, especially observers trained in detecting micro-expressions (Ekman & O'Sullivan, 1991). Although these studies do not show directly whether rapidly produced *responses* influence others, they suggest that rapid, subtle displays in general do indeed affect observers. The findings presented here provide the first empirical support for rapid *responses* influencing others. For the socially active, initial individual differences in ability to modulate RDRs predicted change over time in social support (Studies 1 and 2) and depressive symptoms (Study 2), controlling for initial differences in social support.

By approaching the nature and functions of RDRs from a communicative perspective, I tested and found support for implications that would not be predicted by other approaches. Most notably, there are instances in which matching a display has maladaptive effects. Specifically, I found that individuals who tend to match angry displays are more likely to experience depressive symptoms than those who do not tend to match angry displays (Study 2). Work on emotion regulation strategies has often found that display suppression has deleterious consequences, including higher tolls on physiological systems, increased subjective experience of negative emotion (Gross, 1998; Gross & Levenson, 1993), and negative social consequences (Butler, Egloff, Wilhelm, Smith, Erickson, & Gross, 2003; Huang, 2004). However, studies demonstrating adverse social effects of suppression often neglect to consider conditions in which communicating emotions may be goal-*in*congruent. Under conditions in which suppression supports goal achievement, suppression has been found to be more adaptive than maladaptive. Kashdan and colleagues (Kashdan, Volkmann, Breen, & Han, 2007) compared the effects of emotion suppression in socially anxious and non-anxious individuals. For the less anxious, suppression predicted romantic relationship deterioration but for the anxious, the tendency to withhold negative emotions from one's partner enhanced relationship closeness. The findings from Study 2 are consistent with the context-dependent effects of conveying emotion information. Matching is not always good. RDRs communicate information to those observing their production, and producing a matching display can sometimes be socially costly.

Most generally, the studies presented here contribute to a growing body of evidence that RDRs are multiply determined (Moody & McIntosh, 2011a). Chartrand and Bargh (1999) and others (Chartrand, Maddux, & Lakin, 2005; Niedenthal, Barsalou, Winkielman, Krauth-Gruber, & Ric, 2005) have conceptualized matching responses as non-emotional motor outcomes that can be produced via a direct neural link between perception and action that bypasses emotional systems and may be mediated by the mirror neuron system (Williams, Whiten, Suddendorf, & Perrett, 2001). From this perspective, rapid matching responses are unintentional, nonconscious products of social perception that are "no more than copying another's observables and [require] only the ability to perceive the behavior in the other person and the ability to form the behavior oneself" (Chartrand, Maddux, & Lakin, 2005, p. 335). Rapid matching of stuttering, a non-emotional facial behavior, demonstrates that RDRs are not only emotional (Mood & McIntosh, 2011a). Others, however, argue that a purely non-emotional motor process fails to account for all manner of rapid responses to social stimuli, matching and otherwise. Instead, they argue for another mechanism that is emotional in nature. From this perspective, matching displays can be generated if the observed display evokes the same emotion in the observer which he or she then expresses (Cacioppo, Martzke, Petty, & Tassinary, 1988; Dimberg, 1997; Winkielman & Cacioppo, 2001). Non-matching displays are expressions of emotion elicited by the observed stimulus but differ from that which the stimulus portrays, such as a fearful response to an angry stimulus (Moody et al., 2007).

The findings presented here provide evidence for a third mechanism by which RDRs are produced—a communicative mechanism. This mechanism accounts for both matching and non-matching RDRs and can explain differences in RDRs after controlling for subjective emotional experience of the person producing the RDRs. Similar to emotion displays in general, even rapid responses to others are social tools that can be used to convey information to and influence those who observe them. As demonstrated here, they are subject to principles governing other communicative behaviors. I showed that RDRs vary according to communicative goals, and the ability to produce goal-congruent rapid displays in response to emotional social stimuli is associated with social adjustment, just as the ability to produce goal-congruent, overt responses to emotional stimuli more generally (Bonanno et al., 2004; Westphal, Seivert, & Bonanno**,** 2010). Additional research is needed to better understand how and under what conditions these three mechanisms—motor, emotional and communicative—interact with one another to produce the full range of RDRs. When communication goals are salient and motivation to communicate is high, I predict that the communicative mechanism can trump the others such that an individual would be likely to produce a rapid non-matching response that is inconsistent with her subjective experience of emotion in that moment.

