THE EFFECTS OF FACIAL ATTRACTIVENESS ON SPONTANEOUS FACIAL MIMICRY

By Katlyn Peck

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Abstract

When individuals are presented with emotional facial expressions they spontaneously react with brief, distinct facial movements that 'mimic' the presented faces. While the effects of facial mimicry on emotional perception and social bonding have been well documented, the role of facial attractiveness on the elicitation of facial mimicry is unknown. We hypothesized that facial mimicry would increase with more attractive faces. Facial movements were recorded with electromyography upon presentation of averaged and original stimuli while ratings of attractiveness and intensity were obtained. In line with existing findings, emotionally congruent responses were observed in relevant facial muscle regions. Unexpectedly, the strength of observers' facial mimicry responses decreased with more averaged faces, despite being rated perceptually as more attractive. These findings suggest that facial attractiveness moderates the degree of facial mimicry muscle movements elicited in observers. The relationship between averageness, attractiveness and mimicry is discussed in light of this counterintuitive finding.

Keywords: facial attractiveness, facial mimicry, EMG, emotion.

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Introduction

When presented with images of emotional faces, individuals will react spontaneously with distinguishable facial expressions that mimic the observed emotion, a process referred to as 'facial mimicry' (Dimberg, 1982). These reactions are rapid, and can occur even when faces are presented below the threshold of consciousness (Dimberg, Thunberg, & Elmehed, 2000). The perception of specific emotional expressions has demonstrated a reliable pattern of facial muscle activation. In particular, when presented with sad or angry faces, observers typically respond with movement of the corrugator supercili muscle region, while happy faces elicit activity of the zygomaticus major region (Dimberg, 1982; Dimberg & Thunberg, 1998; Dimberg, et al., 2000; Archaibou, Pourtois, Schwartz, & Vuillemier, 2008). Facial mimicry has been found to improve the accuracy of emotional identification, and to decrease response times (Niedenthal, Brauer, Halberstadt, & Innes-Ker, 2001). When mimicry response is intentionally blocked, emotion recognition is impaired in affective stimuli, and response time is increased (Oberman, Winkielman, & Ramachandran, 2007).

Mimicry has also been shown to enhance affective and cognitive empathy (Stel & Vonk, 2010; 2009). Mimicry triggers affective empathy through a process called facial feedback where observation of others' emotions elicits facial muscle responses that send feedback to our brains leading to corresponding emotions being experienced and perceived (Stel & Vonk, 2009; Strack, Martin, & Stepper, 1988). Further, cognitive empathy, or perspective taking of a target individual is enhanced when emotions expressed by a target individual are perceived as being genuine (Stel & Vonk, 2009). Specifically, mimicking emotional expressions of a target individual leads to adoption of a congruent emotional experience, ultimately enhancing the ability to adopt and understand the perspective of the other (Stel & Vonk, 2009; Stel, Vonk, van Baaren & Smeets, 2009).

Research then, suggests that mimicry also functions in a social context. During social interactions, observers often mimic the facial expressions, gestures, voices, and even breathing rates of individuals they feel more connected to, and are typically unaware of doing so (van Baaren, Janssen, Chartrand, & Dijksterhuis, 2009). Chartrand and Bargh (1999) argued that a perception-behavior link was an important underlying mechanism responsible for mimicry. More specifically, perceiving someone else performing an action would increase the likelihood of an individual engaging in the same behavior and in turn facilitate the generation of a corresponding emotional state (Niedenthal & Brauer, 2012). Participants showed a “chameleon effect”, or a tendency to match their behavior unintentionally in accordance with behavior displayed by a confederate. These findings suggest that unconscious mimicry may have an adaptive function in social interactions, improving the quality of these interactions by creating a feeling of connectedness between those involved.

Similarly, Stel and Vonk (2010) found that during conversational interaction, feelings of empathy and connectedness increased when both partners were mimicking. More specifically, participants that were instructed to mimic their interaction partner also reported feeling more connected to their partner, and reported smoother interactions than between those not instructed to mimic their partners (Stel & Vonk, 2010). Thus, the relationship between mimicry and the quality of interpersonal relationships may be bi-directional. Increasing mimicry of others creates a more positive response connection between individuals (Chartrand & Bargh, 1999), and the more an individual’s feelings of connectedness to others increase, subsequently, the mimicry response increases as well.

Mimicry has been shown to vary as a function of social context. Given that the function of mimicry in social contexts appears to involve building affiliation and liking between interaction partners (Lakin, Jefferis, Cheng, & Chartrand, 2003), it is likely that the relationship between the observer and the observed is relevant with respect to the emotional mimicry reactions (Bourgeois & Hess, 2008), and ultimately strategic as social coordination is essential for survival. In situations where an emotional congruence, and sharing of fundamental values, attitudes, and/or social identities is felt, then these individuals would be more likely to mimicked. Bourgeois and Hess (2008) tested this theory by investigating differences in emotional facial mimicry responses as a function of the relationship between in-group and out-group members between an observer and an expresser. Participants were shown a series of images comprised of both French Canadian and African American men, and were told to rate the emotional expression displayed (happy, sad, neutral, or angry) while EMG activity in the zygomatic and corrugator muscle regions were continuously recorded (Bourgeois & Hess, 2008). Results demonstrated a moderation effect of emotion on facial mimicry such that participants would mimic happy expressions regardless of the group status of the individual presented, but would only mimic sad expressions when the individual was thought to be an in-group member.

A more recent study also looked at convergent and divergent emotional responses to in-group and out-group targets such that participants were presented with emotionally expressive images depicting fear, anger, or happiness while EMG was continuously recorded (van der Schalk et al., 2011). The type of social group was manipulated by telling participants that they were judging emotion in different types of students, and it was predicted that there would be less mimicry to fear and anger if the stimulus was a member of the out-group relative to the in-group, and mimicry would not differ when viewing happy expressions (van der Schalk et al., 2011).

Results confirmed their predictions, and in a second study they showed participants videos of Caucasian and non-Caucasian individuals expressing fear, anger and happiness, and again found that overall, members of the in-group were mimicked more (van der Schalk et al., 2011). Additional evidence in support of a link between liking and mimicry was demonstrated through increased mimicry of negative emotions as a function of in-group status (van der Schalk et al., 2011). Essentially, emotion congruence is likely to occur when individuals feel that they belong to the same social group.

Mimicry has also been shown to have negative consequences in some social interactions. Stel, van Dijk and Olivier (2009) asked participants to mimic another individual that was instructed to lie. Participants who mimicked the deceptive confederates were less able to detect the true emotion being expressed compared to individuals who were also being lied to, but were not asked to mimic the deceptive individual. Further, increased mimicry does not always lead to increased liking of an interaction partner. More specifically, when asked to mimic an individual that was initially disliked, the mimicry itself was not associated with increased liking (Stel et al., 2010). Also, mimicry is not reported to be beneficial when individuals watch others that are mimicking unfriendly behaviors, as they were rated as less socially competent (Kavanagh, Suhler, Churchland, & Winkielman, 2011), or when out-group members are mimicked (van der Schalk et al., 2011). Thus, rapid facial responses, referred to as ‘facial mimicry’, may not simply reflect the rapid unconscious mirroring of emotional content, but complex social phenomena. One important aspect of social interaction is the role of facial attractiveness.

Facial attractiveness is known to modify a range of social behaviors that begin in infancy (Slater et al., 1998). Previous research has established that we generally like attractive people more than unattractive people (Dion, Berscheid, & Walster, 1972). Attractive individuals tend to have greater occupational success as a consequence of being perceived to have higher qualifications, and being more intelligent, sociable, and friendly as compared to those judged as less attractive (Langlois, et al., 2000; Principe & Langlois, 2011). But what makes one face more or less attractive than another?

Facial averageness and symmetry are two measures that are thought to affect the perception of attractiveness (for review, see Rhodes, 2006; Thornhill & Gangestad, 1999). Faces that are closer in appearance to the population average tend to be rated as more attractive. Ratings of attractiveness can also be increased or decreased when facial features are manipulated to resemble more or less of the average configuration (Rhodes & Tremewan, 1996). Langlois and Roggman (1990) presented computer generated composite images of male and female faces comprised of three sample images to create an average face for each gender. Participants rated the averaged faces as being more attractive than the individual faces comprising the averaged faces. Further, a linear trend was shown such that attractiveness ratings increased as each individual face was added to create the average, suggesting a linear relationship between averageness of the face and its attractiveness (Langlois & Roggman, 1990).

