Published in final edited form as:

Cogn Emot. 2011 January ; 25(1): 140–148. doi:10.1080/02699931003612098.

Faces differing in attractiveness elicit corresponding affective responses

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Abstract

We examined whether faces differing in attractiveness elicit positive and negative affect in 7- to 10-year-old children ($N = 66$) and adults ($N = 73$). Facial electromyography measured affective response. Less attractive faces evoked significantly more *levator labii superioris* responses in adults and children. Attractiveness was negatively correlated with *corrugator supercilii* activity in adults, but not significantly in children. These results suggest that less attractive faces evoke greater disgust and negative affect than more attractive faces. Perceivers' affective reactions to attractive faces may play an important role in attractiveness preferences and attractiveness stereotypes.

Keywords

Affect; Faces; Attractiveness; Electromyography; Prototype

Ubiquitous automatic preferences for attractive faces influence almost every social relationship people have, no matter how brief or long lasting (Langlois et al., 2000; Langlois, Ritter, Casey, & Sawin, 1995). People evaluate attractive adults and children as more intelligent, more sociable, and more friendly than less attractive adults and children. The consequences of these evaluations are significant: Attractive people have greater success than unattractive people in several job-related domains including higher perceived qualifications, expected success, and better pay (see Hosoda, Stone-Romero, & Coats, 2003).

Because of the clear societal ramifications, it is critical to better understand attractiveness preferences, their associated mechanisms, and how they develop. Affect is one such mechanism and one that has been largely ignored in attractiveness literature. This is particularly unusual as multiple theories for attractiveness preferences (i.e., cognitive averaging and evolutionary theories) posit that attractive faces should elicit either more positive affect or less negative affect or both than unattractive faces. Yet, this remains an untested assumption.

Cognitive averaging and perceptual fluency theories

Cognitive averaging theory argues that attractive faces are preferred because they are closer to the central tendency of the category and are more prototypical than less attractive faces (Langlois & Roggman, 1990). Preference for prototypes is evident in many domains including dot patterns (Bomba & Siqueland, 1983), music (Smith & Melara, 1990), birds,

fish, and cars (Halberstadt & Rhodes, 2003). With regard to faces, Langlois and Roggman (1990) created a prototype face by mathematically averaging the pixel values of 32 digitised facial images. They discovered that this novel averaged face was rated as more attractive and familiar than most of its individual components. Indeed, the more faces added to the average, the higher the attractiveness ratings became. Although facial prototypes are not necessarily the most attractive face, if a face does not possess the quality of prototypicality, it will not be judged as attractive (Rubenstein, Langlois, & Roggman, 2001).

By what mechanism or process do attractive faces and other prototypes become preferred? Perceptual fluency theory argues that prototypes are processed more rapidly than individual exemplars (Reber, Schwarz, & Winkielman, 2003). Recently, Winkielman and colleagues argued that not only does perceptual fluency account for the processing speed of prototypes, but also for their associated affective preferences. For instance, Winkielman, Halberstadt, Fazendeiro, and Catty (2006) found that more prototypical (defined as the mathematical average) dot and geometric patterns evoked more *zygomaticus major* activity—a facial muscle correlated with positive affect—than less prototypical stimuli. Additionally, prototypicality predicted both reaction time and attractiveness ratings; therefore, Winkielman et al. concluded that the brain prefers stimuli that are easier to process. Thus, according to cognitive averaging theorists, attractive faces are more prototypical, fluently processed, and should have a linear relationship with positive affect; the less attractive the face, the less positive affect or more negative affect should be evoked.

Evolutionary theories: Good health or bad genes

Evolutionary psychology also predicts affective response to faces: Attractive faces are preferred because they advertise good health and are less likely to carry bad genes. Good health and bad genes are complementary hypotheses, but with important differences in emphasis. The former position stresses that facial attractiveness is a cue to good health because certain facial features (e.g., clear eyes, smooth skin) are linked with perceptions of wellness (e.g., Thornhill & Gangestad, 1999; although see Kalick, Zebrowitz, Langlois, & Johnson, 1998, for a different view). Given that salubrious organisms are expected to produce more offspring, cues to good health are reproductively adaptive and should be preferred over time. Affective response should have evolved via the limbic system as a signal to approach attractive people (positive affect) who are healthy and fertile, and avoid unattractive people (negative affect) who carry pathogens. The latter position stresses that facial unattractiveness is a cue to inferior breeding. In the context of face processing, because it is more important for humans as a species to avoid mating hazards than to affiliate with medium or high attractive people, not only should we expect to find positive and negative affective responses to faces, we would predict corresponding disgust responses, particularly to the most unattractive faces, as these faces could be markers of inferior genes and regarded as noxious stimuli (Zebrowitz, Fellous, Mignault, & Andreoletti, 2003).