Alternative Explanations

An alternative interpretation of the findings presented here is that individual differences in emotion regulation ability—that is, the ability to alter the subjective experience of an emotion—was responsible for both RDR modulation ability and social adjustment. By this account, when participants were instructed to respond or suppress some were better able to enhance or decrease their experience of the emotion evoked by the stimulus and this ability to change emotional experience was responsible for social adjustment while RDR modulation ability was simply a byproduct of this emotion regulation process. Indeed, the ability to regulate one's experience of emotions has been linked to positive outcomes over time (Gross & John, 2003; John & Gross, 2004; Mauss, Cook, Cheng, & Gross, 2007; Troy, Wilhelm, Shallcross & Mauss, 2010), and differences in emotion regulation ability are associated with differences in response displays: deficits in the ability to amplify positive emotion are associated with reduced facial responding to positive stimuli (Burton & Kaszniak, 2006), and deficits in emotion suppression are associated with increased facial responding to negative stimuli (Smith, 1995).

The present research was not designed to measure regulation of subjective experience and whether it was a cause, or perhaps even a consequence, of RDR modulation. Regulating one's displays does not necessarily require a change in the underlying emotion (Fridlund, 1994, 1997; Gross & Levenson, 1993; Richards & Gross, 2000; Schmeichel, Demaree, Robinson, & Pu, 2006), but a recent study suggests that coherence between subjective state and display behavior may be more potent than display behavior alone in procuring positive social effects (Mauss et al., 2011). Future studies should examine the interaction between RDR modulation and change in subjective experience of emotion and their unique versus combined influences on social outcomes.

Another possible explanation of the results is that RDR modulation ability draws upon more general cognitive control processes and it is these control processes that drive social adjustment, not the ability to modulate RDRs. Indeed, cognitive control ability is associated with social functioning and social adjustment (e.g., Rueda, Checa & Rothbart, 2010). Among cognitive control processes, working memory (WM) is of particular interest as a process that supports RDR modulation ability because it allows for goal-congruent processing despite competing goal-irrelevant stimuli. As such, WM is involved in both emotion and display regulation processes. In a series of experiments, Schmeichel, Volokhov,

& Demaree (2008) showed that compared to those with lower WM capacity, individuals higher in WM capacity were better able to suppress displays of negative and positive emotion when instructed to do so in response to emotional stimuli. Individuals with high WM capacity were also better able to downregulate their experience of negative emotion and, as a consequence, reduce their expression of negative emotion. Thus, RDR modulation ability may reflect more general cognitive control processes such as WM capacity, and individual differences in cognitive control may be associated with individual variation in the ability to flexibly modulate one's RDRs.

Cognitive control processes may indeed support the ability to modulate RDRs but cannot fully account for the findings presented here. If cognitive control were driving both the ability to modulate RDRs in the laboratory task and social adjustment, then individual differences in responding to all types of stimuli under both the respond and suppress conditions should have predicted social adjustment. In both Studies 1 and 2, however, a specific stimulus-response pair predicted social adjustment. Additional research is needed to determine the degree to which RDR modulation ability draws on more general cognitive control processes.

Limitations and Future Directions

The longitudinal design of Studies 1 and 2 allowed me to predict longer-term social adjustment using RDR modulation ability measured with a laboratory task. I assumed that the ability that was measured supports communicative goal achievement in single episodes which then over time (i.e., across many episodes) results in positive long-term social outcomes like gaining and maintaining social support. However, communicative success in a single episode was not measured. Future research should measure more proximal, episodic outcomes of RDR modulation ability that in turn give rise to longer-term outcomes. Furthermore, social and communicative success may not always come in the form of support and liking; success could be getting a reluctant tenant to pay the rent, for example. Success is influencing an interaction partner to think or behave in a way that aligns with one's goals, and future studies examining the communicative functions of RDRs should incorporate a variety of communicative strategies—beyond simply respond and suppress—and conditions in which the outcome goal is to elicit a wide array of attitudes and behaviors in one's interaction partner.