A symmetrical face is also considered to be a component of attractiveness, contributing to attractiveness independent of facial averageness (Rhodes, Sumich, & Byatt, 1999; Valentine, Darling, & Donnell, 2004). Perrett et al (1999) created symmetrical faces from a composite while controlling for skin texture, and presented them in pairs with an asymmetrical image of the same face. Results showed that when the texture of the skin was held constant in the face pairs, participants rated both the male and female symmetrical faces as significantly more attractive than the asymmetrical images of the same face (Perrett, et al., 1999).

Facial mimicry and facial attractiveness have each separately been shown to have influential effects on emotional perception and social interaction. To the author's knowledge however, there have not been any studies investigating the direct effect of facial attractiveness on spontaneous facial mimicry. As emotional expressions in the face elicit low-level automatic responses during social interaction, facial attractiveness may play a moderating role in observers' mimicry responses. Existing research provides tentative support for this theory. Karremans and Verwijmeren (2008) showed that individuals in a romantic relationship mimicked other attractive faces less when they were closer and more connected to their relationship partners. Similarly, Gueguen (2009) found that higher levels of behavioral mimicry increased ratings of partner attractiveness.

Given the established evidence showing that attractive people are generally treated and evaluated more favorably than moderate-non-attractive counterparts (e.g., Langlois et al., 2000) and the tendency of observers to mimic individuals they like more (e.g., Chartrand & Bargh, 1999), it would be expected that a proneness to mimic the actions of more attractive people would exist. A recent study by van Leeuwen, Veling, van Baaren, and Dijksterhuis (2009), demonstrated that art pieces supposedly created by an attractive individual were reproduced more frequently compared to art pieces thought to be created by a less attractive individual (images depicting an attractive and un-attractive individual were placed next to an art piece in order to manipulate attractiveness). While this particular study does not include any interaction between the participants and the attractive individuals, or perception of emotional stimuli, the findings do suggest that the level of attractiveness is influencing behavior on an unconscious level. It would be intuitive then to suggest that proneness for mimicking attractive individuals could also occur on a more rapid, unconscious level through facial mimicry, and that these mimicry responses could be moderated by the degree of attractiveness.

In this thesis, 1 pilot and 1 experiment are reported that examined the role of facial attractiveness on observers' facial mimicry responses to emotional facial expressions. In the pilot study, participants were presented images of female faces that had been manipulated using computerized averaging software. It was expected that composite, more-averaged faces would be rated as more attractive than less-averaged and original un-averaged faces. In the main experiment, observers were presented with a validated set of images from pilot, and asked to rate the attractiveness and emotional intensity of faces, while having their facial movements recorded using electromyography (EMG).

Hypotheses

It was expected that composite faces with more averaging iterations would be rated as more attractive. It was also predicted that more-averaged images that were rated as more attractive would elicit larger facial mimicry muscle responses in observers relative to less-averaged images that were also rated as less attractive. Lastly, it was expected that participants would show increased zygomaticus muscle region activity relative to baseline in response to happy faces, and increased corrugator muscle region activity relative to baseline in response to sad faces.

Pilot Study

The pilot study was designed to validate the degree of attractiveness of stimuli to be used in the main experiment. Participants were presented original and averaged composites of female faces expressing happiness, anger, sadness, and neutral, and were asked to rate the attractiveness, emotional category, and emotional intensity of the expression. It was predicted that faces that were composited to be more average, would be rated as more attractive by observers. These particular emotions were chosen because they have been used in past EMG studies, and have been shown to demonstrate reliable responses corresponding to the zygomaticus and corrugator muscle regions (Chan, Livingstone, & Russo, 2013; Dimberg & Petterson, 2000; Dimberg & Thunberg, 1998).

Method

Participants

Eleven[1] undergraduate, and graduate students (age range = 17-42 years) from the Science of Music, Auditory Research, and Technology (SMART) lab volunteered to participate.

Stimuli

Eight still photographs of females expressing happiness and anger, within a similar age range (17-35), and similar ethnicity were chosen from the NimStim Set of Facial Expressions (Tottenham, et al., 2009), a battery of emotional expressions previously validated to show reliable accuracy in identification of the depicted emotions. Prior to testing, original images were randomly paired in different combinations to create 4 2-face averaged composites, 2 4-face averaged composites, and 1 8-face averaged composite, totaling 15 images for each emotion (8x1 + 4x2 + 2x4 + 1x8). Images were averaged using PsychoMorph (Tiddeman, Burt, & Perrett, 2001), a software tool that renders realistic average faces from two separate images (e.g., Saxton,

[1] Note: Two individuals were not included in the pilot analyses due to incomplete responses.

Debruine, Jones, Little, & Roberts, 2009; Tigue, Pisanski, O'Connor, Fraccaro, & Feinberg, 2012). In order to isolate the presentation of the stimuli to only the face and its features, external features of each image such as hair and ears were removed using Photoshop™ CS software. Each image was presented as an oval against a black background, and skin was evened out at edges of oval when necessary to achieve a more natural look.

Design, Procedure, and Analyses

The experimental design was a 4 (Emotion: happy, angry, sad, neutral) × 4 (Average: 0, 2, 4, 8) × 2 (Repetition) within-subjects design, with 240 trials per participant. Observers were asked to rate the original images and averaged composites on dimensions of attractiveness, and intensity of emotional expressivity on a Likert scale of 1 to 9 (e.g., 1= "not attractive" and 9=”very attractive"). Images were presented individually for approximately 5 seconds on an LCD monitor. Because of the small sample size and variability in the use of the response scale, observers' ratings of attractiveness and intensity were converted to z-scores. The relationships between averageness and ratings of attractiveness, and averageness and ratings of intensity were each analyzed with Pearson correlations (one-tailed). All analyses were performed in IBM Statistical Package for the Social Sciences (SPSS).

Results and Discussion

These particular emotions were chosen because they have been used in past EMG studies, and have been shown to demonstrate reliable responses corresponding to the zygomaticus and corrugator muscle regions (Chan, et al., 2013; Dimberg & Petterson, 2000; Dimberg & Thunberg, 1998).

The correlation between the number of facial averages and observer ratings of facial attractiveness was positive for happy, $r(388) = .40$, $p < .001$; angry, $r(388) = .40$, $p < .001$, sad $r(328) = .50$, $p < .001$, and neutral images $r\ (328) = .57$, $p < .001$. These results suggest that ratings of facial attractiveness increased with the degree of facial averaging for all four emotions.

Results of the separate correlation analyses investigating the relationship between degree of averageness and ratings of intensity of emotional expression showed that as averageness increased, ratings of intensity of happy images increased significantly, $r\ (388) = .13$, p(one-tailed) < .01. A significant amount of the variance in the model was accounted for by happy images with respect to predicting an increase in intensity ratings. Conversely, as degree of averageness increased in angry $r\ (388) = -.26$, p(one-tailed) < .001, sad $r\ (328) = -.25$, p(one-tailed) < .001, and neutral images $r\ (328) = -.26$, p(one-tailed) < .001, ratings of intensity decreased. A significant amount of the variance in the models were also accounted for by angry, sad and neutral images with respect to predicting a decrease in intensity ratings with increasing degrees of averageness.

Ratings of attractiveness for happy, angry, sad, and neutral images increased as degree of averageness of the images increased, as hypothesized. Ratings of emotional intensity increased with degree of averageness in happy images, but decreased in angry, sad, and neutral images. This suggests that images that are more highly averaged could have compromised emotional intensity in their expression. This will be explored further in the general discussion.

It is also important to note that images expressing sadness were chosen over angry expressions for use in the main experiment due to increased distortion effects observed in highly averaged angry faces. Neutral faces were not chosen because they lacked emotional expressivity, and hence, would likely not elicit a detectable mimicry response. Previous studies have used happy and sad emotional expressions, which have demonstrated a reliable EMG response with respect to mimicry (e.g., Chan, et al., 2013).

Main Experiment

The main experiment examined observers' spontaneous facial mimicry responses to emotional facial expressions that vary in attractiveness. Facial EMG was used to measure the degree of muscle activity in response to the individual and averaged face composites expressing happiness or sadness.

Method

Participants

Thirty-one participants (24 female, *M* = 22.7 years, *SD* = 2.82), none of who participated in the pilot study, were recruited through the Ryerson University community and psychology research testing pool and were awarded course credit for their participation. Twenty participants had normal vision and 11 had corrected-to-normal vision, and all individuals reported having normal hearing. Twenty-seven participants were right handed, 2 were left handed, and 1 was ambidextrous.

