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# Power Plays: Expressive Mimicry of Valid Agonistic Cues

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## Abstract

Both transient and stable facial cues have evolved as essential features of social communication in humans. Accumulating research links actual and perceived aggression to a higher ratio between the height and bizygomatic width of a person's face (facial width-to-height ratio [WHR]) and shows that digitally increasing this ratio can alter apparent aggressiveness. We present evidence that facial behaviors associated with anger—the state most closely associated with aggressive intentions—also increase facial WHR, mimicking the facial morphology of aggressive individuals. In Study 1, individuals induced to appear aggressive naturally increased their facial WHR using anger-related facial behaviors. In Study 2, we found that validated anger expressions increased facial WHR and that this change predicts increased attributions of aggressiveness. We also found statistical suggestions that anger-related facial behaviors may serve as cues that overrepresent the expresser's aggressiveness. Our findings suggest that facial behaviors associated with anger may have emerged to facilitate aggressive encounters.

## Keywords

aggression, facial expressions, emotion, status

Anger is an emotional state that is commonly associated with the intention to attack in response to frustration or perceived threat (Blair, 2012; Fridlund, 1994). The expressive facial movements associated with anger include lowered brows, compressed or raised lips, and changes in the shape of the eye (Fridlund, 1994). An essential but as yet unanswered question is: Why? Why do *these particular* facial behaviors comprise the facial expression most closely associated with the intention to attack? In this study, we test the hypothesis that these particular facial behaviors may have been selected to serve a specific social goal, which is to distort the features of the face to enhance the expresser's apparent readiness and ability to attack by increasing the ratio between bizygomatic width and midface height (facial width to height ratio [WHR]). In this way, we hypothesize that the facial behavior that has evolved to accompany an angry emotional state can effectively signal agonistic, or aggressive, ability and intent.

A growing body of research links high facial WHR, meaning a midface that is relatively wide with respect to its height, to both actual aggressive behavior and perceivers' attributions of aggression. The proportion of the midface of human adults is shaped by pubertal-onset growth patterns that are thought to result in wider faces in males, proportional to height, than in females (Weston, Friday, & Lio, 2007), and for particularly large (Deaner, Goetz, Shattuck, & Schnotala, 2012) and aggressive (Carré & McCormick, 2008) males to have faces with the most pronounced sexually dimorphic features in this regard (although it should be noted that some studies have failed to identify sex differences in facial WHR; Kramer, Jones, & Ward, 2012; Lefevre et al., 2012; Özener, 2012). In adults, high facial WHR has been linked to increased aggressiveness both in the laboratory and in the naturalistic contexts. Both professional and collegiate hockey players with higher facial WHR accrue more time in the penalty box for fighting over the course of a season than do players with lower facial WHR, and college students with higher facial WHR respond more aggressively against anonymous partners in laboratory computer games (Carré & McCormick, 2008).

Perceivers appear to be sensitive to the link between facial WHR and aggression. Human observers reliably view faces with higher facial WHR, whether naturally occurring or experimentally manipulated, as less trustworthy and more aggressive (Carré, McCormick, & Mondloch, 2009; Carré, Morrissey, Mondloch, & McCormick, 2010; Short et al., 2011; Stirrat & Perrett, 2010). Thus, from an adaptive standpoint, a valid signal of aggressive potential like facial WHR may serve the purpose of statistically reducing actual aggression by increasing the

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likelihood of submission in the other party (van Staaden, Searcy, & Hanlon, 2011). Manipulations of the proportions of faces can also be effective in altering perceptions related to aggression. Stirrat and colleagues digitally manipulated faces by vertically compressing or expanding their height to mimic the appearance of naturally high or low facial WHR and successfully altered faces' perceived trustworthiness (Stirrat & Perrett, 2010).

These findings indicate that manipulations of facial proportions can mislead perceivers about the actual aggressive potential of the target. This suggests the possibility that nonverbal behaviors that distort an expresser's facial proportions by increasing facial WHR could also enable the expresser to accrue the advantages of a naturally aggressive-looking face. Nonverbal cues are used in similar ways across many species. Behavioral ecology research demonstrates that evolved behavioral signals of agonistic ability and intent typically exaggerate the actual energy, strength, or size of the expresser (Arnott & Elwood, 2010; Goodwin, Bradshaw, & Wickens, 1997; Hughes, 2000; Marsh, Yu, Schechter, & Blair, 2009). Familiar examples occur in dogs and wolves, which display erect posture, raised tail, and piloerection during dominance encounters—behaviors that all serve to visually increase the animals' apparent mass and height (Harrington & Asa, 2003). The simplicity, low energy costs, and effectiveness of such cues have maintained them across the phylogenetic spectrum (Goodwin et al., 1997; Hughes, 2000; van Staaden et al., 2011). This includes humans who may also use postural cues that make them appear larger or more powerful as competitive signals (Marsh et al., 2009; Tracy & Robins, 2004; Tiedens & Fragale, 2003).