Future research should also examine how individual differences affect RDR modulation. Relevant individual differences include 1) the degree to which a person gleans communicative goals from a given situation or context and 2) the tendency to display emotions. In the studies presented here, communicative goals were explicit, thereby eliminating any effects of goal salience and reducing effects of variability in motivation. Outside the laboratory, people vary in the degree to which they are aware of and motivated to achieve communicative goals. Women high in self-monitoring, for example, may be more aware of expressive gender norms and more motivated to present themselves in a more normative way. They may be more aware of negative perceptions of women who display anger and therefore more likely to suppress displays of anger in response to anger-provoking models. Other individuals may simply be less motivated to display emotion in general, regardless of goal salience. Future studies should employ more ecologically valid paradigms to account for these individual differences in goal detection and display production.

A final limitation is that the research presented here did not test non-communicative functions that RDR modulation may serve. As discussed above, the ability to flexibly deploy RDRs may alter one's subjective experience, and it is the match between subjective experience and context that influences outcomes. Another function of RDR modulation may be instrumental in nature. In both Studies 1 and 2, social activity moderated the effect of RDR flexibility on outcomes; therefore, it is unlikely that subjective experience and instrumental functions were solely responsible for the relationship between RDR modulation and social adjustment. However, these auxiliary functions were not tested here. Future research should attempt to better understand how RDR modulation serves non-communicative functions in addition to its communicative effects.

Conclusion

Rapid responses to others help us make sense of and influence the social world. These responses are not simply automatic reflexes; like emotion displays in general, even the most rapid responses to others display information to those who observe them and can be modulated in the service of explicit communication goals. The ability to modify rapid responses to match communicative goals has consequences for longer-term social adjustment and even mental wellbeing. Future research should consider communicative mechanisms as one important process by which rapid responses to others are produced.

This communicative approach can provide valuable insights into their nature and functions that cannot be explained by other perspectives alone.

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Footnote

[1] Previous research employing EMG (e.g., McIntosh et al., 2006) and MEG (e.g., Nishitani & Hari, 2000) measures suggest that responses prior to 300 ms are unlikely to be engendered by the stimulus because the neural signal from primary visual cortex to motor cortex to activate corresponding muscles cannot propagate through the system faster than this for either spontaneous or intentional responses in neurotypical adults. Spikes in muscle activation, particularly corrugator, prior to 300 ms have been attributed to an orienting response rather than to the affective content of a stimulus (Dimberg, 1996).

Appendix A

Table 1
Study 1: Mean Difference and SE of the difference in Muscle Magnitude between Conditions by Stimulus Class (N = 35)

Comparison	Happy Faces	Angry Faces	Fearful Faces
Zygomaticus: Suppress versus Uninstructed	-.09 (.02)***	-.12 (.03)***	-.02 (.04)
Zygomaticus: Uninstructed versus Respond	-.33 (.03)***	-.07 (.02)**	-.05 (.03)
Zygomaticus: Suppress versus Respond	-.42 (.02)***	-.19 (.04)***	-.09 (.04)*
Corrugator: Suppress versus Uninstructed	.00 (.02)	-.01 (.01)	-.01 (.01)
Corrugator: Uninstructed versus Respond	.08 (.02)***	-.13 (.03)***	-.07 (.02)**
Corrugator: Suppress versus Respond	.08 (.02)**	-.15 (.03)***	-.08 (.02)**
Frontalis: Suppress versus Uninstructed	-.01 (.02)	.00 (.01)	.00 (.01)
Frontalis: Uninstructed versus Respond	.05 (.01)***	-.02 (.01)	-.13 (.03)***
Frontalis: Suppress versus Respond	.04 (.02)*	-.02 (.02)	-.13 (.03)***

Note. *$p < .05$. **$p < .01$. ***$p < .001$.

Table 2

Study 1: Regression Analysis Predicting T3 Social Support from T2 Social Support and T1 Zygomaticus Magnitude in the Uninstructed Condition, Zygomaticus Magnitude in the Respond Goal Condition in Response to Happy Faces and Number of Facebook (FB) Friends Added in 45 Days before T2 (N = 20)

Predictors	*B*	*SE*	β
T2 Social Support	.63***	.34	.74
Zygomaticus Magnitude (uninstructed)	2.55	1.47	.19
Zygomaticus Magnitude (respond)	-2.07*	.88	-.16
FB Friends Added	.003	.002	.06
FB Friends Added × Zygomaticus (respond)	.03*	.01	.16

Note. $R^2 = .75$, $F(5, 14) = 12.29$***.

*$p < .05$. ***$p < .001$.