Stimuli and Apparatus

Thirty images taken from the pilot study expressing either happiness or sadness were used. Refer to Appendix A for a set of experimental images that demonstrate the different degrees of averageness.

Raw electrical potentials were collected at a sampling rate of 1000Hz continuously throughout the experiment. One-inch square cloth solid gel self-adhesive surface electrodes

(Biopac, EL 504) were applied to the left side of the face to collect facial muscle activity in accordance with guidelines from Fridlund and Cacioppo (1986). Areas of skin where the electrodes were to be attached were cleaned using “NuPrep” Gel, a mild exfoliate which is known to improve conduction of the EMG signal by removing any debris on the face that could compromise the clarity of the signal. Two electrodes were placed on the zygomaticus major muscle region approximately 25 mm apart (Tassinary, & Cacioppo, 2000), and corrugator supercili muscle regions on the left side of the face in order to facilitate facial mimicry responses (Dimberg, et al., 2000; Sackheim, Gur, & Saucy, 1978). A ground electrode was placed on the mastoid bone, located behind the ear. It is important to note that some participants needed the ground electrode placed on the frontal bone, located on the top of the forehead on the right hand side. This was necessary in some cases in order to maintain the integrity of the signal as some individuals had problematic amounts of hair too close to the mastoid.

The electrodes were connected to a Biopac EMG100C amplifier and MP100 (Biopac Systems, Santa Barbara, CA) data acquisition system with the high and low-pass filters at 5 and 1000 Hz respectively. Raw signals recorded using AcqKnowledge software (Biopac Systems) running on a Mac Mini desktop computer.

Design and Procedure

The design was comprised of 120 trials per participant with 30 distinct images of female faces expressing both happiness and sadness as the set of stimuli presented. The stimuli were comprised of 16 original images, which were then blended together to create 8 2-face averaged composites; 4 4-face averaged composites, and 2 8-face averaged composites. The images presented consisted of the original and averaged composite faces previously created and validated in the pilot study, and were each presented 4 times in order to ensure consistent responses over time. Original images were obtained from the NimStim database (Tottenham et al., 2009). It is important to note that the number of images in each category differed as a result of the degree of averageness. For instance, as more images are averaged together to create more highly averaged composites, the number of images is reduced in comparison to a category where fewer images are averaged together.

The individual and composite female images expressing both happiness and sadness were presented separately pseudo-randomly, and perceptual ratings of attractiveness, intensity, and a forced-choice emotion categorical response were collected. Facial mimicry responses were measured using EMG continuously throughout the experimental trials.

Each image was presented for a total duration of 3000 ms, and participants were given an unlimited duration of time to rate each stimulus. The inter-trial interval time randomly varied from 5000-7000 ms in order to avoid anticipation of time between trials, and to allow time for physiological measures to return to a relative baseline. Trials were presented in blocks of 30 and randomized within each block in order to control for any possible habituation in EMG response. A break was given halfway through the experiment (following presentation of 60 trials) for a duration of time specified by the participant, in hopes of reducing any possible boredom or habituation to the stimuli.

Informed consent was obtained upon arrival. Participants were tested individually for an approximate duration of 35 minutes in an IAC double-walled sound-attenuated booth. A cover story was given in order to minimize demand characteristics; such that the interest of the study was to measure involuntary responses to pictures and that the electrodes were measuring skin conductance activity in relation to that response (Cacioppo, Tassinary, & Bernsten, 2007; Chan et al., 2013; Dimberg, et al., 2000). Placements of electrodes, as mentioned above were administered in order to record EMG data while participants view the stimuli. The still photographs and averaged composites of the female actors were presented on a 19’ LCD computer monitor connected to a Mac Mini desktop computer and the experiment was presented and programmed through PsyScope (Cohen, MacWhinney, Flatt, & Provost, 1993).

After the EMG equipment was properly secured, the participant was instructed to relax for 2 minutes in order to allow for a return to baseline after hooking up the EMG equipment and initial exposure to the testing environment. Participants were instructed to not make any sudden or constant body movements during the task, in order to avoid additional motion artifacts, which could occur during the EMG recordings. During each experimental trial, and for each image, participants were asked to rate the attractiveness of each image on a Likert type scale from 1 to 9 (e.g., 1 = “not attractive”, and 9 = “very attractive”), make a forced-choice response judging what emotion is being expressed (1 = happy or 2 = sad), and rate the degree of intensity of the expressed emotion on a scaled from 1 to 9 (e.g., 1 = “not at all intense”, and 9 = “very intense”) using a numerical keypad.

Upon completion of the experiment, participants were asked to fill out a short background questionnaire (see Appendix B), and were asked if they had any guesses in regards to the hypotheses being tested, to safeguard against possible demand characteristics in possible exaggerated EMG responsivity. The duration of the experiment was approximately 60 minutes in length, including EMG hookup, consent and debriefing procedures, and stimulus presentation. Participants received course credit as compensation.

Analyses

EMG data were filtered using a high-pass filter of 5 Hz (Butterworth, 3rd order) to minimize any motion artifacts, a low-pass filter of 500 Hz (Butterworth, 3rd order) due to the lack of valuable muscle information available above this cut-off, and a notch filter of 59-61 Hz (Butterworth, 5th order) in order to attenuate any main electrical noise artifacts. The high-pass filter greatly reduced low-frequency artifacts that can affect the quality of the EMG signal, such as large-scale muscle movements during the experiment. The low-pass filter reduced interference by attenuating high frequency noise from the amplifier that could potentially compromise the quality of the EMG signal (Cutmore & James, 1999; Fridlund & Cacioppo, 1986). A notch filter was also used in order to reduce any line noise from the power supply of the EMG equipment that could compromise the quality of the signal.

Data was full-wave rectified and smoothed using an RMS filter of with a 50ms-sliding window. All filtering was conducted using FeatureFinder software (Andrews, Nespoli, & Russo, 2011), a Matlab toolbox for custom analysis of physiological signals. Data was zeroed using a baseline subtraction method in FeatureFinder determined by the differences of averages function. This function calculated the difference between the mean amplitudes of the target and baseline windows. A baseline window of 2000ms was selected prior to stimulus onset, and a target window of 2500ms was selected during presentation of the stimulus.

Processed EMG data, and perceptual ratings of attractiveness and intensity were analyzed separately with repeated measures analyses of variance. T-tests were used to compare EMG data for happy vs. sad. Perceptual ratings of intensity were standardized and converted to z-scores.

Results

Perceptual Data

Separate Repeated Measures (RM) Analyses of Variance (ANOVA's) were conducted in order to establish differences in perceptual ratings of attractiveness and intensity as a function of degree of averageness. All ratings were standardized and converted into z-scores prior to analyses using SPSS. Ratings were standardized due to the small sample size, and to reduce individual variability in standards used to rate the attractiveness and intensity of the stimuli. Data were converted into z-scores and standardized separately by participant ($M = 0$, $SD = 1$). Supplementary analyses were performed with the unstandardized values (refer to Appendix C).

Attractiveness

Mauchly's test indicated that the assumption of sphericity had been violated for the main effects of averageness, $\chi^2(5) = 23.15$, $p < .01$, the main effect of repetition, $\chi^2(5) = 18.31$, $p < .01$ the interaction between averageness and repetition, $\chi^2(44) = 103.98$, $p < .01$, and the 3-way interaction between averageness, emotion, and repetition, $\chi^2(44) = 83.86$, $p < .01$, Therefore, degrees of freedom were corrected using Greenhouse-Geiser estimates of sphericity ($\varepsilon = .66$ for the main effect of averageness, $\varepsilon = .70$ for the main effect of repetition, $\varepsilon = .56$ for the interaction between averageness and repetition, and $\varepsilon = .62$ for the 3-way interaction between averageness, emotion, and repetition).