That facial cues can also increase perceptions of dominance is well established (Hall, Coats, & Smith LeBeau, 2005). In particular, angry facial expressions and individual components of these expressions are known to increase perceptions of dominance and aggressiveness (Hess, Blairy, & Kleck, 2000; Keating, Mazur, & Segall, 1977). We hypothesize a novel *mechanism* by which angry facial cues may alter the expresser's facial appearance to make the expresser appear more aggressive: by increasing the expresser's apparent facial WHR such that he or she momentarily takes on the appearance of an actually aggressive individual. Support for this hypothesis could include evidence that naive study participants induced to appear aggressive display anger-associated facial behaviors that increase their facial WHR and evidence that the extent to which expressions like anger increase apparent aggressiveness can be predicted in part by the extent to which they increase facial WHR.

We tested our hypotheses in two studies. In Study 1, we asked untrained and naive participants to photograph themselves looking maximally aggressive and hypothesized that they would naturally engage in behaviors that distorted their features in such a way as to increase facial WHR. The behaviors that we predicted would be most likely to occur were facial behaviors associated with anger (e.g., raised upper lip, lip press, chin raise, lowered brow; Ekman, Roper, & Hager, 1980; Kohler et al., 2004), which is the emotion associated with the intent to aggress (Blair, 2012; Horstmann, 2003). The thread that unifies these facial behaviors is that each has the potential to compress the apparent vertical height of the midface. However, the hypothesis that expressers induced to appear aggressive engage in behaviors that increase facial WHR has not previously been tested. In Study 2, we used a well-controlled, independently developed set of emotional facial expressions to assess whether validated anger expressions increase facial WHR relative to other emotional expressions like happiness, sadness, and fear and whether observers' attributions of aggression can be predicted on the basis of the degree to which the expression increases an individuals' facial WHR.

## Study 1

### Participants

Undergraduate study participants (11 men, 29 women, $M$ age = 21.7 years, standard deviation [$SD$] = 5.65) received either course credit or payment for participation. All procedures were approved by the Institutional Review Board at Georgetown University.

### Procedures

Photographs of the participants in this study were collected using the embedded camera in the laboratory Apple computers. First, participants were photographed posing a baseline (neutral) expression. Then, they were asked to imagine themselves in an interaction in which they wished to appear maximally aggressive and dominant, with these terms defined, respectively, as, "Ready or likely to attack or confront someone," and "Strong, powerful, likely to win an aggressive encounter." Participants were instructed to look straight into the camera while the images were captured (participants captured the images themselves, photo-booth style, using a mouse click) and afterward they were permitted to select the image that best represented their attempt to appear aggressive and dominant. Participants were given the option for photos to be deleted if they did not wish them to be used for further testing.

For each neutral and aggressive face, facial WHR was measured according to the original criteria used by Weston and colleagues, such that bizygomatic width (the distance between the left and right zygion) was divided by the upper facial height (distance between the upper lip and mid brow) to index facial WHR (Carré et al., 2009; Weston et al., 2007). Three trained raters separately measured the proportions of each face (four participants' aggressive expressions were discarded because occlusions, e.g., bangs, prevented accurate measurement of facial proportions). Next, a certified Facial Action Coding System (FACS) coder who was blind to the study's hypotheses ascertained the presence and intensity of each of seven action units (AUs) associated with anger in the aggressive faces (4, 5, 10, 17, 23, and 24) using the 6-point intensity scale described in the FACS manual (Ekman, Friesen, & Hager, 2002). We also coded two AUs associated with happiness (6, 12), given prior questions about the association between dominance and smiling (Hall et al., 2005, but see LaFrance, Hecht, & Paluck, 2003).

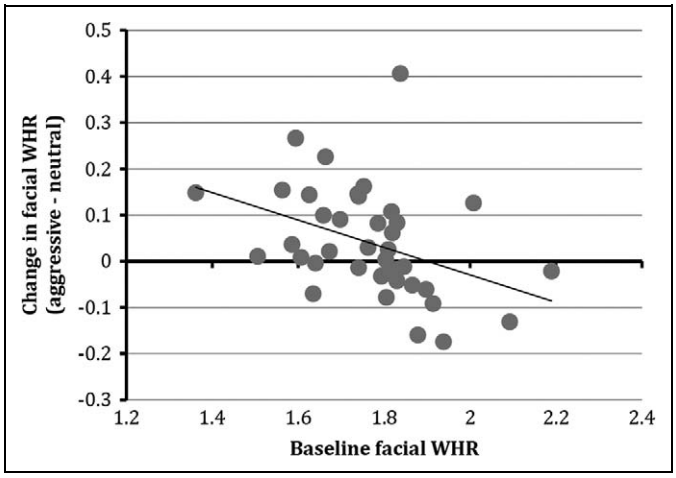


**Figure 1.** Correspondence between baseline facial width-to-height ratio (WHR) and change in facial WHR in response to aggression prompt.

