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Emotion in Motion: Investigating the Relationship between Interpersonal Motor Coordination and Emotional States

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EMOTION AND INTERPERSONAL MOTION

Abstract

The present study investigated the relationship between a person's emotional state and interpersonal coordination. Researchers primed fifty-one participants to either be angry or happy through a writing prompt. Participants did an arm curl activity while watching a video-taped confederate doing arm curls at a set pace with a congruent or incongruent emotion. The participants were told that this video was a projected live stream. Finally, participants completed measures of post-activity emotions and rapport with and likeability toward the confederate. Our experimental design included an independent samples t-tests to examine the effect of congruency on interpersonal coordination, post-activities, and rapport with the confederate, and one-way ANOVAs to understand the effect of the conditions on interpersonal coordination, post-activity emotions, confederate likeability, and confederate rapport. There was no significant main effect difference of conditions on level of coordination and no significant difference of congruency on coordination. There was a significant effect for condition on sadness and a trending effect on anger and disgust, such that having an angry primed emotion and seeing an angry confederate resulted in higher negative emotions. There was a significant effect of congruency on anger, meaning that those that had incongruent primed emotions to the confederate had increased anger compared to those with congruent emotions. There was no significant difference between conditions or congruency for likeability measures; however, there was a significant difference of condition on rapport ratings, with participants who were primed happy and saw the happy confederate or were primed angry and saw the happy confederate had higher rapport ratings with the confederate compared to any other conditions. Therefore, the results suggest that there is a complex relationship between emotion and interpersonal coordination.

Keywords: Interpersonal, coordination, emotion, rapport, likeability

Emotion in Motion: Investigating the Relationship between Interpersonal Motor

Coordination and Emotional States

Humans are social creatures that desire to interact and engage with others, and this social interaction is more intertwined with movement than one may think. It is seen in simple behaviors like coworkers shaking hands, friends walking to class together, or two people dancing. In general, there is more to movement than the action itself. Rather, movement should be thought of in a perception-action framework, such that the environment and the movement itself are both important. The context of the environment of an action is often ignored due to an ego-centric view of behavior that negates the embodied and embedded relationship of the physical body and mind to the environmental contexts it experiences (Richardson et al., 2011; Niedenthal et al., 2005).

Interpersonal coordination

When people interact, their movements may lead to coordination over time, and sometimes these rhythmic movements in some environments can become synchronized between people (Lumsden et al., 2011). This spontaneous interpersonal synchronization may not occur for long durations, and the amount of synchrony among the movement coordination between two people has a large amount of individual variation (e.g., Lumsden et al., 2011). The variation in the level of interpersonal synchrony may be the result of many social factors. Specifically, in regard to the embodied approach that is present in dynamical system theories, various social constructs are connected to movement coordination (e.g., Michael, 2011; Hove & Risen, 2009). Thus, this movement coordination both affects and is affected by the social aspects of one's environment.

Emotion interaction

One social aspect that has an established relationship with coordination is emotion. This relationship has been built on the idea that even on a neurological level, emotion experiences and motor schemas are related and have the ability to activate each other (Anderson et al., 2012). This general embodiment of motor coordination and emotion on an intrapersonal level has then been expanded to the interpersonal dynamics of movement coordination and emotion. In general, it is known that this embodiment is involved in how one processes different emotions, as there is a reciprocal relationship between emotion and interpersonal interaction (Niedenthal et al., 2005).

The research on emotion interaction, generally speaking, is primarily focused on facial feedback. In other words, researchers find that the way a person arranges their face can ultimately affect their emotions, rather than just the traditional understanding of the emotion itself telling the person how to fixate their expressions. Thus, facial expressions provide feedback about one's emotional state. When one mimics another's facial expression, the mind interprets the meaning of the expression in order to help one perceive emotion (Dimberg et al., 2000; Neal & Chartrand, 2011). The effect of facial feedback on emotion perception has been examined in the past. In particular, perception becomes less accurate when facial feedback is restricted and can be increased when facial feedback is enhanced (Neal & Chartrand, 2011). This pattern of accuracy is consistent regardless of whether the facial feedback was positive or negative.

Emotion congruency and social factors

Furthermore, facial feedback is a relatively automatic feature, outside of awareness (Niedenthal et al., 2005). When another person is physically present, one embodies the other's behavior, specifically through their innate tendency to imitate another's facial expression (Dimberg et al., 2000; Niedenthal et al., 2005). The congruency of these emotion expressions can

lead to feelings of empathy (Niedenthal et al., 2005) as well as impact judgments on another person. The congruency of the action can give rise to positive emotions toward the other person (e.g., Reigenberg et al., 2012). However, this emotion judgment is impacted by the current emotional state of the perceiver. Such that, if the emotion of the person and the target are congruent, the emotion perception will be more accurate; whereas if the person and the target have incongruent emotions, the judgment of the emotion will be less accurate (Niedenthal et al., 2002). Therefore, while restricting or enhancing emotional feedback can impact the accuracy of emotion perception, the ability to judge another person's emotion also depends on one's current emotional state. It is then evident that there exists some relationship between coordination and emotion, and this relationship is seen more in emotion's involvement in other social factors.

As previously explained, sharing emotions can facilitate emotion perception, emotion contagion (i.e. taking on the same emotion as the other person) and empathy; however, shared emotions can also result in increased feelings of rapport (Michael, 2011). It is within interpersonal facial feedback coordination that rapport develops, as it signals to another a form of mutual interest. Conversely, feelings of rapport can affect this same unconscious facial mimicry, resulting in a circular effect of rapport and emotion (Michael, 2011).

Interpersonal coordination and social factors

These social factors can then be explored in the context of larger interpersonal coordination. Again, there is a bidirectional impact of interpersonal coordination and social factors, and research has examined both of these directions. The more two or more people synchronize, the more it positively affects the perception of the other person involved in the coordination. Synchronous movements have been found to affect a feeling of belonging and closeness (Lumsden et al., 2014), increased interpersonal support (Miles et al., 2009), and

increased rapport (Miles, 2009). Moreover, due to the general positive attitudes and harmonious feelings generated from easy coordinated movement, the other person is found to be more likable and friendly (Marsh et al., 2009), even to the extent of increased affiliation with the other person (Hove & Risen, 2009).