Table 3

Study 2: Mean Difference and SE of the difference in Muscle Magnitude between Conditions by Stimulus Class (N = 86)

Comparison	Happy Faces	Angry Faces	Fearful Faces
Zygomaticus: Suppress versus Uninstructed	-.08 (.02)**	-.07 (.02)***	-.06 (.02)***
Zygomaticus: Uninstructed versus Respond	-.31 (.04)***	-.09 (.02)***	-.10 (.02)***
Zygomaticus: Suppress versus Respond	-.38 (.05)***	-.16 (.03)***	-.16 (.03)***
Corrugator: Suppress versus Uninstructed	.02 (.01)	-.01 (.01)	.00 (.01)
Corrugator: Uninstructed versus Respond	.06 (.02)***	-.18 (.03)***	-.11 (.02)***
Corrugator: Suppress versus Respond	.07 (.02)***	-.19 (.03)***	-.11 (.02)***
Frontalis: Suppress versus Uninstructed	.00 (.01)	.01 (.01)	.00 (.01)
Frontalis: Uninstructed versus Respond	.01 (.01)	-.06 (.02)***	-.12 (.02)***
Frontalis: Suppress versus Respond	.01 (.01)	-.07 (.02)***	-.12 (.02)***

Note. *$p < .05$. **$p < .01$. ***$p < .001$.

Table 4

Study 2: Regression Analysis Predicting T2 Social Support from T1 Social Support, RDR Magnitude in the Uninstructed Condition and RDR Magnitude in the Suppress Goal Condition in Response to Angry Faces (N = 86)

Predictors	*B*	*SE*	β
Block 1: T1 Social Support	.70***	.08	.72
Block 2: Zygomaticus Magnitude (uninstructed)	-.07	.81	-.01
Block 2: Corrugator Magnitude (uninstructed)	-.27	.55	-.05
Block 2: Frontalis Magnitude (uninstructed)	.91	.80	.13
Block 3: Zygomaticus Magnitude (suppress)	-.05	.38	-.01
Block 3: Corrugator Magnitude (suppress)	.70	.68	.12
Block 3: Frontalis Magnitude (suppress)	-1.96**	.75	-.27

Note. $R^2 = .57$, $F(7, 73) = 14.25$***.

*$p < .05$. **$p \leq .01$.

Table 5

Study 2: Regression Analyses Predicting Depressive Symptoms from T1 Depression, RDR Magnitude in the Uninstructed Condition and RDR Magnitude from 300 to 1000 ms Post Stimulus Onset in the Communication Goal Condition in Response to Angry Faces (N = 86)

Model 1 Predictors	*B*	*SE*	β
Block 1: T1 Depression	.60***	.10	.58
Block 2: Zygomaticus Magnitude (uninstructed)	-8.48	13.48	-.10
Block 2: Corrugator Magnitude (uninstructed)	20.42*	8.86	.23
Block 2: Frontalis Magnitude (uninstructed)	10.17	13.60	.09
Block 3: Zygomaticus Magnitude (respond)	14.09***	4.25	.32
Block 3: Corrugator Magnitude (respond)	2.69	3.62	.09
Block 3: Frontalis Magnitude (respond)	-9.64	6.46	-.18
Model 2 Predictors			
Block 1: T1 Depression	.60***	.10	.58
Block 2: Zygomaticus Magnitude (uninstructed)	-8.48	13.48	-.10
Block 2: Corrugator Magnitude (uninstructed)	20.42*	8.86	.23
Block 2: Frontalis Magnitude (uninstructed)	10.17	13.60	.09
Block 3: Zygomaticus Magnitude (suppress)	-.66	6.97	-.09
Block 3: Corrugator Magnitude (suppress)	-11.03	12.00	-.13
Block 3: Frontalis Magnitude (suppress)	37.35***	13.55	.33

Note. Model 1: $R^2 = .46$, $F(7, 73) = 8.89$***. Model 2: $R^2 = .44$, $F(7, 73) = 8.31$***.

*$p < .05$. ***$p < .001$.