There was a significant main effect of degree of averageness on attractiveness $F(1.98, 59.53) = 86.46$, $p < .001$, $\eta^2 = .74$. Simple effect analyses revealed that ratings of attractiveness of 2 averages $F(1, 30) = 168.42$, $p < .001$, partial $\eta^{2 =}$ .84, 4 averages $F(1, 30) = 142.17$, $p < .001$, partial $\eta^{2 =}$ .82, and 8 averages $F(1, 30) = 114.05$, $p < .001$, partial $\eta^{2 =}$ .79 were significantly higher when compared to original images. There was also a significant main effect of repetition, or multiple exposure to the images on ratings of attractiveness, $F(2.06, 63.18) = 4.69$, $p < .01$, $\eta^2 = .13$. Simple effects analysis revealed that ratings of attractiveness at 3rd exposure $F(1, 30) = 5.47$, $p < .05$, partial $\eta^{2 =}$ .15, and 4th exposure $F(1, 30) = 7.34$, $p < .01$, partial $\eta^{2 =}$ .19, to the images were significantly lower compared to initial exposure. However, contrasts did not reveal a significant difference in ratings of attractiveness between the initial and 2nd exposures $F(1, 30) = 2.87$, $p = ns$, partial $\eta^{2} =$ .08, to the images. Lastly, a main effect of emotion $F(1, 30) = 254.54$, $p < .001$, $\eta^2 = .89$, was revealed such that attractiveness ratings were significantly higher for images expressing happiness (*M* = .577, *SE* = .036), compared to sadness (*M* = -.577, *SE* = .036).

Results also demonstrated a significant interaction between degree of averageness and emotion type, $F(2.58, 77.35) = 7.65$, $p < .01$. This indicates that different degrees of averageness of images had different effects on perceptual ratings depending on emotion type. Simple effects analyses were performed to break down the interaction comparing all degrees of averaged composites to original images in both emotion types (happy, sad). Significant effects were revealed when comparing happy and sad expressions both for original and 2 averaged images $F(1, 30) = 19.08$, $p < .001$, partial $\eta^{2} =$ .39, and original to 8 averages (most highly averaged images), $F(1, 30) = 8.32$, $p < .001$, partial $\eta^{2} =$ .34. Figure 1. depicts the effects such that images expressing happiness (compared to sadness) increased ratings significantly in images composed of 2 and 8 degrees of averageness compared to unaveraged images. The remaining contrast did not reveal significant effects when comparing happy and sad images for original images compared to 4 averages $F(1, 30) = 1.03$, $p = ns$, partial $\eta^{2} =$ .03.

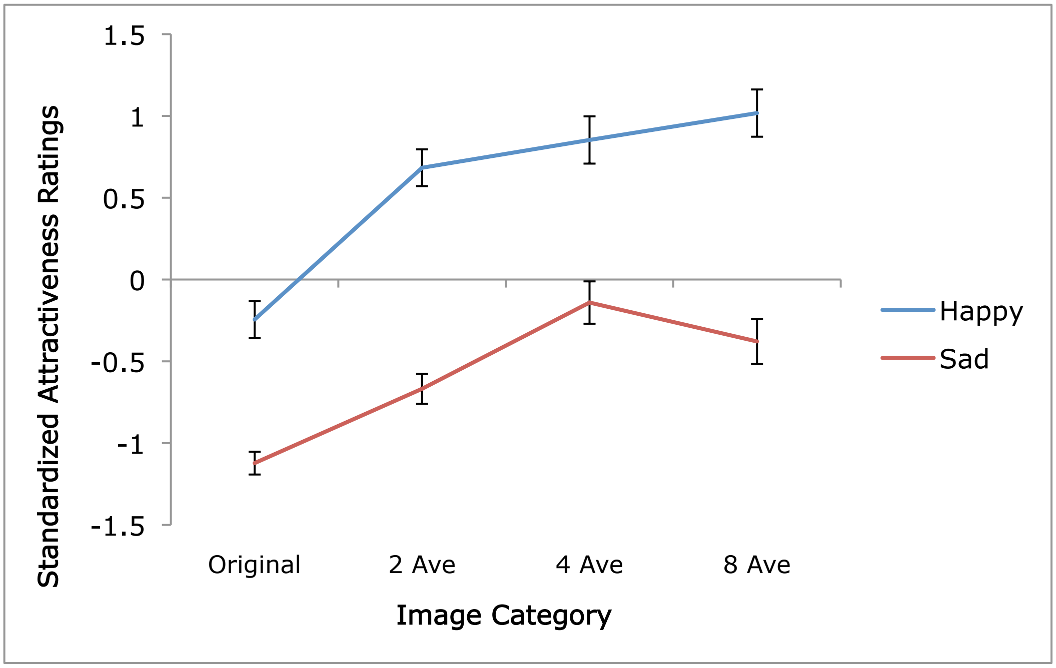

Figure 1. Perceptual ratings of attractiveness as a function of degree of averageness in the main experiment.

Results also demonstrated a significant 3-way interaction between degree of averageness, emotion type, and repetition (degree of exposure to the stimuli), $F(5.58, 68.30) = 2.67$, $p < .05$, $\eta^2 = .08$. Simple effects analyses were performed and the only significant difference between images expressing happiness and sadness was when comparing original and 8-face averaged composites during the initial exposure to the image compared to the second exposure, $F(1, 30) = 4.40$, $p < .05$, partial $\eta^2 = .13$. Figures 2 and 3 demonstrate that regardless of emotion type, original images were rated significantly lower compared to all other averaged composites, and the most highly averaged images were rated as less attractive when sadness was expressed compared to happiness between the first and second repetitions.

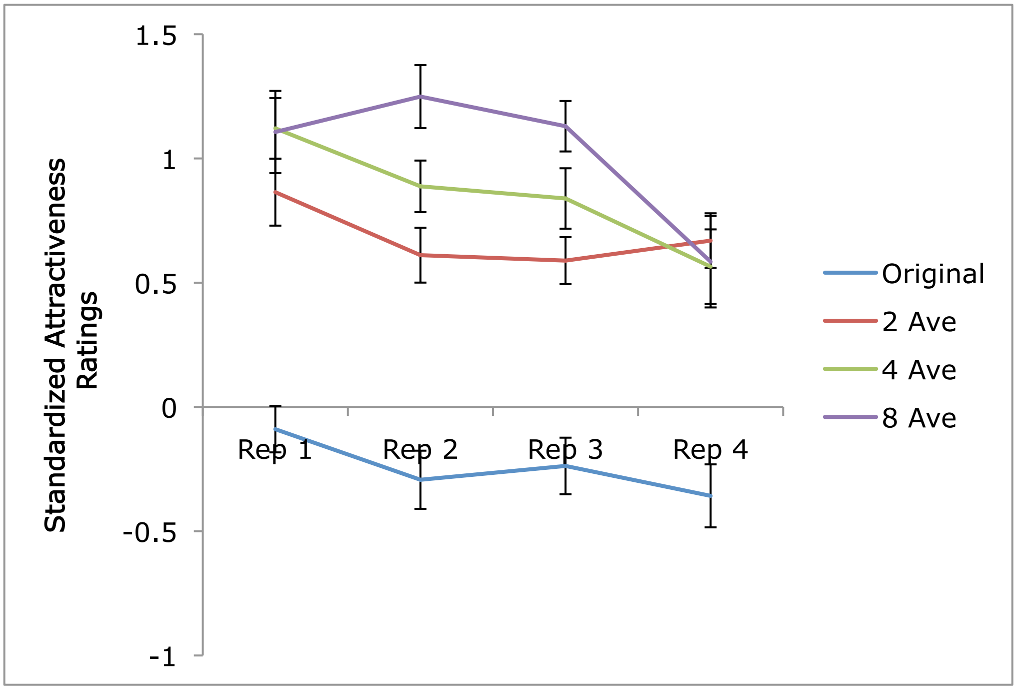

Figure 2. Three-way interaction between standardized perceptual ratings of attractiveness, degree of intensity, and number of repetitions in happy images.