On the reverse, initially having these attitudes and social perceptions will affect the ability to coordinate. Such that, liking the other person will actually result in increased synchrony as the task progresses (Zhao et al., 2017). For example, Lumsden and colleagues (2011) tested how one's cooperative social nature impacts their ability to coordinate. They primed participants to have a pro-social, individualistic, or competitive mindset and calculated the amount of spontaneous interpersonal coordination one had with a confederate doing an arm curl activity. This research suggests that the psychological mindset of being pro-social, whether innate or primed, results in a greater amount of coordination in movement between two people. Regardless of whether the research measures social factors' impact on coordination or coordination's effect on social perception, there is a connection between interpersonal coordination and positive emotions, attitudes, and perceptions.

Group dynamics and social dynamics

Extending this research further into group dynamics, there is vast research in the area of group identity, specifically the impact of associating as part of an in-group or out-group (e.g., Miles et al., 2011). There is limited research on the affiliation of being a part of a group in regard to interpersonal coordination. Miles and colleagues (2011) examined this question through assigning participants different colored stickers, which represented being a part of a group. The participants were either congruent or incongruent with the confederate's sticker and asked to perform an arm curl activity while watching the confederate on a video screen. Researchers

measured the synchrony between the participant and the confederate and found that all groups coordinated. The participants that were told the explanation about the colored sticker (art preferences) had a difference in the level of coordination, such that those that had a different sticker than the confederate, and thereby considered the confederate part of the out-group, actually had a higher level of coordination. Previous research with similar results proposed that coordination was only needed for people without a commonality, as interpersonal coordination could be an attempt to reduce intergroup differences (Cross et al., 2019). However, given the fact that positive feelings toward others influence perception of being part of the same in-group (e.g., Dovidio et al., 1995) and research indicating that positive feelings toward another person will increase synchrony (e.g., Zhao et al., 2017), this research needs to be further examined to understand group affiliation in regard to interpersonal coordination. Furthermore, research should examine the potential effects that emotion may have on identifying as part of a group, coordinating with another person, and forming a perception of another as a result.

The current study

Therefore, the present study purposed to build on previous research on interpersonal motor coordination to determine whether a person's emotional state can affect their coordination with another, and whether the level of the measured coordination would impact their end-state emotions as well as their likability of and rapport with another person. Participants were initially primed to elicit emotions of anger or happiness through an autobiographical prompt. After which, participants were instructed to perform an arm curl activity while viewing what they were told was a live video stream of another participant in the adjoining room (adapted from Miles et al., 2009). The live video was in fact a pre-recorded video of a confederate, congruent to the participant's gender, who was performing the arm curl activity at a set rate. The participants

viewed either a confederate performing the arm curls with a happy (e.g., smiling) or an angry (e.g., grimacing) expression, which was either congruent or incongruent to the emotional prime of the participant. Participants then took a questionnaire that measured their post-coordination emotion, their perception of rapport with the confederate, and their likeability toward the confederate.

Hypotheses

H1: We expected that those participants whose emotions were congruent with the confederate's emotion associated the confederate with their ingroup, whereas those participants whose emotions were incongruent with the confederates would associate the confederate as someone different and thus part of the outgroup (Zhao et al., 2017; Dovidio et al., 1995).

H2: We predicted that those participants with a congruent emotion to the confederate would have higher level of synchrony than those participants that were primed with an incongruent emotion to the confederate, regardless of the type of emotion (Regenberg et al., 2012; Neal & Chartrand, 2011).

H3: In regard to the perception of the confederate, we expected that those participants congruent in emotion with the confederate, and thus seeing the confederate as part of their ingroup, would report higher levels of rapport with and likeability toward the confederate compared to those participants incongruent with the confederate.

H4: Finally, we predicted that the participants in the incongruent emotion conditions would report changes in their emotions, such that their post-coordination emotions would become closer to the emotion of the confederate (Niedenthal et al., 2005, 2002; Dimberg et al., 2000).

Method

Participants

Participants consisted of fifty-seven undergraduate students at a small liberal arts college. Three of these participants were excluded due to data collection errors, resulting in fifty-four participants, ranging in age from 18 to 23 (M age = 20.45 years; SD = 0.88; 35 females). The participants were recruited through various locations across campus and by different methods, such as reaching out to clubs and sending recruitment emails. The participants partook in the research for approximately 20 minutes.

Materials

Emotion prime prompt. In order to prime and elicit specific emotions, an emotional prompt was randomly presented to the participant. The prompts were adapted from Caasanto and Dijkstra (2010) and have reliably shown to produce a negative or positive emotion through thinking about an autobiographical event. The prompt to elicit happiness was *Please write about a time that you had a lot of fun*. The prompt to elicit anger was *Please write about a frustrating event that you experienced*.

Arm curl activity weights and software. Both the instructions and design for the arm curl activity, were adapted from Miller and colleagues (2011). For the arm curl activity, weights of 2kg were used. Participants were instructed to perform an arm curl with the weight held vertical in their arms. The participant's arms were fully extended and fully flexed to their chest during the activity (See Figure 1). To measure the motor movement of the arm curls, the motion was recorded at 60 Hz using a magnetic tracking system (Polhemus G4, Polhemus Corporation, Colchester, VT) and 6-D Research System software (Skill Technologies, Inc., Phoenix, AZ). The G4 device was attached to the participants' clothing and each source sensor was attached to one of the weights. The sensors connected to the weights were consistently in the same hand across

all participants. The G4 software recorded the sensors' movements about the physical space. Each participant's file of activity was saved under the participant's randomized identification number on a secure computer.

Confederate Video. The participants saw one of four potential videos of confederates. Participants were told that these videos were a live stream recording of another participant in an adjoining room, rather than a pre-recorded confederate. The video / "live stream" was projected on a wall in the testing room with a projector connected to a computer. The confederate videos were adapted from Miles et al. (2011). The video was taken in a different room than the testing room for both the male and female confederates. The confederates were undergraduate age and strangers to the participants from another college. The confederates did the arm curl activity with either a happy face (e.g., smiling) or an angry face (e.g., grimacing). The confederates in the video had their movement recorded in the same manner as the participants. In order to control the confederates' movements, they performed the arm curl activity for 60 seconds to the beat of a metronome at 1.4 Hz (Miles et al., 2011).