Appendix B

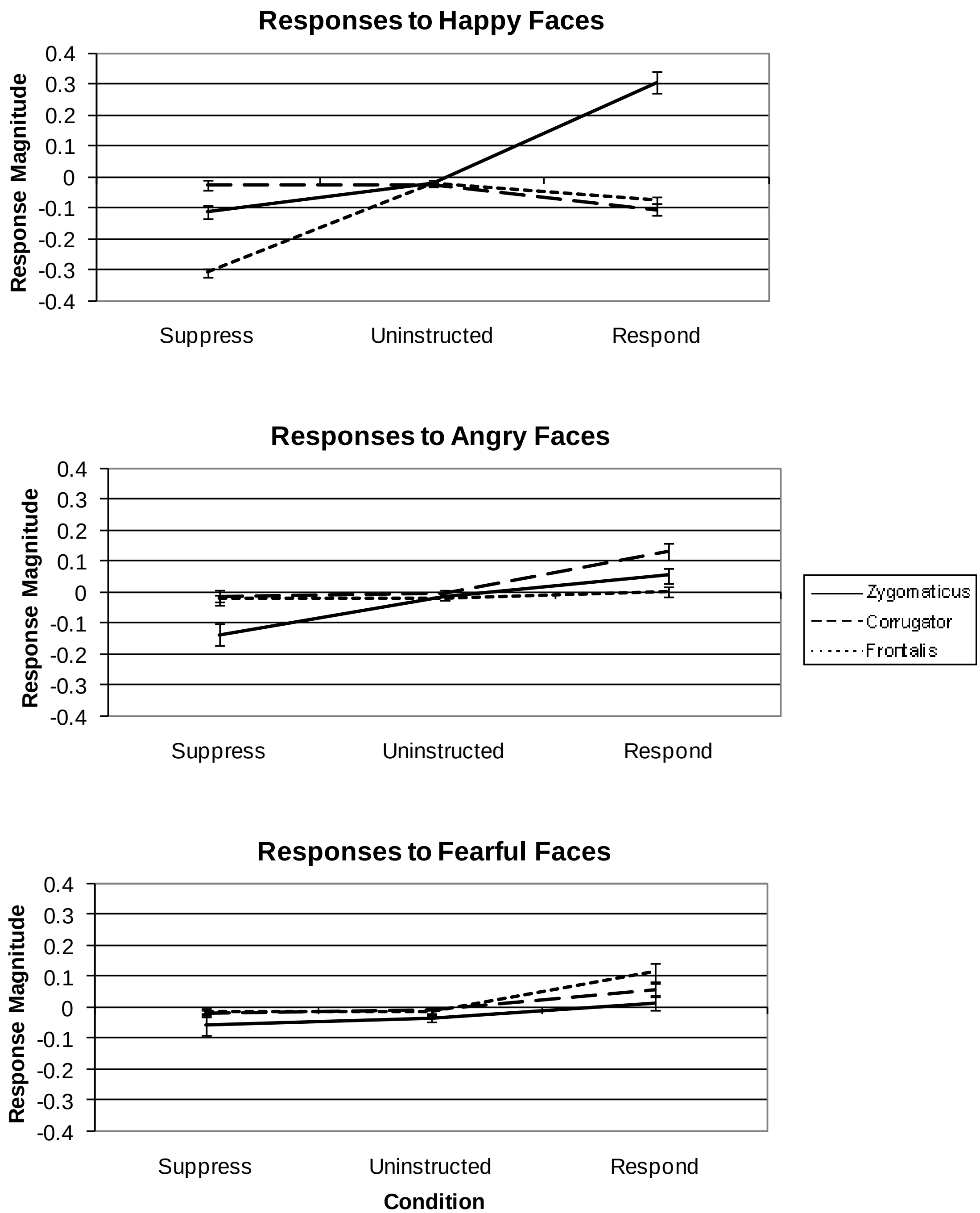

Figure 1. Magnitude of each muscle elicited in response to each stimulus type in each of the three communicative goal conditions (Study 1).