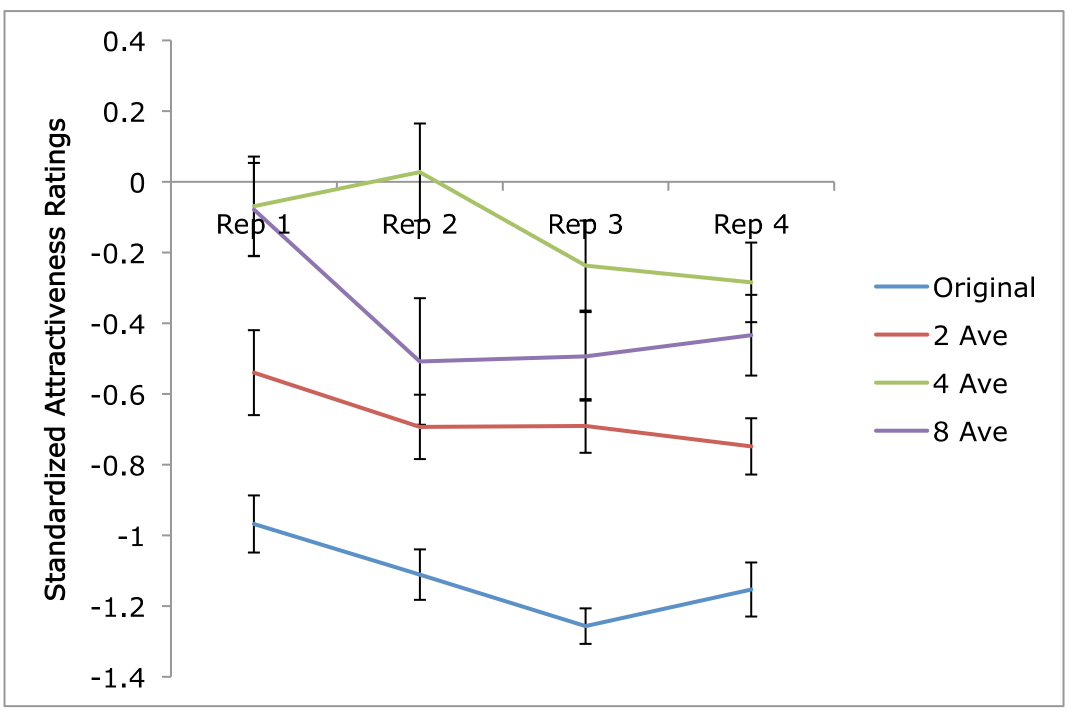

Figure 3. Three-way interaction between standardized perceptual ratings of attractiveness, degree of intensity, and number of repetitions in sad images.

Intensity

Mauchly's test indicated that the assumption of sphericity had been violated for the main effects of averageness, $\chi^2(5) = 17.13$, $p < .01$, and the interaction between averageness and emotion, $\chi^2(5) = 21.46$, $p < .01$. Therefore, degrees of freedom were corrected using Greenhouse-Geiser estimates of sphericity (ε = .78 for the main effect of averageness, and ε = .71 for the interaction between averageness and emotion.

Results of the ANOVA investigating perceptual ratings of intensity as a function of degree of averageness in both happy and sad expressions revealed a significant main effect of averageness $F(2.33, 69.99) = 14.84$, $p <.001$, $\eta^2 = .33$. Simple effects analyses revealed that ratings of intensity of 2 averages $F(1, 30) = 19.96$, $p < .001$, partial $\eta^{2 =}$ .40, 4 averages $F(1, 30) = 14.22$, $p < .001$, partial $\eta^{2 =}$ .32, and 8 averages $F(1, 30) = 11.06$, $p < .001$, partial $\eta^{2 =}$ .48 were significantly higher when compared to original images. Results also revealed a significant main effect of emotion type $F(1, 30) = 6.98$, $p <.05$, $\eta^2 = .19$,such that intensity ratings were significantly lower for sad images (M = -.175, SE = .066) compared to happy images (M = .175, SE = .066).

There was a significant interaction between degree of averageness and emotion type $F(2.13, 64.06) = 27.42$, $p < .001$, $\eta^2 = .48$, indicating that the ratings of intensity of varying degrees of averageness differed in happy compared to sad images. Simple effects analyses were performed to break down the interaction comparing all degrees of averaged composites to original images in both emotion types (happy, sad). Significant effects were revealed when comparing happy and sad expressions to all degrees of averageness such that 2-face averaged composite images $F(1, 30) = 134.21$, $p < .001$, partial $\eta^{2} =$ .82, 4 averages $F(1, 30) = 46.51$, $p <$ .001, partial $\eta^{2} =$ .61, and 8 averages (most highly averaged images), $F(1, 30) = 45.07$, $p < .001$, partial $\eta^{2} =$ .60 were rated with a lower intensity compared to original images. Figure 4. depicts the effects such that images expressing happiness (compared to sadness) were rated with higher intensity as degree of averageness increased.

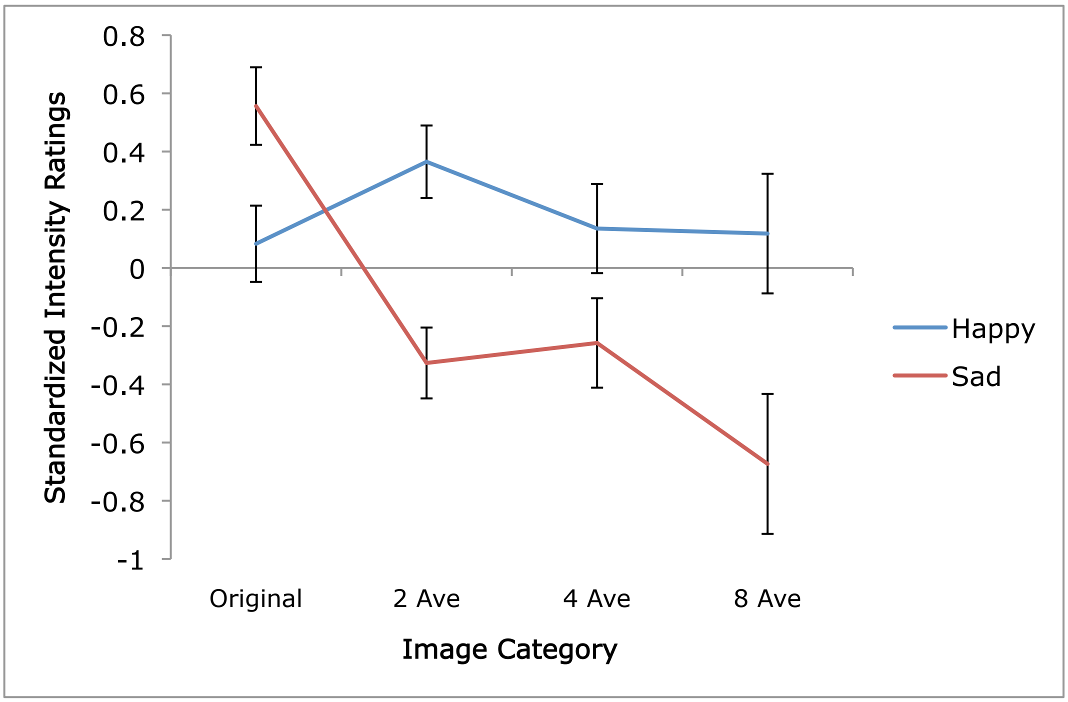

Figure 4. Perceptual ratings of intensity as a function of degree of averageness.

Physiological Data

RM ANOVA's were conducted separately in order to investigate differences in EMG responsivity to faces of increasing degrees of attractiveness as a function of degree of averaging in both the corrugator and zygomaticus muscle regions respectively.

Zygomaticus EMG activity

According to Mauchly's test, all significant effects met assumptions of sphericity, so corrections were not needed for degrees of freedom. There was a significant main effect of emotion type $F(1, 30) = 16.65$, $p < .05$, $\eta^2 = .15$, such that EMG activity in the zygomaticus muscle region was significantly higher when presented with happy images ($M = .130$, $SE = .056$) compared to sad faces ($M = -.130$, $SE = .056$). Main effects of averageness and repetition did not reach significance.

The interaction between degree of averageness x emotion type was trending toward significance $F(3, 90) = 2.26$, $p = .08$, $\eta^2 = .07$, such that EMG activity in the zygomaticus region appeared to be decreasing in happy compared to sad images as degree of averageness increased (see Figure 5). In order to further explore this trend, original, and the most highly averaged composite images (8 averages) were directly compared in a separate RM ANOVA including happy and sad images. Results as depicted in Figure 6, show a significant interaction between degree of averageness and emotion $F(1, 30) = 4.98$, $p < .05$, $\eta^2 = .14$, such that zygomaticus activity is lower in highly averaged happy images compared to sad images when the most highly averaged composites were directly compared to original images.