Questionnaires. There were four questionnaires used that were developed specifically for this project. The first measured post-activity emotion ratings. The questionnaire used a 5-point Likert scale of agreement for five of the basic emotions (i.e., surprised, angry, disgusted, happy, sad). The second questionnaire measured the perception of rapport with the confederate, using an agreement 5-point Likert scale. There were ten items the participants rated their perception of the confederate on. The questionnaire had five positive-keyed and five negative-keyed items (See Figure 2). All items on the questionnaire were synonyms or antonyms to rapport. The third questionnaire measured the likeability of the confederate, using a 5-point Likert scale (See Figure 3). The participants rated the likelihood that the confederate was the

type of person they would spend more time with (See Figure 4). There were five positive-keyed and five negative-keyed expressions. The final questionnaire asked demographic questions about gender, ethnicity, and age. All participants were also asked if they were suspicious of anything from the study.

Procedure

When participants entered the lab, they were greeted and told that the study was to examine the relationship between emotions and exercise, both alone and with another person. Participants filled out a consent form. The researcher explained to the participants that they would complete a writing assignment, an arm curl weight activity, a series of questionnaires, and an interaction activity with another participant. The participants were randomly assigned ID numbers and condition types before coming to the laboratory.

Once the consent process was complete, participants read and responded to either a happy or an angry autobiographic prompt. The participants had one minute to think about the prompt and another two minutes to write and respond to the prompt. Researchers saved these prompts under the participants' ID number on a secure computer and read at a later point of time to ensure that the prompt elicited the correct emotion. After the emotional priming condition, the researcher demonstrated the arm curl activity for the participants, instructing the participants to hold the weight vertically and fully extend and flex in their movement. Then the researchers attached the Pohlemus device to the participants and their weights. The researchers informed the participants that they would see a live-stream video of another participant in an adjoining room, but they were instructed not to try to communicate until the last activity of the study when they would interact in a discussion (this was modelled after Miles et al., 2014). The pre-recorded video of a confederate was then projected on the wall, and it was matched to the participant's

gender. Participants either saw a happy or an angry confederate that either was congruent or incongruent with their emotional prime. Researchers began the recording software of the Pohlemus motion device and instructed the participants that they were beginning to video record them as well. The participants did the arm curl activity for 60 seconds while the pre-recorded confederate video played. Afterwards, the participants completed a series of questionnaires about emotion, rapport with and likability toward the confederate, and demographic information. Researchers then told the participants that the study was over and that there was not going to be an interaction with another participant, as the other participant was a pre-recorded confederate. The researcher fully debriefed the participants regarding the video deceit and the project's goals and expected results.

Results

We excluded another 3 total participants, one person for suspecting the correct study hypothesis and two people with outlying data (larger than three SD), for a total of 51 participants. There was approximately an even distribution of participants in each condition. Preliminary analyses found no significant effects or interactions between participant sex. Thus, the analyses were conducted collapsing across both sex variables. For increased power in some analyses, the conditions were split into two groups: congruent and incongruent. There was approximately an even distribution of participants in each congruency group.

To confirm that the participants had successfully been primed to elicit either a happy or angry emotion through the emotion priming prompt, a manipulation check was completed. All participants wrote only about the emotions they were primed to write. Therefore, all conditions were expected to accurately reflect the primed emotions.

To examine the effect of congruency (congruent vs. incongruent) on level of interpersonal coordination, we conducted an independent samples t-test. Here, coherence is a measure of interpersonal coordination, with 0 as an indication of no coordination to 1 as an indication of perfect coordination. There was no significant difference in coherence whether or not the participant had been primed congruent or incongruent emotions with the confederate, $t(49) = -.36, p = .718$ (See Figure 6). Thus, these results suggest, contrary to H2, that condition and the congruency of participant and confederate emotions did not impact the amount of coordination the participant had with the confederate.

To further understand how the congruency of these emotion conditions impacted the post-activity emotions, an independent t-test was conducted comparing congruent and incongruent groups. There was no significant effect for surprised, $t(49) = .43, p = .670$, disgusted, $t(49) = -2.05, p = .148$, happy, $t(49) = .12, p = .902$, nor sadness, $t(49) = -.88, p = .390$. There was a significant effect of congruency on anger, $t(49) = -2.05, p = .046, d = .57$, with the congruent group ($M = 1.10, SD = .40$) having less anger than the incongruent ($M = 1.47, SD = .81$) group. Thus, participants whose primed emotions were congruent to the confederate's displayed emotion reported less anger than those who had incongruent emotions.

To understand whether the emotion congruency of these conditions affected rapport with the confederate, we conducted an independent samples t-test. There was no significant difference in rapport ratings of the confederate for participants that had congruent or incongruent emotions with the confederate, $t(49) = 1.05, p = .301, d = .29$. This finding suggests that the congruency of the participants' primed emotion and the confederates' displayed emotion did not impact their perceived rapport with the confederate.

To determine the effect of conditions on level of interpersonal coordination, we conducted a one-way ANOVA with condition (Participant: Happy – Confederate: Happy, Participant: Angry – Confederate: Happy, Participant: Happy – Confederate: Angry, Participant: Angry – Confederate: Angry) as a between-subjects factor. The dependent variable was the level of coherence, with 0 as an indication of no coordination to 1 as an indication of perfect coordination. There were no significant effects of condition on coherence, $F(3, 47) = 1.03$, $p = .388$, $\eta^2 = 0.06$ (see Figure 5).