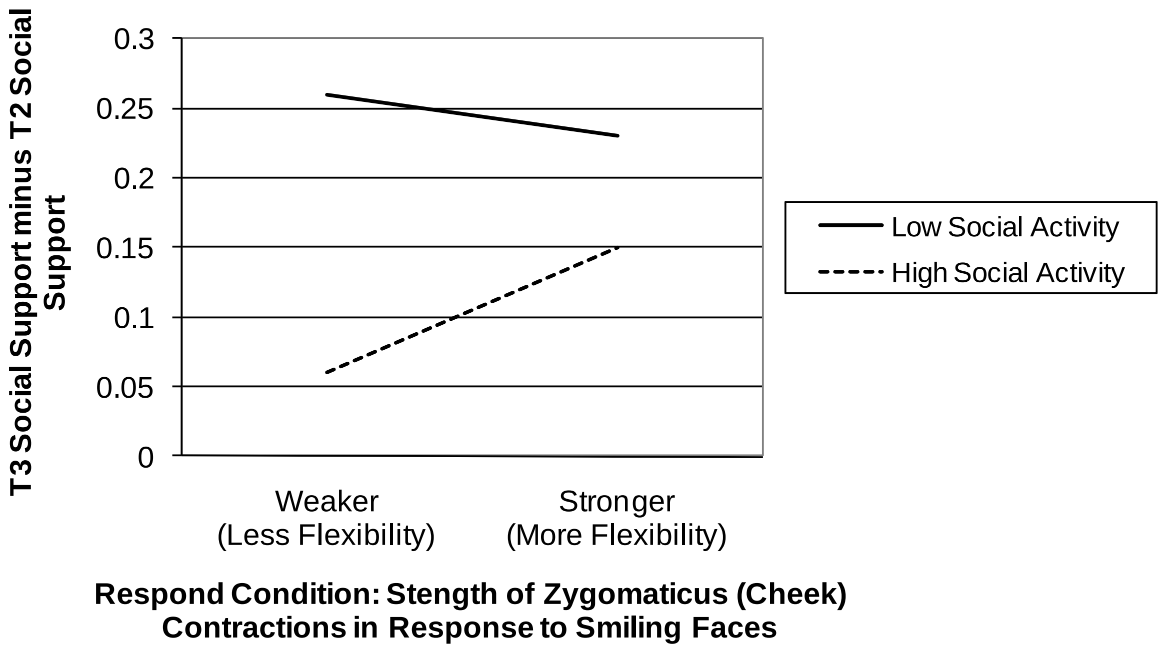

Figure 2. Change in social support from T2 to T3 as a function of zygomaticus (cheek) contractions in response to smiling faces in the respond condition (+/- 1 SE) and social activity as measured by the number of Facebook friends added in the 45 days prior to T2 (+/- 1 SE).