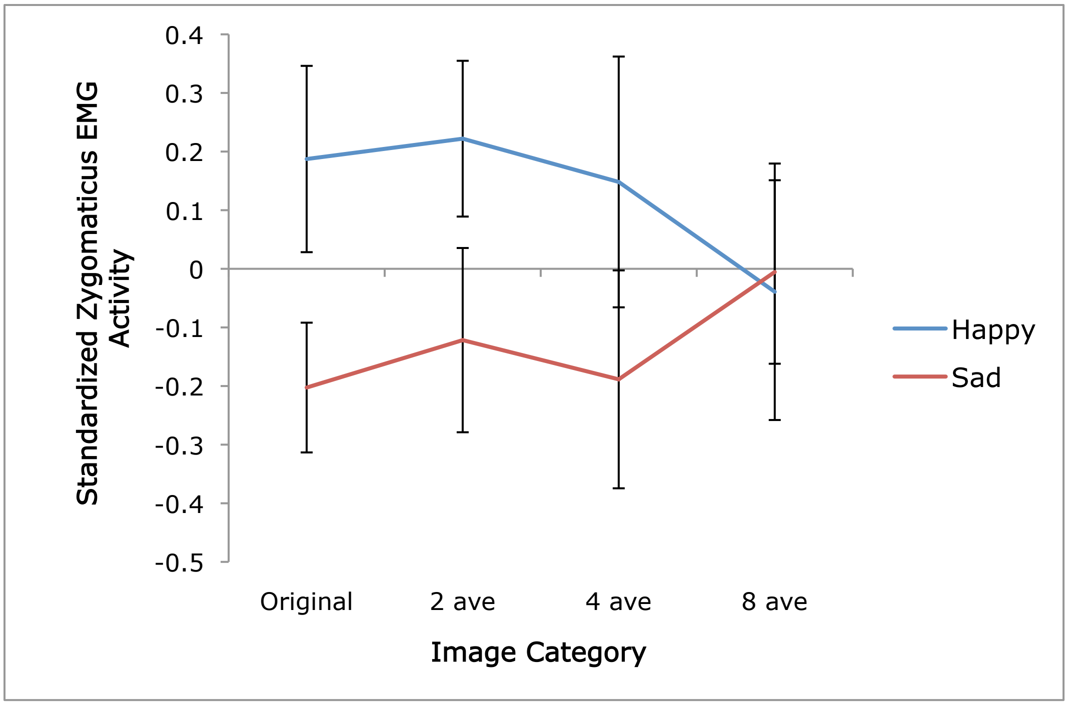

Figure 5. Standardized EMG Activity in the Zygomaticus muscle region as a function of degree of averageness.

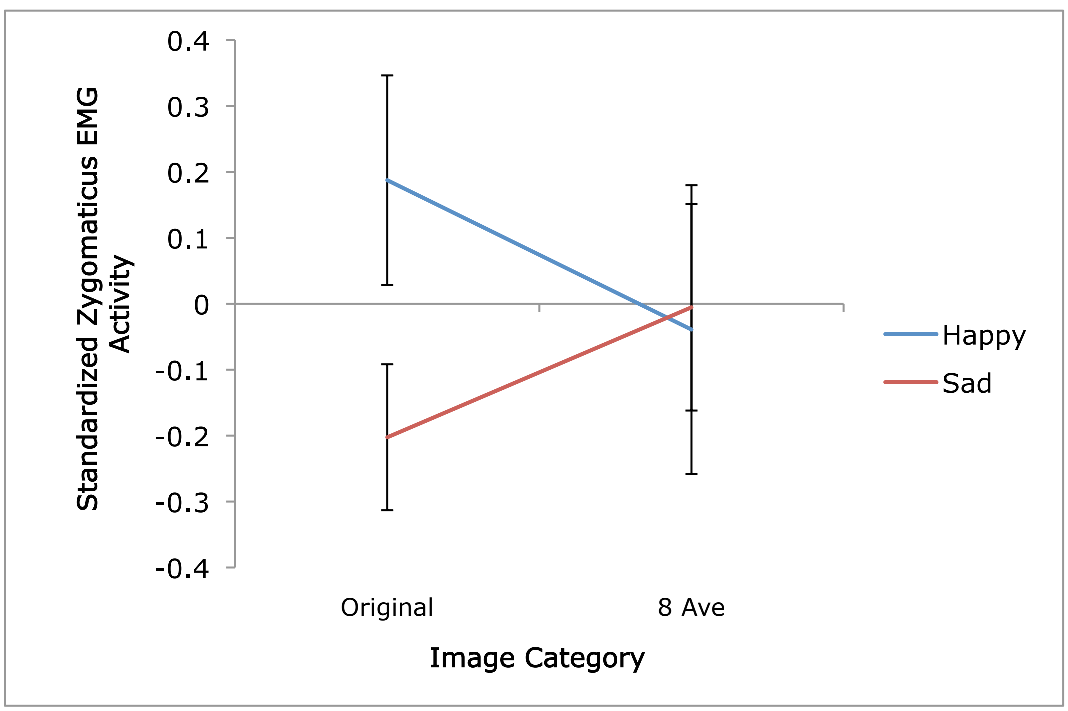

Figure 6. Standardized EMG Activity in the Zygomaticus muscle region as a function of degree of averageness in original vs. highly averaged composite images.

Corrugator EMG muscle region activity

Results of the RM ANOVA show a significant main effect of emotion type $F(1, 30) = 6.87$, $p < .05$, $\eta^2 = .19$ (Refer to Figure 7). Average corrugator EMG activity was significantly higher when images depicting sadness ($M = -.124$, $SE = .047$) were presented relative to happy images ($M = -.124$, $SE = .047$). All other main effects and interactions were not statistically significant (all p's > .05).

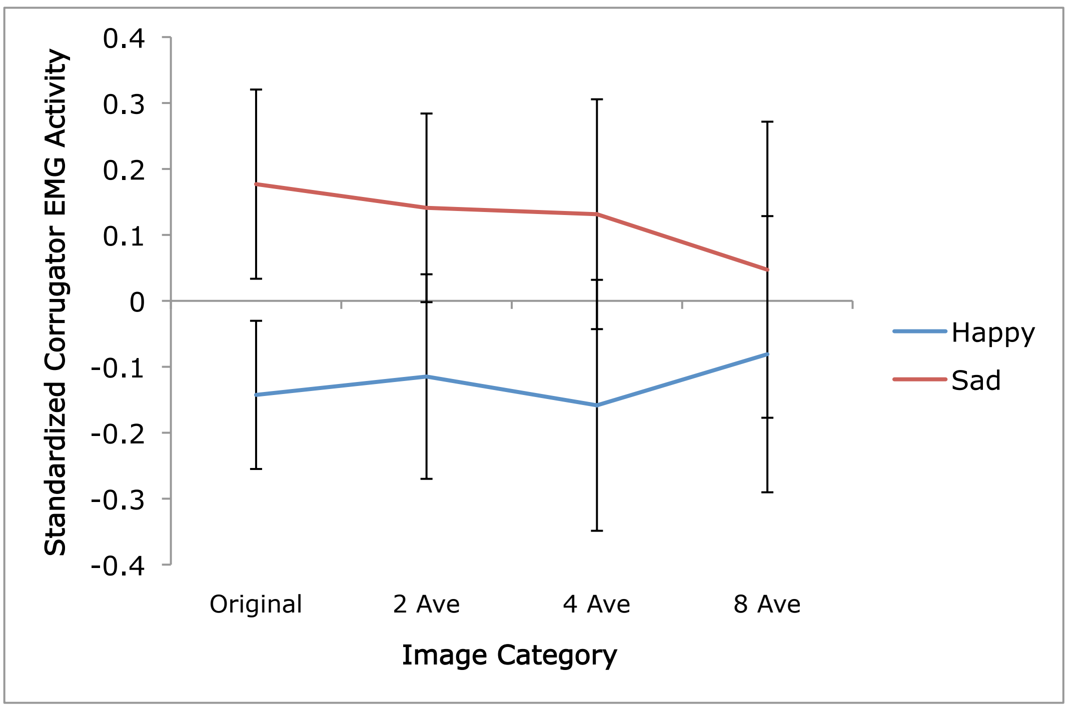

Figure 7. EMG activity in the corrugator muscle region as a function of degree of averageness.

EMG activity by emotion

In order to investigate the prediction that there is indeed significantly more zygomaticus EMG activity when presented with happy images, and more corrugator EMG activity when presented with sad images, 2 separate paired-samples t-tests were conducted. As depicted in Figure 8., mean zygomaticus activity was significantly higher when happy images were presented compared to sad images, $t(1859) = 8.38$, $p < .001$. Conversely, mean corrugator activity was significantly higher when sad images were presented compared to happy images, $t(1859) = -7.61$, $p < .001$. As predicted, emotionally congruent facial responses were observed regardless of degree of averageness.

Figure 8. Mean zygomaticus and corrugator muscle region activity for happy and sad faces.