To examine how the conditions, and thus the confederate's displayed emotion, impacted participants post-activity emotions, we conducted a one-way ANOVA with conditions (P:H – C:H, P:A – C:H, P:H – C:A, P:A – C:A) as the between-subjects factor. The dependent variables were the five basic emotion self-ratings. There was a significant effect for condition on sadness, $F(3, 47) = 3.20$, $p = .032$, $\eta_p^2 = .17$. Fisher's Least Significant Difference (LSD) post-hoc tests revealed that the Angry-Angry condition differed significantly from each of the other three conditions, such that participants who were primed to be angry and saw an angry confederate had higher self-reports of sadness than those who were primed to be happy and saw a happy confederate ($p = .032$), than those who were primed to be angry and saw a happy confederate ($p = .005$), and compared to those who were primed to be happy and saw an angry confederate ($p = .049$). There was a trending effect of condition on the emotion of anger, $F(3, 47) = 2.46$, $p = .074$, $\eta_p^2 = .14$, and another trending effect of condition on disgust, $F(3, 47) = 2.30$, $p = .089$, $\eta_p^2 = 1.13$. The trending result of anger was driven primarily by the significant difference between the P:H – C:A condition and the P:A – C:A condition, such that there were higher self-ratings of anger for those that experienced an anger prime and an angry confederate compared to those that elicited happiness before seeing the angry confederate ($p = .012$). The trending result of disgust

was driven by significant differences of the P:A – C:A condition compared to the P:A – C:H condition and the P:H – C:A condition, such that those that experienced both an angry prime and an angry confederate had higher ratings of disgust than those that experienced an angry prime and a happy confederate or a happy prime and an angry confederate ($p = .043$). There was no significant effect of condition on happiness, $F(3, 47) = .42, p = .739$, nor for the emotion surprised, $F(3, 47) = .39, p = .759$. These results taken together suggest that conditions did affect the emotional state of the participants, similar to H4, in which participants had higher rates of the negative emotions of sadness, anger, and disgust when they had an angry prime and an angry confederate.

To quantify likability, we calculated a composite score based on the positive-keyed and negative-keyed questions, which resulted in a total score out of 50. A higher composite score indicated higher levels of likeability toward the confederate. To explore the effect of experiment condition on likeability, we conducted a one-way ANOVA with condition (P:H – C:H, P:A – C:H, P:H – C:A, P:A – C:A) as the between-subjects factor, and the likeability composite score as the dependent variable. There was no significant difference between conditions for likeability, $F(3, 43) = 2.30, p = .091, \eta_p^2 = .14$. To examine whether congruency of emotion affected likability, we conducted an independent samples t-test. There was no significant difference for likeability between congruent and incongruent conditions, $t(49) = .15, p = .878, d = .04$. Taken together, these results suggest that the participants' primed emotions and the confederates' displayed emotions did not impact the likability toward the confederate, contrary to H3.

To quantify rapport, we again calculated a composite score, based on the positive-keyed and negative-keyed items, which resulted in a total score out of 50. A higher composite score demonstrated higher levels of rapport with the confederate. To investigate the effect of condition

on rapport, we conducted a one-way ANOVA, with condition type (P:H – C:H, P:A – C:H, P:H – C:A, P:A – C:A) as the between-subjects factor and rapport composite score as the dependent variable. There was a significant difference in the effect of condition on rapport ratings, $F(3, 43) = 6.51, p = .001, \eta_p^2 = .31$ (see Figure 7). We conducted Fisher's Least Significant Difference (LSD) post-hoc tests to further understand the relationship of condition and rapport. Post-hoc tests revealed that the P:H – C:H condition differed significantly from the P:H – C:A condition and the P:A – C:A condition, such that participants who were primed to feel happy and saw the happy confederate, had higher perceived rapport with the confederates than participants who were primed to be happy and saw an angry confederate ($p = .010$) or had higher perceived rapport with the confederate than participants who were primed to be angry and saw an angry confederate ($p < .001$). There was no significant difference between the P:H – C:H condition and the P:A – C:H condition.

Post-hoc tests also showed that the P:A – C:H condition differed significantly in rapport ratings compared to the P:H – C:A condition and the P:A – C:A condition, indicating that participants who were primed to be angry and saw a happy confederate had higher perceived rapport with the confederate than participants who were primed to be happy and saw an angry confederate ($p = .015$) or had higher perceived rapport with the confederate than participants who were primed to be angry and saw an angry confederate ($p < .001$). There was a trending significant difference between the P:H – C:A condition and the P:A – C:A condition, such that those who were primed happy and then saw an angry confederate had higher perceived rapport with the confederate than those that were primed angry and saw an angry confederate ($p = .089$).

Discussion

The present study explored the relationship of emotions and interpersonal coordination, specifically whether an original emotional state and another person's emotional state can affect one's ability to coordinate on an interpersonal motor task, and whether this coordination impacts how a person perceives another in regard to likeability and rapport. Contrary to what we predicted, the conditions and congruency of the participant's and confederate's emotions did not affect the level of interpersonal coordination. However, the findings do suggest that the conditions impacted the post-activity emotions in regard to negative emotions of anger, sadness, and disgust. The findings also suggest that condition type affected the perceived rapport with the confederate, whereas the conditions had no effect on the perceived likeability toward the confederate. Therefore, it is apparent that the findings suggest a complicated relationship between emotion and interpersonal coordination.

To our surprise, there was an overall lack of interpersonal coordination. The participants coordinated less with the confederate than expected. Given previous research from Lumsden and colleagues (2011), we anticipated a range of coordination; however, all our participants had limited levels of interpersonal coordination, regardless of their condition. One possible explanation for this lack of coordination could be the speed in which the confederate completed their arm curl activity. The metronome speed for the confederate was set at 1.4 Hz. This frequency was chosen based on the research conducted by Miles and colleagues (2011). However, other research has examined the level of interpersonal coordination that occurs with different frequency bands. For example, Fukiwara and Daibo (2016) determined that the coherence value decreases as the frequency increases. They proposed that the frequency range of 0.2 – 0.5 Hz leads to larger amounts of interpersonal coordination. Other research has also suggested that similar low frequencies of below 0.5 Hz leads to higher coordination levels

between participants (Schmidt et al, 2012). Therefore, it is possible that the absence of an effect of condition on interpersonal coordination was a result of the overall lack of coordination from too high of a frequency of motor movement. Another potential reason for these participants not coordinating with the confederate could be a result of the confederates used in the study. The male confederate was very tall. Therefore, the amplitude in his arm movements would be larger, which would affect his movement and thus the coherence data. Everyone has very different natural frequencies of movement given their size and makeup, and these different frequencies can impact the ability for a dyad to coordinate (Miles et al., 2011).