The current study

A majority of studies on attractiveness preferences has used ratings of liking (i.e., attitudes) to quantify affect. However, while attitudes may be significantly correlated with affect, they are separate entities. Further, study participants may be reluctant to consciously attach particularly negative affective labels such as “disgust” to images of potential peers. We can overcome both of these issues, however, by using an objective indicator of affect—facial electromyography (EMG). EMG records affective response not always seen by observers and that often go unnoticed by participants themselves (Tassinari & Cacioppo, 1992).

To test whether study participants have corresponding affective responses to faces differing in attractiveness, we assessed activation of the *corrugator supercilii* (CS; knits brow), *levator labii superioris* (LLS; raises nostrils), and the *zygomaticus major* (ZM; pulls corner of lips into a smile). Particular muscles are correlated with affective response and participant self-reports (Larsen, Norris, & Cacioppo, 2003; Tassinari & Cacioppo, 1992). Larsen et al. (2003) found that activation of the CS muscle is strongly negatively correlated with ratings of liking, whereas activation of the ZM muscle is positively correlated with ratings of liking. Activation of the LLS muscle is greater toward stimuli that elicit disgust (Vrana, 1993).

Although these findings are well established in the psychophysiological literature, there is not a necessary one-to-one relationship among affects and muscles. Note that Vrana (1993) also found LLS activation when participants felt angry. Further, brows may not only furrow when one does not like something, but when one is concentrating on a task. Thus, any EMG study must have a clear theoretical basis for predicting that a muscle response reflects one affect and not another. With regard to the current study, we expected to find a non-linear inverse relationship with attractiveness ratings (i.e., $y = 1/x$) and the LLS muscle, suggesting stronger disgust responses for the least attractive faces and significantly less for medium and high attractive faces, supporting the prediction of evolutionary theories that people consider the least attractive faces to be aversive stimuli. Unlike the LLS where we expected a threshold effect, in keeping with cognitive averaging and good health theories, we predicted a negative linear relationship with attractiveness ratings and CS activity—a bipolar measure of valence—reflecting greater negative affect, or less positive affect, as a function of decreasing prototypicality. Likewise, we predicted a positive linear relationship between the ZM muscle and ratings of attractiveness. Previous research on affective stimuli suggests a possible negativity bias; participants react more strongly to negatively valenced stimuli than to positively valenced stimuli of the same magnitude (see Vaish, Grossmann, & Woodward, 2008, for a developmental review). Therefore, we also predicted stronger relationships between the LLS and CS muscles than the ZM muscle to facial stimuli for all participants. Further, a majority of attractiveness studies has examined only high and low attractiveness groups. However, attractiveness is not a dichotomous variable. We endeavoured to be more ecologically valid by including medium attractive faces, although predictions for these faces are less clear. For example, the ZM muscle is less responsive to smaller changes in valence (Larsen & Norris, 2009; Larsen et al., 2003) so we may only be able to observe a difference between groups of high and low attractive images (i.e., prototypical and non-prototypical; Winkielman et al., 2006).

We tested two different age groups to assess developmental differences between 7- to 10-year-olds and college-age adults. In keeping with the bulk of attractiveness preference literature (see Langlois et al., 2000), we expected that both adults and children would have corresponding affective reactions to faces differing in attractiveness. We also expected that children would show affective responses of higher magnitudes (youth reactions are far less likely to be covert).

METHOD

Participants

One hundred thirty-nine children and adults participated: 73 adults ($M = 18.98$ years old, $SD = 1.16$ years) and sixty-six 7- to 10-year-old children ($M = 8.37$ years old, $SD = 1.17$ years). We excluded the data of 9 adult participants from the analysis for the following reasons: equipment ($n = 5$) and experimenter error ($n = 4$). We excluded the data of 10 child participants from the analysis for the following reasons: equipment error ($n = 2$) and participant off-task ($n = 8$). The adult participant group included: 46% Caucasian, 17% Hispanic, 20% Asian/Asian American, 11% African American, and 5% mixed/other. The

child participant group included: 75% Caucasian, 9% Hispanic, 3% African American, 1% Native American, and 12% mixed/other. We recruited adult participants as part of a course requirement for research participation. We identified potential child participants from birth records provided by the Texas Department of Health. We sent a letter describing the study to parents. After one week, an experimenter contacted the parents to ascertain interest and schedule participants. Children who participated received a nominal prize.