General Discussion

Findings from the pilot and main experiment provided converging evidence that as faces become more average, they are also perceptually rated as more attractive. The pilot study validated a set of affective stimuli with varying degrees of averageness, which was presented as the primary stimuli in the main experiment. In both instances, as degree of averageness increased, a corresponding increase in ratings of attractiveness was demonstrated overall in response to the presented stimuli. Participants consistently rated more averaged faces as more attractive compared to original images regardless of emotion, but happy images were rated as more attractive when compared to sad images regardless of the degree of averageness. Perceptual ratings of intensity of emotional expression showed a decrease as averageness increased specifically in sad images, whereas happy images showed an initial increase, and then returned to baseline as averageness increased. When perceiving sad images specifically, faces that are more highly averaged together appear to be less emotionally expressive which could influence how they are perceived compared to happy images that showed a linear pattern of ratings as a function of degree of averageness.

Further, as hypothesized in the main experiment, participants showed emotionally congruent facial muscle activity to happy and sad images, where EMG activity in the zygomaticus muscle region was higher when presented with happy images compared to sad, and conversely, EMG activity in the corrugator muscle region was higher when sad images were presented relative to happy. These emotionally congruent facial responses are consistent with past EMG literature (Archaibou, et al., 2008; Dimberg, 1982; Dimberg & Thunberg, 1998; Dimberg, et al., 2000; Likowski et al., 2011), lending further support emotionally congruent mimicry responses to affective stimuli.

Counter to our expectation however, participants displayed decreased zygomatic muscle activity as degree of facial averageness increased, suggesting that mimicry was attenuated as happy images became more averaged. More specifically, this finding was most evident when original images and the most highly averaged composite images (8-face averages) expressing happiness were directly compared in the zygomatic muscle region. EMG activity significantly differed between original and the most highly averaged composites such that highly averaged faces demonstrated a decrease in EMG activity as averageness increased, suggesting that facial mimicry decreased as a function of averageness. Although more pronounced in the zygomatic region when observing happy images, it is important to note that activity in the corrugator muscle region was trending toward significance displaying a similar pattern of decreased activity in sad images as the degree of averageness increased, also suggestive of a decrease in mimicry as averageness increased. This lack of a significant effect despite the observation of a similar pattern could potentially be attributed to the small sample size of the experiment, which likely reduced the degree of power. With an increased number of participants it is quite likely that this pattern will be strengthened and ultimately reach significance.

An obvious question arises from the observed results; why does the mimicry response appear to decrease as degree of averageness increases, and what mechanisms can account for this unexpected difference? One potential explanation could involve the degree of familiarity or experience in preference for attractive faces. An effect of familiarity is demonstrated in the literature suggesting that faces become more preferential when exposure is increased, as indicated by both perceptual ratings, and differential affective physiological responses as a function of attractiveness (Principe & Langlois, 2011; Principe & Langlois, 2012).

As previously mentioned, an increase in degree of averageness resulted in the number of distinct images in each category to decrease, leaving an unequal amount of averaged composites per category in the present experiment. The most highly averaged images would be the product of all 8 distinct female faces and 1 composite would be created for each emotion category (happy, sad). While each stimulus was presented 4 times throughout the course of the experiment, presentations of highly averaged composites were increased, but as a result, this also increased the presentation of original images for each emotion. For instance, original images would be presented a total of 64 times and fully averaged composites only 8 times throughout the experiment, likely creating a heightened sense of familiarity to the original images relative to images with more iterations of averaging. This could potentially explain the decreased mimicry response to highly averaged faces and the similar pattern in response to sad images of increasing attractiveness. Participants would have less exposure to the highly averaged images in both happy and sad images, and are potentially showing higher mimicry responses to the original and less averaged composites simply because they have seen more of them throughout the experiment.

This reduced mimicry response in relation to averageness is likely more complex, with unconscious processes influencing responses, such as decreased empathy and motivation to affiliate with the target. For instance, there is strong evidence that the mirror neuron system (MNS) in humans is activated during perception of observation and action of others (Iacoboni 2009; Iacoboni & Dapretto, 2006), and is proposed to be an underlying neural mechanism of mimicry and empathy (Carr et al., 2003). Facial mimicry contains both motor and emotional components, and the MNS is thought to represent both components through connections with the pre-motor cortex and the limbic system respectively (Rizzolatti & Craighero, 2004; Rizzolatti, Fogassi, & Gallese, 2001; van der Gaag, Minderaa, & Keysers, 2007).

There is strong evidence that the MNS is activated during both observation and execution of emotional facial expressions (van der Gaag, et al., 2007), and is linked to the ability to perceive and produce emotional states, hence, underlying the understanding of the emotional states and intentions of other individuals important for social interaction (Carr et al., 2003). Carr et al. (2003) demonstrated that viewing or mimicking an affective facial expression activated the

MNS and relevant emotional areas in the limbic system. The activation of similar muscle patterns used to create the observed expression is thought to lead to greater emotional understanding, and ultimately generates an empathic response (Carr et al., 2003). MNS activity was not measured in the present study, however, a future study could look at MNS activity while participants are viewing affective images with varying degrees of averageness in order to determine if there is in fact less neural activation within that network when perceiving more highly averaged faces.

As previously mentioned, facial mimicry has been demonstrated to be activated in response to affective images at an unconscious level (Dimberg et al., 2000), and in situations without pre-existing rapport or intent (Chartrand, Maddux, & Lakin, 2005), an additional explanation for the attenuation in mimicry activity in response to happy images as averageness increased, is a lack of social context presented within the experiment. Participants were asked to rate the affective images presented to them as facial muscle activity was continuously recorded, but they were not given any further contextual information related to the images. Providing this type of information was not a main objective of the present experiment, but studies demonstrating increased affiliation, rapport, and liking as a function of mimicry typically involve active interaction between the mimicker and mimickees (e.g., Lakin & Chartrand, 2003; Karremans & Verwijmeren, 2008; Stel & Vonk, 2010), hence, creating more of a social context. Pre-existing rapport or intent does not typically exist in these studies, however, they do involve observation of others actions as well as other relevant social information rather than simply observation of affective images, that might create a sense of motivation to mimic to build rapport and encourage affiliation.

Although not a main motivation of the present studies, an interesting finding did emerge when interpreting perceptual ratings of intensity of the emotional expression portrayed in the presented images. For instance, happy images appear to be slightly unaffected relative to sad images such that happy images show an initial increase, and then seem to return to baseline whereas sad images show a marked decrease as averageness increases. Although happy images seem to be differentially affected by degree of intensity, the intensity of expression in sad images decreased as averageness increased. This is a novel and interesting finding with respect to sad images, suggesting that degree of intensity can influence on perceptual judgments of attractiveness. Given the reported decrease in intensity of highly averaged images, affective information available to the observer is also reduced, which in turn could attenuate participant's mimicry responses as well.

While studies looking at attractiveness ratings of images with varying degrees of averageness typically use composites with a neutral expression (e.g., Langlois & Roggman, 1990; Langlois et al., 2000; Rhodes & Tremewan, 1996), mimicry studies use images with distinct affective expressions (e.g., Dimberg 1982; Dimberg & Thunberg, 1998; Niedenthal et al., 2001; Oberman et al., 2007). Since the main dependent variable of interest in the present study was degree of facial muscle activity, intensity of emotional expression is an important variable of interest to consider, as it does appear to be influencing both perceptual ratings, and physiological reactions to judgments of facial attractiveness in the sad images specifically. If the intensity of the affective expressivity of sadness is decreasing as a face becomes more average, then mimicry responses could be showing a corresponding decrease due to less available affective information detected in the more highly averaged faces. As a result, the original faces in this category could simply be more emotionally expressive, and hence, elicit higher levels of mimicry compared to more highly averaged faces, where the affective information is more neutralized.

It is important to note that although intensity ratings of happy expressions were higher compared to sad images overall, when looking at ratings of happy expressions exclusively, aside from a slight increase in intensity from original images to 2 average composites, happy expressions were not influenced by degree of averageness. Conversely, intensity ratings of sad images significantly decreased as averageness increased, which could provide an explanation as to why there was also a trend toward a decrease in mimicry in the corrugator region in response to more averaged images depicting sadness. Degree of intensity, however, does not provide a plausible or applicable explanation for the decrease in mimicry observed when more averaged images were presented in the zygomatic muscle region in response to happy images.

Future Directions

Future studies could investigate the role of motivation in facial mimicry in order to determine if the level of averageness in the presented images influenced how motivated they would be to affiliate with, or befriend those individuals in a social setting. Participants could be asked to mimic the actions of other individuals who have been previously rated to vary in levels of attractiveness and mimicry responses could be directly compared to simply observing affective images of the same individuals. This could determine if mimicry activity is greater when there is more of a social context, and hence, more motivation to affiliate with more attractive individuals.