Despite having no interpersonal coordination, the perceived relationship of the participant and the confederate was impacted by the activity, specifically by the primed emotion of the participant compared to the displayed emotion of the confederate. Overall, those participants with incongruent emotions to the confederate were angrier than those participants with congruent emotions to the confederate. This finding suggests a level of frustration that can occur when someone has a different emotion than you (Shafir, Tsachor, & Welch, 2016). Furthermore, because shared emotions can result in increased feelings of empathy and rapport (e.g., Michael, 2011; Regenberget al., 2012), the participants with congruent emotions may overall feel more positive, which could decrease their level of anger.

More specifically, dependent on the condition type, participants had a difference in their post-activity self-reported emotion. Participants reported relatively high levels of surprise and happiness post-activity regardless of their condition. However, the participants reported the negative emotions of sadness, anger, and disgust differently among the conditions. Participants that were primed to be angry and saw the angry confederate had higher levels of sadness, anger, and disgust compared to participants who were primed to be happy and saw an angry confederate

or were primed to be angry and saw a happy confederate. The increased levels of negative emotions for those in the Angry-Angry condition may be a result of the fact that anger mimicry is weak (Olszanowski, Wrobel, & Hess, 2019). Thus, when participants saw the angry confederate despite being primed with the happy emotion prompt, they did not take on the negative emotion strongly. Also, because of the strength of happiness mimicry (Olszanowski et al., 2019), those that had the angry prompt were not as angry after the activity with the happy confederate, as the happy expression of the confederate served as a buffer for the angry prompt. Therefore, the combination of having the angry primed emotion and seeing another person angry resulted in the highest levels of negative emotions compared to any of the other combinations of happy and angry prompts and confederates.

Because of the lack of interpersonal coordination present, the impact of the conditions on rapport and likeability must be due to the emotion manipulation itself. There were differences between conditions for perceived rapport with but not for likeability toward the confederate. These differences in rapport ratings did not occur due to the congruency of the primed emotion and the confederate emotion; therefore, the increased ratings of rapport for some of the conditions is not a result of in-group and out-group dynamics as we originally predicted. The limited difference of congruent and incongruent groups on rapport and likeability could be due to the fact that emotion itself is not a large enough indication of being a part of the in-group and out-group as it is a small visual cue (Miles et al., 2011).

Even though group dynamics were not a factor in this study, the emotion conditions themselves impacted how the participants viewed the confederate. Contrary to our predictions, likeability had no differences in regard to condition type. However, one explanation of this finding may be due to the fact that likeability is closely tied to interpersonal coordination.

Previous research has found that higher levels of interpersonal coordination increases the perceived likeability and friendliness of the other person (Marsh et al., 2009). Perhaps, without any coordination between the dyads, the participants were unable to form a harmonious feeling with the confederate and thus did not report the confederate as being likeable.

However, perceived rapport did change depending on the participants condition, such that both conditions that saw a happy confederate, regardless of their primed emotion, had significantly higher ratings of rapport with the confederate compared to those participants that saw an angry confederate. This result may be driven by the facial feedback effect triggered by the confederate. The confederate's facial expressions allowed the participants to understand the meaning of their expressions and conclude whether the confederate was happy or angry. The concept of emotion contagion, or taking on another's emotions (Olszanowski et al., 2019; Dimberg et al., 2000; Niedenthal et al., 2005), could be a factor in this rating of rapport. Because people are better able to facially mimic happy emotions (Olszanowski et al., 2019), the participants could have unknowingly taken on the confederate's happy emotion through mirroring their smiling expression. Thus, the more the participants took on the confederate's happy expression, the higher levels of rapport they may have reported with the confederate. In general, smiles, the basic expression of a happy emotion, suggest a closeness and facilitate a bond between dyads (Olszanowski et al., 2019; Bernieri et al., 1996). Therefore, the fact that the confederates displayed a smiling face throughout the 60 second arm curl activity implies to the participants a mutual attentiveness and positivity that is important in building rapport (e.g., Bernieri et al., 1996). This connection through smiling felt with the happy confederates explains the increased perceived rapport that those participants who saw the angry confederate were unable to achieve.

It is surprising that these results were not similar for likeability ratings as for rapport ratings. One possible explanation for the difference in the likeability and rapport findings could be due to the question types presented to the participants. The rapport questionnaire was created using synonyms and antonyms associated with rapport. The questions presented an adjective to rate the confederate on a Likert scale. The likeability questionnaire was similar to the rapport questionnaire as a Likert scale was used; however, instead of a 5-point agree-disagree scale, the likeability questions used a 5-point likely-unlikely scale. The likeability questionnaire also differed from the rapport questionnaire as it focused more on actions (e.g., how likely are you to get a meal with or to avoid on your way to class). Potentially, posing the questions as an action decision was difficult for participants to imagine given the fact that the confederate was a complete stranger. Thus, this study's questionnaire may not be effective in determining the perceived likeability of the confederate. However, other questionnaires about likeability (e.g., Reysen, 2005) used action statements to measure likeability in a similar manner to the questionnaires used in this study, so the questionnaire structure itself cannot be the only factor that impacted the difference in likeability and rapport ratings.

Another potential explanation is the fact that rapport is more of a social construct than likeability. Rapport involves a shared dyadic interaction (Bernieri et al., 1996) that likeability does not necessarily entail. Likeability is defined by attractiveness, similarity to ourselves, compliments, and association (Reysen, 2005), suggesting a more individual rather than relational definition. Therefore, because the judgment of the confederate relied on the interpersonal activity and because rapport is understood as a connection between at least two people, rapport measures in this study would be more likely influenced than likeability.