Stimuli

Thirty-one digital images of Caucasian undergraduates (17 male) comprised the visual stimuli. Image subjects donned a sheet to obscure clothing cues and posed with neutral facial expressions, so as not to confound affective responses to attractiveness with mirror responses. We standardised each image for size and lighting condition using Adobe Photoshop 8.0™. Ninety-six undergraduate students (58 male) rated each image on a 7-point Likert scale of attractiveness (“How physically attractive is this face?”).¹ Because research consistently shows that adults and children do not differ significantly in their ratings of attractiveness (see meta-analysis by Langlois et al., 2000), we obtained ratings from adults only. Further, as this is the first study to test for a relationship between affect and attractiveness, we compared average attractiveness ratings to affective response, as is typical of previous research. Thus, we did not have EMG participants rate faces for attractiveness, avoiding confounding positive affect induced by attractiveness with affect elicited by exposure/familiarity effects (see Harmon-Jones & Allen, 2001). The 31 stimulus faces were chosen to represent roughly equal groups of low, medium, and high attractiveness. The overall attractiveness mean rating was 3.30; the range of mean ratings was 1.99 to 5.08.

Procedure

For both adults and children, two experimenters placed nine Ag/AgCl self-adhesive disposable electrodes on the left side of the participant’s face, on the *corrugator supercilii*, *zygomaticus major*, *levator labii superioris*, and the *orbicularis oculi* (to monitor eye-blink artefact). We placed each electrode using the guidelines of Fridlund and Cacioppo (1986). After placing all electrodes, we dimmed the lights to reduce glare on the computer monitor and launched the image presentation on the monitor. To establish a baseline response for each participant, we showed a face-sized black dot for 8 s. Following baseline, we displayed each of the 31 stimuli faces in a random order for 2 s each, with a variable ISI of 4–8 s. Participants sat approximately 1.5 m away from the computer monitor.

Data acquisition and treatment

A Biopac MP150 acquisition unit with shielded bipolar leads collected the electrophysiological data. We amplified the initial signal 5000× with a high-pass filter of 10 Hz, digitised at 1000 Hz, and used the EMG root mean square calculation on Biopac AcqKnowledge 3.9 software to transform and record the data to a computer (see Fridlund & Cacioppo, 1986, for a discussion of data-processing options). We digitally recorded video of each participant to evaluate movement artefact. Offline, we inspected digital recordings and visually assessed the data for additional artefact, such as yawns or sneezes. We did not use the data from stimuli faces that included such artefacts. We defined the index of EMG activity as the mean transformed activity of the 2 s stimulus event minus 2 s of the baseline event (dot). Due to the inherent positive skew of all EMG data, we normalised the regression residuals to meet all mixed-model regression assumptions using logarithmic transformations.

¹An additional 36 undergraduate students (16 male) rated each image on a 7-point Likert scale of typicality (“How good of an example of a face is this face?”). As cognitive averaging predicts, there was a strong correlation between attractiveness and typicality ($r = .85$). The inter-rater reliability for both attractiveness and typicality ratings was above $\alpha = .96$.

We analysed the data using hierarchical linear modelling (HLM). Although HLM is classically used when individuals are “nested” within groups, in the case of our data, affect variables were nested within individuals. Thus, in the parlance of multilevel modelling, we treated affect and ratings of attractiveness as level 1 variables and treated subject characteristics (age, gender) as level 2 variables in our statistical models. Further, HLM analysis enabled us to model random factors (both slopes and intercepts) to predict the amount of variation in the data explained by individual differences. We began with an unconditional model and added fixed and random factors, noting the change in the $-2 \log$ likelihood with each successive model. For the sake of brevity, however, we report only the full significant model for each dependent variable.