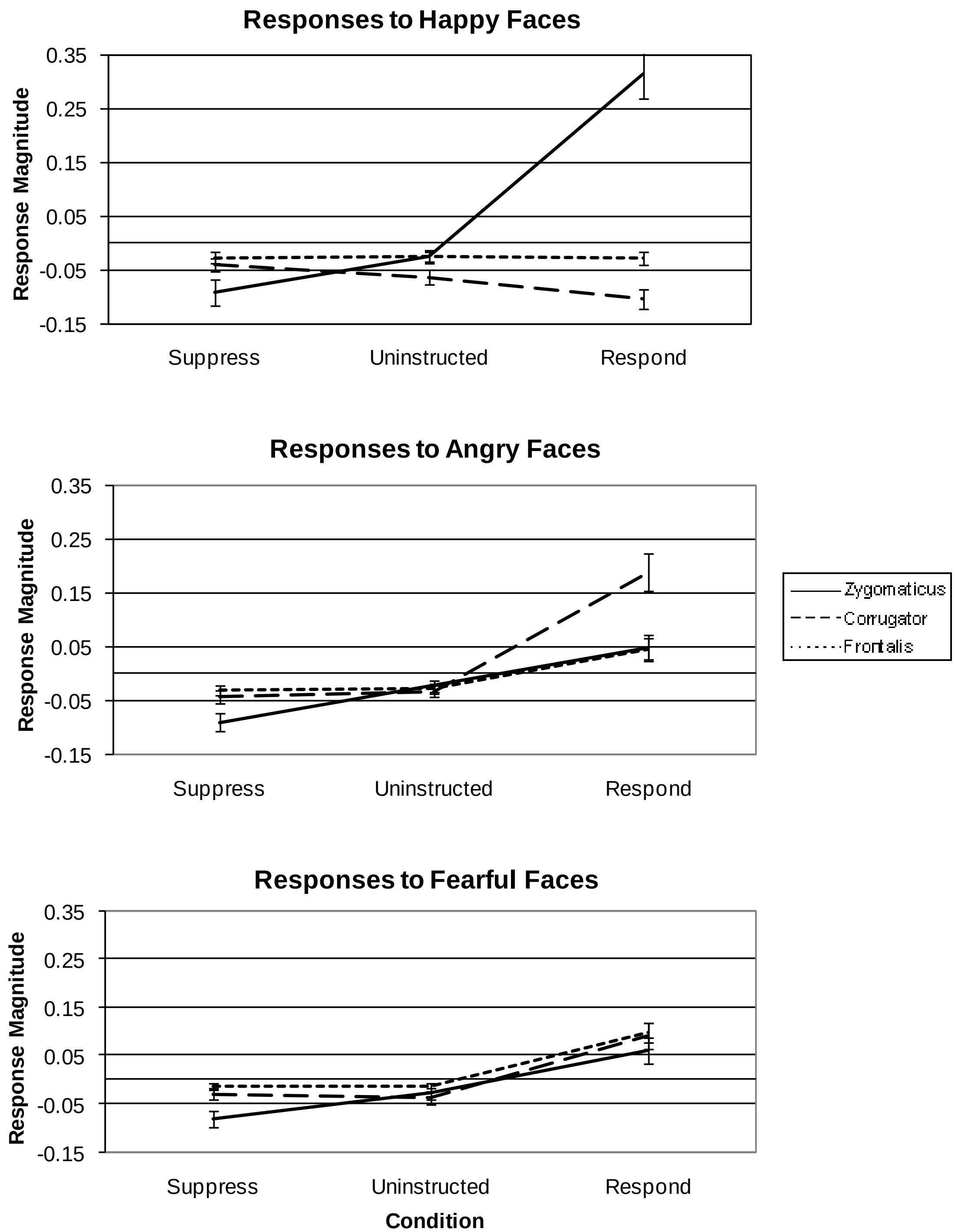

Figure 3. Magnitude of each muscle elicited in response to each stimulus type in each of the three communicative goal conditions (Study 2).

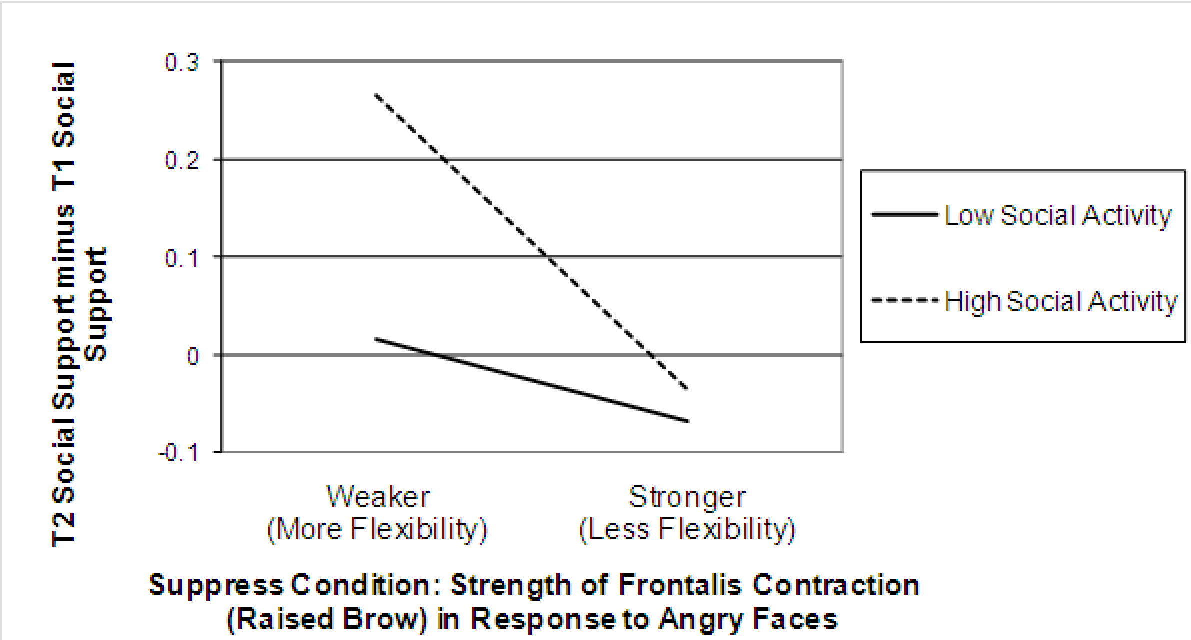

Figure 4. Change in social support from T1 to T2 as a function of the magnitude with which frontalis (responsible for raising the brow) was activated in response to angry faces in the suppress condition (+/- 1 SE) and social activity as measured by the degree to which support was sought from others (+/- 1 SE).