This study's findings about interpersonal coordination, emotion, rapport, and likeability could imply that even without coordination, another person's emotional expressions could impact one's emotional state as well as one's feelings of rapport with another person. Further research, however, would be needed to better understand whether interpersonal coordination has an effect on this established relationship. Conducting a replication of this study with a lower frequency for the confederate could potentially provide coordination data that is needed to understand the potential benefits of syncing up in motor movement with others. Moreover, while participants did not outright report a suspicion of the projected "live-stream," another potential direction would be to repeat this experiment with a real live-feed of a confederate or even having a confederate present in the room. Furthermore, the study overall provides more insight into emotion feedback and its relationship with rapport and likeability. More research should explore the differences in likeability and rapport findings to determine if the difference found is simply due to the type of questions asked or if it is a result of a different innate understanding of likeability and rapport in regard to a dyadic relationship. Also, given the complexities of emotion seen in the post-activity emotion findings, a future study should replicate this study with other emotions to understand the impact of various types of negative and positive emotions on coordination and rapport and likeability.

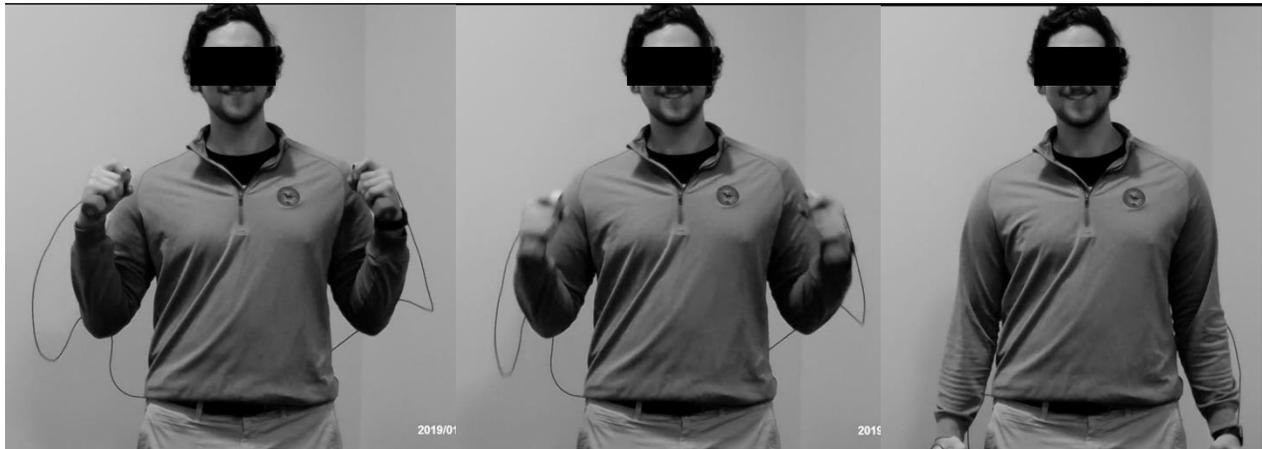
Overall, the relationship between emotions, coordination, likeability, and rapport is very complicated. The current study tried to further our understanding of this complicated system with the idea that more knowledge of these relationships may allow us to better understand disorders characterized with interpersonal deficits and/or repetitive movements, like Autism Spectrum Disorder (ASD) or Tourette's syndrome. Insight into these relationships could help develop better treatments targeted toward these specific challenges.

References

- Anderson, M. L., Richardson, M. J., & Chemero, A. (2012). Eroding the boundaries of cognition: Implications of embodiment. *Topics in Cognitive Science*, 4(4), 717-730. doi:10.1111/j.1756-8765.2012.01211.x.
- Bernieri, F. J., Gillis, J. S., Davis, J. M., & Grahe, J. E. (1996). Dyad rapport and the accuracy of its judgment across situations: A lens model analysis. *Journal of Personality and Social Psychology*, 71(1), 110–129. doi: 10.1037/0022-3514.71.1.110.
- Casasanto, D., & Dijkstra, K. (2010). Motor action and emotional memory. *Cognition*, 115(1), 179–185. <https://doi.org/10.1016/j.cognition.2009.11.002>
- Cross, L., Turgeon, M., & Atherton, G. (2019). Moving with the in-crowd: Cooperation and interpersonal entrainment in in- vs. out-groups. *Current Psychology*, 1-8. doi:10.1007/s12144-019-00283-0.
- Dimberg, U., Thunberg, M., & Elmehed, K. (2000). Unconscious facial reactions to emotional facial expressions. *Psychological Science*, 11(1), 86-89. <https://doi.org/10.1111/1467-9280.00221>.
- Dovidio, J. F., Gaertner, S. L., Isen, A. M., & Lowrance, R. (1995). Group representations and intergroup bias: Positive affect, similarity, and group size. *Personality and Social Psychology Bulletin*, 21(8), 856-865. <https://doi.org/10.1177/0146167295218009>.
- Fujiwara, K., & Daibo, I. (2016). Evaluating interpersonal synchrony: Wavelet transform toward an unstructured conversation. *Frontiers in psychology*, 7, 516. <https://doi.org/10.3389/fpsyg.2016.00516>.
- Hove, M. J., & Risen, J. L. (2009). It's all in the timing: Interpersonal synchrony increases affiliation. *Social Cognition*, 27(6), 949-960. <https://doi.org/10.1521/soco.2009.27.6.949>.