RESULTS

Formula:

$$\log(\text{LLS activity}) = \beta_0 + \beta_1(1/\text{Attractiveness Ratings}) + \beta_2(\text{Age}) + \varepsilon$$

$$\text{where } \beta_0 = \gamma_{00} + u_0 \quad 1$$

As expected, we found significant main effects for the inverse of attractiveness, i.e., $1/\text{attractiveness}$; $b = .02$, $t(3381.60) = 2.52$, $p = .01$, and age, $b = -.01$, $t(114.59) = -2.33$, $p = .02$, predictive of LLS muscle activity (disgust; see Equation 1). This finding suggests that unattractive faces evoke significantly more disgust than medium or high attractive faces in both children and adults (see Figure 1). Additionally, there was a significant random effect of a level 2 intercept, which suggests the magnitude of affective response varies across individuals, $\chi^2(1) = 790.30$, $p < .001$. The intraclass correlation coefficient (ICC = .27) indicates 27% of the total variance of the HLM model is accounted for by individual differences in the intercept. Attractiveness ratings and LLS activity were also nearly significantly linearly related, $b = -.001$, $t(3381.58) = -1.90$, $p = .06$, but the inverse of attractiveness was a better predictor, $\chi^2(1) = 7.60$, $p < .01$.

Formula:

$$\log(\text{CS activity}) = \beta_0 + \beta_1(\text{Age}) + \varepsilon$$

$$\text{where } \beta_0 = \gamma_{00} + u_0 \quad 2$$

Further, we found significant main effects for age, $b = -.02$, $t(109.52) = -3.48$, $p = .001$, predictive of CS activity (bipolar affect; see Equation 2). We did not find an effect of attractiveness for all of our participants, however ($p = .19$). The lack of significant results can most likely be attributed to the greater amount of variance in the child data (see Figure 1). Although, as expected, children and adults do not differ significantly across attractiveness ($p = .68$), we found there was a significant relationship of attractiveness and CS activity for adult participants, $b = -.001$, $t(1752.05) = -2.23$, $p = .03$. Thus, for adults, as faces increase in attractiveness, they evoke less negative affect, more positive affect, or both. Again, there was a significant random effect of a level 2 intercept, indicative of individual variation in affectivity, $\chi^2(1) = 935.93$, $p < .001$. The intraclass correlation coefficient (ICC = .32) indicates 32% of the total variance of the HLM model is accounted for by individual differences in the intercept.

Formula:

$$\log(\text{ZM activity}) = \beta_0 + \beta_1(\text{LLS activity}) + \beta_2(\text{Attractiveness Ratings}) + \varepsilon$$

where $\beta_0 = \gamma_{00} + u_0$

An HLM model using attractiveness to predict ZM activity (positive affect) revealed a non-significant and negative relationship. Since we predicted a positive relationship between attractiveness and ZM activity, we suspected that electrical cross-talk from the LLS muscle was suppressing the true relationship between attractiveness ratings and ZM activity. Therefore, we compared a model with attractiveness, age, and LLS as predictors of ZM, and discovered that once the variance in ZM activity attributable to LLS has been accounted for, attractiveness had a positive, albeit still non-significant relationship with the ZM muscle, LLS: $b = .40$, $t(3444.22) = 36.95$, $p < .001$; Attractiveness: $b = .0003$, $t(3348.62) = 0.71$, $p = .48$ (see Equation 3). Note that when LLS was included as a predictor, age was no longer a significant variable, $b = -.003$, $t(112.74) = -1.70$, $p = .09$. Again, there was a significant random effect of a level 2 intercept, indicative of individual variation in affectivity, $\chi^2(1) = 525.48$, $p < .001$; ICC = .20. It should be noted that we found no effects of participant gender, stimuli gender, or random effects of attractiveness ratings. These non-significant findings suggest that affect was the result of a general sense of attractiveness and not sexual attraction and that there is not significant individual variation in the relationship of affective response and attractiveness.

Finally, we were interested in determining the amount of variance within previously established attractiveness ratings that might be explained by physiological reaction to the stimuli. For adult participants, we found that both LLS and CS responses negatively predicted normative attractiveness ratings: $y = 5.26 + -5.52(\text{CS}) + -4.85(\text{LLS})$, $p < .01$, $R^2 = .28$. Thus, for our image set, physiological reactions account for nearly 30% of the variance of attractiveness ratings. We did not find any multiple regression model that significantly predicted attractiveness from children's physiological response.