Past research has reliably demonstrated that greater behavioral mimicry is observed in response to members of similar social group who share attitudes, social identities, and fundamental values (Bourgeois & Hess; van der Schalk, 2011). Greater mimicry of an in-group member occurs even when an out-group member behaves more similarly to that individual, and mimicry is attenuated when the stimuli consists of an out-group member, especially when negative affect is also expressed (Bourgeois & Hess, 2008). More specific information gathered pertaining to different ethnicities or types of individuals included in each participant's social circle could help to better inform the possibility of an in-group/out-group influence that affects degree of mimicry responses. As this type of information was not collected or assessed in the present experiment, and the stimuli was comprised of only Caucasian females, it is not possible to conclude or infer that the decrease in facial mimicry responses as averageness increased in happy images occurred as a result of perception of the stimuli as an ethnic in-group or out-group.

Future studies could present observers with different sets of images of facial expressions comprised of varying degrees of averageness and have them provide ratings of attractiveness of one image relative to another in order to establish a baseline of what is perceived to be attractive. Participants could then rate how attractive and similar/dissimilar they felt relative to the stimuli, which could provide subjective contextual information that could be examined in conjunction with physiological reactions to the stimuli.

Although individual differences in depression and levels of empathy were not directly measured in this study, as it was not expected that mimicry responses would decrease as averageness increased, existing evidence in the literature provides a strong case to include these measures in future studies. The ability to detect the emotional information being transmitted by another individual is a fundamental aspect of empathy (Dimberg, Andreasson, & Thunberg, 2011; Levenson, 1996). As mimicry is a proposed mechanism associated with enhancing feelings of empathy, it could be expected that individual differences in empathy can influence mimicry responses. For instance, individuals higher in trait empathy showed a more intense mimicry response compared to those lower in empathy even when exposed to stimuli for a brief time period (Sonnby-Borgstrom, 2002). A recent study by Dimberg et al. (2011) looked at the EMG responses of high and low empathizers while they perceived happy and angry images and found that individuals scoring high on measures of empathy were more reactive to both the happy and angry stimuli. In addition, depressed individuals often have biased emotional perception and generally demonstrate attenuated EMG activity in response to affective stimuli (Likowski, et al. 2011). Information collected with respect to participant's level of depression could allow for an investigation in future studies into a possible influence of these factors on resulting physiological activity in response to affective images varying in degrees of attractiveness.

Further, lower EMG responsivity in happy images could have been influenced by a sample that was generally lower on empathy, and potentially less reactive to emotional stimuli. Future studies could include measures of trait empathy as well as a rating of how much participants feel empathetic toward the faces. Ratings of the images presented along with a stable measure of empathy could be investigated in association with EMG responsivity in both happy and sad expressions in order to determine a possible effect on degree of facial mimicry.

Conclusions

The main purpose of the present study was to investigate the potential effect of facial attractiveness on spontaneous facial mimicry. Although the current study predicted an increase in mimicry activity as a function of increasing facial attractiveness, the findings related to happy images were counterintuitive, and not in the predicted direction. The results, however, are interesting and relevant in their demonstration that low-level perceptual processes involved in mimicry can be influenced by attractiveness, a higher-level social construct. This raises questions about the underlying mechanisms of spontaneous facial mimicry, and future studies need to focus on the complexity of this process, and to determine if attractiveness itself is influencing mimicry responses, or if something far more complex and diverse is occurring here. If reduced mimicry in response to highly averaged affective facial expressions is indeed a reliable and replicable effect, future studies should focus on the investigation of neural mechanisms and responsivity using imaging techniques and physiological measures to explore differences in activity during the perception of these expressions. Further, individual differences in assessments of attitudes, social identities, affective states, felt similarity, and degree of empathy should be explored in combination with the above measures to create a more holistic understanding of the complexity of facial mimicry responses and the influence of various social contexts. Patterns of facial mimicry responsivity should also be investigated in individuals that have specific difficulties or deficits with emotion perception and understanding such as individuals with depression, deficits in empathy, or individuals with autism in order to explore the role of attractiveness in facial mimicry responsivity relative to healthy populations.

In sum, the main findings of the present study, although divergent from initial predictions, do provide preliminary evidence of the complex nature of the role of facial attractiveness in modulating spontaneous facial mimicry responses. The findings suggest that facial mimicry responses are moderated by the attractiveness of the emotional facial expression, such that different patterns of mimicry activity emerge as a function of level of averageness. Further, degree of intensity of emotional expression of the composite images emerged as a variable that could potentially influence physiological responsivity, suggesting the importance of emotion in elicitation of facial mimicry. Together, the present findings have important consequences in relation to the complexity of mimicry, and suggest further exploration of the moderating role of facial attractiveness.

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Appendix A

Figure 1. The left image depicts one of the original faces used in Experiments 1 and 2, and the right image depicts a 2x averaged face composite also used in both experiments.

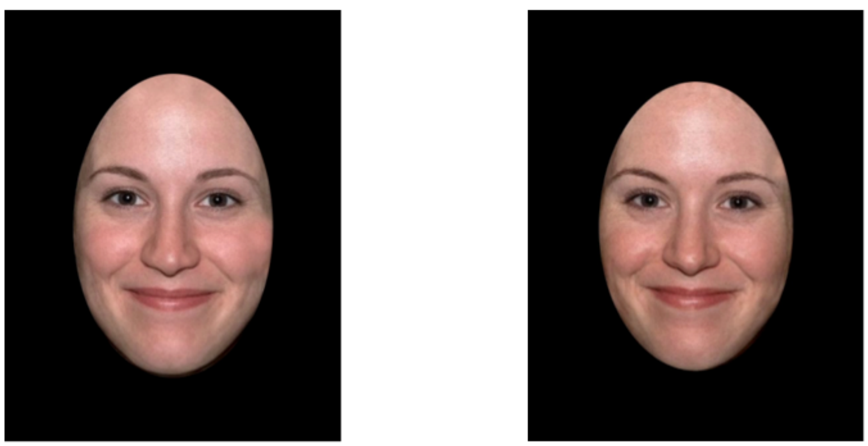

Figure 2. The left image depicts one of the 4x-averaged composites used in the main experiment. The right image depicts an 8x averaged (most highly averaged) face composite also used.

Appendix B.

Confidential Participant Information Sheet – Perception of Facial Emotions

Participant #: ___________________

Date of testing: ____________________

Time of testing: ____________________

Gender: _______________________

Vision (normal or corrected to normal?): _______________________

Hearing (normal or corrected to normal?): _____________________

Age: ___________________________

Handedness (check): Right __________ Left ___________ Ambidextrous _____________

Years of Education (since grade 1): ____________________

Any psychiatric disorders (if so, what): ______________________

Any neurological disorders (if so, what): _____________________

On any psychiatric meds (if so, what): ____________________

Any general health issues/developmental disorders (if so, what): ____________

____

After experiment, before debriefing:

1) Any guesses as to the hypothesis of the study:

2) What was your impression of the images that were presented during the study?

Throughout experiment: ANY notes about the participant, about electrode impedance issues, technical issues, suggestions/problems with study:

Appendix C

Supplementary Analyses

Unstandardized Zygomaticus EMG Activity

According to Mauchly's test, all significant effects violated assumptions of sphericity, so Greenhouse Geiser corrections were applied for degrees of freedom. There was a significant main effect of emotion type $F(1, 30) = 4.33$, $p < .05$, such that EMG activity in the zygomaticus muscle region was significantly higher when presented with happy images ($M = .003$, $SE =$ ..001) compared to sad faces ($M = .000$, $SE = .000$). The main effects of degree of averageness and repetition were not significant.

The interaction between degree of averageness x emotion type was trending toward significance $F(2.11, 63.23) = 2.43$, $p = .088$ such that EMG activity in the zygomaticus region appeared to be decreasing in happy compared to sad images as degree of averageness increased. All other interactions did not reach statistical significance.

Corrugator Muscle Region

Mauchly's test of sphericity was not violated for any significant main effect, so corrections were not used for the degrees of freedom. Results of the RM ANOVA show a significant main effect of emotion type $F(1, 30) = 5.70$, $p < .05$. Average corrugator EMG activity was significantly higher when images depicted sadness ($M = .002$, $SE = .001$) were presented compared to happy images ($M = -3.14\text{E-}05$, $SE = 0$). All other main effects and interactions were not statistically significant.