- Lumsden, J., Miles, L. K., & Macrae, C. N. (2014). Sync or sink? Interpersonal synchrony impacts self-esteem. *Frontiers in Psychology, 5*(1064), 1-11. doi: 10.3389/fpsyg.2014.01064.
- Lumsden, J., Miles, L. K., Richardson, M. J., Smith, C. A., & Macrae, C. N. (2012). Who syncs? Social motives and interpersonal coordination. *Journal of Experimental Social Psychology, 48*(3), 746–751. <https://doi.org/10.1016/j.jesp.2011.12.007>.
- Michael, J. (2011). Shared emotions and joint action. *Review of Philosophy and Psychology, 2*(2), 355-373. <https://doi.org/10.1007/s13164-011-0055-2>.
- Miles, L. K. (2009). Who is approachable? *Journal of Experimental Social Psychology, 45*(1), 262-266. <https://doi.org/10.1016/j.jesp.2008.08.010>.
- Miles, L. K., Lumsden, J., Richardson, M. J., & Macrae, N. C. (2011). Do birds of a feather move together? Group membership and behavioral synchrony. *Experimental Brain Research, 211*(3–4), 495–503. <https://doi.org/10.1007/s00221-011-2641-z>.
- Miles, L. K., Nind, L. K., Macrae, C. N. (2009). The rhythm of rapport: Interpersonal synchrony and social perception. *Journal of Experimental Social Psychology, 45*(3), 585-589. <https://doi.org/10.1016/j.jesp.2009.02.002>.
- Neal, D. T. & Chartrand, T. L. (2011). Embodied emotion perception: Amplifying and dampening facial feedback modulates emotion perception accuracy. *Social Psychological and Personality Science, 2*(6), 673-678. <https://doi.org/10.1177/1948550611406138>.
- Niedenthal, P. M., Barsalou, L. W., Winkielman, P., Krauth-Gruber, S., & Ric, F. (2005). Embodiment in attitudes, social perception, and emotion. *Personality and Social Psychology Review, 9*(3), 184-211. https://doi.org/10.1207/s15327957pspr0903_1.
- Niedenthal, P. M., Ric, F., & Krauth-Gruber, S. (2002). Explaining emotion congruence and its

- absence in terms of perceptual simulation. *Psychological Inquiry*, 13(1), 80-83. <https://doi.org/10.1037/e633912013-171>.
- Olszanowski M, Wróbel M, Hess U. (2019) Mimicking and sharing emotions: A re-examination of the link between facial mimicry and emotional contagion. *Cognition and Emotion*, 1-10. doi:10.1080/02699931.2019.1611543.
- Regenberg, N. F. E., Hafner, M., & Semin, G. R. (2012). The groove move: Action affordances produce fluency and positive affect. *Experimental Psychology*, 59(1), 30-37. <https://doi.org/10.1027/1618-3169/a000122>.
- Reysen, S. (2005). Construction of a new scale: The Reysen likability scale. *Social Behavior and Personality*, 33(2), 201-208. doi: 10.2224/sbp.2005.33.2.201.
- Schmidt, R. C., Morr, S., Fitzpatrick, P., & Richardson, M. J. (2012). Measuring the dynamics of interactional synchrony. *Journal of Nonverbal Behavior*, 36(4), 263–279. doi: 10.1007/s10919-012-0138-5.
- Shafir, T., Tsachor, R. P., & Welch, K. B. (2016). Emotion regulation through movement: Unique sets of movement characteristics are associated with and enhance basic emotions. *Frontiers in Psychology*, 6, 1–15. <https://doi.org/10.3389/fpsyg.2015.02030>.
- Zhao, Z., Salesse, R. N., Marin, L., Gueugnon, M., & Bardy, B. G. (2017). Likability's effect on interpersonal motor coordination: Exploring natural gaze direction. *Frontiers in Psychology*, 8, 1–15. <https://doi.org/10.3389/fpsyg.2017.01864>.

Figure 1*Arm Curl Activity Example*

Note. The figure shows the arm curl activity motion completed by the Happy Male confederate. The figure's face is blocked for the confederate's privacy.

Figure 2*Emotion Questionnaire*

Please rate how strongly you feel the following emotions **Right Now**:

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5
Surprised				
<input type="range"/>				
Angry				
<input type="range"/>				
Disgusted				
<input type="range"/>				
Happy				
<input type="range"/>				
Sad				
<input type="range"/>				

Note. The figure shows the prompt and questions for the emotion questionnaire.

Figure 3*Rapport Questionnaire*

Please think about the other participant for the following questions. Given your interaction, do your best to determine your perspective on them.

On a scale from 1-5, how likely are they the type of person that you would find...

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5
Dishonest				
<input type="range"/>				
Genuine				
<input type="range"/>				
Disattentive				
<input type="range"/>				
Agreeable				
<input type="range"/>				
Impolite				
<input type="range"/>				
Conceited				
<input type="range"/>				
Compassionate				
<input type="range"/>				
Good Listener				
<input type="range"/>				
Trustworthy				
<input type="range"/>				
Hostile				
<input type="range"/>				

Note. The figure shows the prompt and questions for the rapport questionnaire.

Figure 4*Likeability Questionnaire*

Please think about the other participant for the following questions. Given your interaction, do your best to determine your perspective on them.

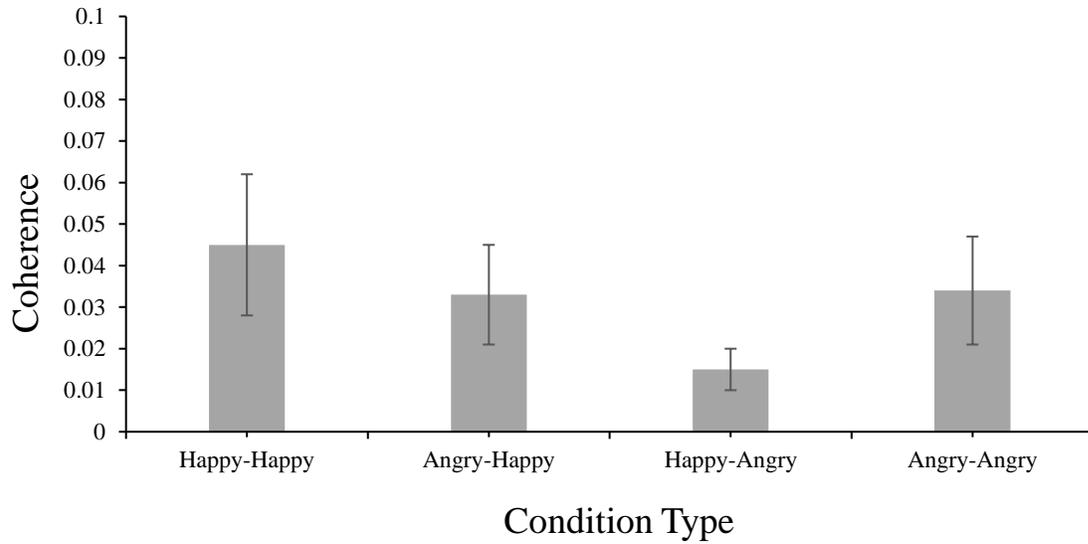
How likely are they the type of person that you would...