DISCUSSION

Physiological response to faces

As expected, we found an inverse relationship between attractiveness ratings and LLS response suggesting that unattractive faces elicit more disgust than either medium or high attractive faces. Although LLS is also associated with anger responses (Vrana, 1993), we had no theoretical reason for predicting that faces with a neutral expression should elicit anger, whereas evolutionary theory does predict that unattractive faces may indicate "bad genes" and thus may be noxious stimuli (Zebrowitz et al., 2003). This is the first study to have demonstrated that people have physiological reactions of disgust to normal, albeit unattractive faces. To expand on this finding, future work should examine whether automatic disgust responses influence social interactions and relationships. For example, Chapman, Kim, Susskind, and Anderson (2009) found that the LLS was activated both when participants experienced basic disgust elicited by images and moral disgust elicited by unfair treatment. In many cases, attractiveness may be a mediating variable, considering that attractiveness is also associated with prosocial behaviours such as honesty (see Langlois et al., 2000). Perhaps the emotion of disgust provides an additional preconscious link between two previously unassociated characteristics.

Additionally, there is a negative linear relationship between the CS muscle and attractiveness ratings for adults. This evidence supports cognitive averaging theory: As faces become less typical and further from the mathematical average, they elicit greater negative affect, less positive affect, or both. Evolutionary theories also support this finding and it is

possible that people respond to attractive faces with less negative affect/greater positive affect because they possess cues of good health and fertility. Mating cues may also help to explain why our results are more variable in children who have less conscious concerns with mating. Considering, however, that we found no effects of participant gender or face stimuli gender in our data, a mate-selection evolutionary theory seems less plausible than cognitive averaging.

Limitations

The chief limitation of this study is one that is inherent to all EMG studies. Although facial EMG is more likely to reveal affective reactions even if participants are motivated to conceal their feelings, it is more difficult than ratings to make inferences about affective experiences because EMG is a measure of muscle of activity rather than an explicit preference or attitude. Additionally, because CS is thought to be a bipolar measure of valence, we cannot make claims as to whether attractive faces evoke positive affect, unattractive faces evoke negative affect, or both. As for the LLS, the shape of the relation provides some information. A non-linear shape indicates a stronger influence at one end of the bipolar continuum: Unattractive faces seem to be more emotionally salient.

There are a few possibilities why we did not find linear ZM responses. First, as previously mentioned, we expected to see stronger effects for the corrugator and levator muscles because of the negativity bias. The fact that we discovered inverse and negative relationships between LLS and CS with attractiveness ratings in adults, but not between ZM and attractiveness ratings supports this conclusion. Second, ZM does not reliably respond to minor-to-moderate changes in valence (Larson & Norris, 2009), thus our stimuli set of faces may not have had the necessary variance to see a clear linear trend given that the faces were all within the normal range and none were deformed. Previous research has found a relationship between prototypicality and ZM activity (Winkielman et al., 2006), however, that study was designed as a repeated-measures test on dichotomous groups of high prototypicality and low prototypicality (of dot patterns). Our study design (31 faces of varying levels of attractiveness presented in a random order) does not allow for a paired-stimuli comparison. It is still possible that had we exposed participants to groups of high attractive and low attractive faces in a systematic order, we would have seen a positive and significant relationship between attractiveness and ZM response. Lastly, it is conceivable that had we included a wider range of faces (facial deformities and supermodels) we would have seen a clear ZM trend; however, we do not view this as a limitation of the study: For the first time, we have demonstrated that an average range of faces elicits disgust in children and adults.

Because we did not ask EMG participants to rate faces for attractiveness we can only claim that there is a relationship between normative attractiveness ratings with emotional responses. If future researchers are interested in discovering a relationship between individuals' preferences and affective responses, they must statistically control for the influence of seeing the pictures twice to account for possible mere-exposure effects (Harmon-Jones & Allen, 2001). Given that people agree about who is and is not attractive, however, we would not expect individual results to differ greatly from those reported here.

Most importantly, we cannot say from this study alone what role affect plays in forming or maintaining attractiveness stereotypes or its societal repercussions. The results of this study, however suggest that affect—particularly disgust—is significantly related to attractiveness preferences. This suggests that low attractive people are at higher risk for discrimination. We suggest that future work be directed toward manipulating affect to determine whether stereotype effects can be modified.

Acknowledgments

This work was supported by grant R01HD021332 to JHL from the National Institute of Health.

The authors thank Teresa Taylor-Partridge, Rebecca Bigler, Jacqui Woolley, Catherine Norris, and Eric Moody for their helpful suggestions on this study.

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Figure 1.

The relationship of change in facial muscle reaction from baseline in μV to facial attractiveness. Scatterplots of children's data are shown in the top row, adults' below. The prediction lines are shown only when the relationship was significant. Note: For the sake of clarity, the data points represent the raw data averaged across participants for each of the 31 stimuli; HLM analyses were performed on the log transformed affect data comprising these averages.