Extremely Unlikely 1	Slightly Unlikely 2	Neither Likely nor Unlikely 3	Slightly Likely 4	Extremely Likely 5
Be friends with				
<input type="range"/>				
Get a meal with				
<input type="range"/>				
Never see again				
<input type="range"/>				
Be roommates with				
<input type="range"/>				
Never introduce to your other friends				
<input type="range"/>				
Spend more time with				
<input type="range"/>				
Avoid on your way to class				
<input type="range"/>				
Not want as a coworker				
<input type="range"/>				
Ask for advice				
<input type="range"/>				
Not become close with				
<input type="range"/>				

Note. The figure shows the prompt and questions for the likeability questionnaire.

Figure 5

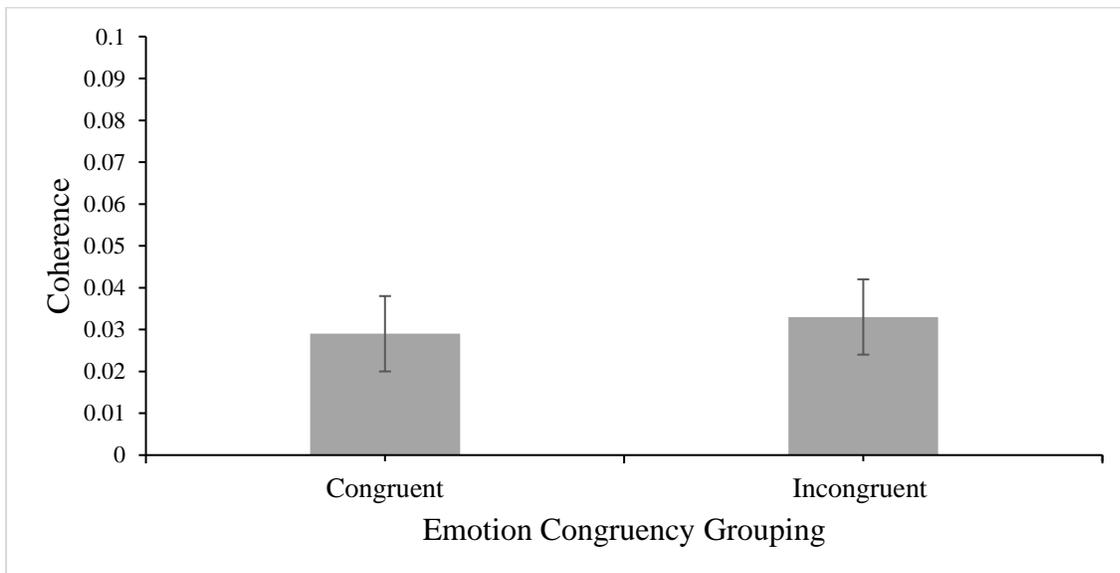
The Effect of Condition Type on Coherence



Note. Error bars reflect the standard error of the mean.

Figure 6

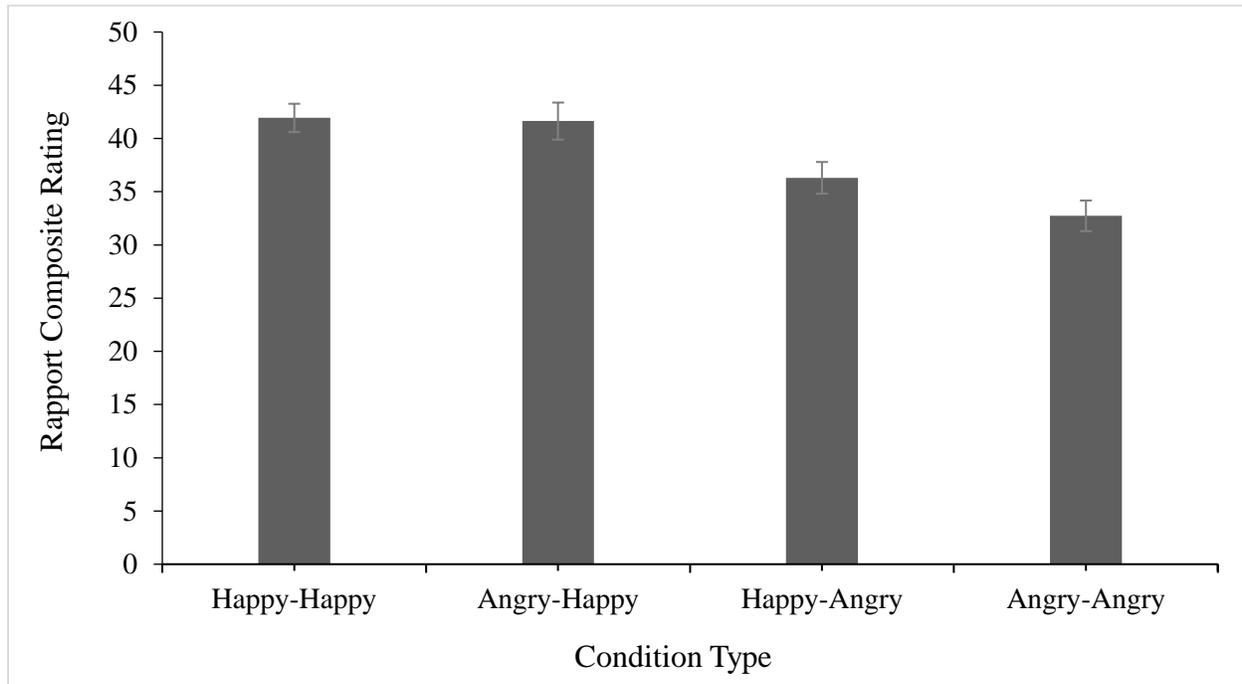
The Effect of Emotion Congruency Grouping on Coherence



Note. Error bars reflect the standard error of the mean.

Figure 7

The Effect of Condition Type on the Perceived Rapport Composite Rating



Note. Error bars reflect the standard error of the mean.