## Results

An intraclass correlation coefficient was applied to raters' facial WHR measurements, which were highly internally consistent ($R = .960$), so the average of the measurements for each face was computed. We applied a log transformation to mitigate the effects of any extreme values on the data and calculated a paired samples *t*-test to compare participants' facial WHR at baseline and when instructed to appear maximally dominant and aggressive (means and standard deviations are expressed as raw values to permit comparison with prior results). The results showed that participants attempting to appear aggressive naturally increase their facial WHR ($M = 1.81$, $SD = 0.15$) relative to baseline ($M = 1.77$, $SD = 0.15$) using expressive cues, $t(39) = 2\ .20$, $p < .05$, $\eta^2 = .10$. There was no difference in the increase in facial WHR as a function of participant sex (male $M$ diff $= 0.036$, $SD = 0.10$; female $M$ diff $= 0.04$, $SD = 0.13$), $t(38) = 0.10$, *ns*. We also computed the correlation between these values and expressers' baseline WHR. We found that lower facial WHR at baseline was associated with relatively greater change in aggressive facial WHR, $r(38) = -.392$, $p < .05$ (Figure 1).

Finally, we assessed the contribution of individual AUs to the increase in facial WHR observed in expressers. We first calculated the correlation between the total number of anger-relevant AUs present in the aggressive faces (the absence of a cue was coded as "0" and the presence of a cue was coded "1") and the relative difference in facial WHR in aggressive relative to neutral faces. Each participant generated anywhere from 0 to 4 of the AUs that we measured, with a median of 2. We found a positive correlation, indicating that the more anger-related AUs appeared, the more facial WHR increased, that is, the more participants' faces mimicked the morphologies typical of aggressive individuals, $r(38) = .45$, $p < .005$. Results were nearly identical when we calculated the correlation using the average AU intensity scores across all 7 AUs rather than counts $r(38) = .47$, $p < .005$. Across participants, the individual AUs whose presence was most closely associated with increased facial WHR were lowered brows, $r(38) = .46$, $p < .005$, and raising of the upper lip, $r(38) = 0.53$, $p < .001$. In general, participants attempting to appear dominant did not employ happiness-related AUs. AU6 did not appear at all among dominant faces, and AU12 appeared only twice (and in both cases, also appeared in the participant's neutral baseline face).

## Discussion

The results of Study 1 support our hypothesis that individuals induced to appear dominant and aggressive engage in behaviors that mimic the appearance of naturally high facial WHR, including lowering the brows and raising the upper lip, cues characteristic of the expression of anger. The extent to which participants increase their facial WHR using these behaviors is inversely related to their baseline facial WHR, consistent with the idea that these cues enable expressers to overrepresent their competitive abilities. In Study 2, we tested whether standard anger expressions accomplish the same changes in facial proportions using anger and neutral expressions from a well-validated stimulus set (the NIMSTIM set, Tottenham et al., 2009). We also presented these faces to untrained study participants who assessed the perceived aggressiveness of the faces in the set, permitting us to examine the relationship between how expressive behavior changes facial WHR and how it changes perceived aggressiveness. We hypothesized that anger expressions would increase facial WHR relative to neutral expressions and that the change in facial WHR from neutral to anger would predict changes in the faces' perceived aggression. We also predicted that digitally manipulating anger expressions to further increase or decrease facial WHR would result in observers' attributions of aggression being strengthened or attenuated, respectively.

## Study 2

### *Participants*

Undergraduate study participants (13 men, 35 women, $M$ age $= 21$ years, $SD = 1.27$) received either course credit or payment for participation.

### *Stimuli and Procedures*

Photographs were obtained from 18 young adult male expressers in the NIMSTIM expressive faces set, selected because this set provides validated and well-controlled neutral and angry expressions (Tottenham et al., 2009). We used the closed-mouth variants of both angry and neutral expressions and we selected only Caucasian males to avoid judgments based on stereotypes (Carré et al., 2009). Three trained raters separately measured the proportions of each face measured according to Weston and colleagues' criteria (Weston et al., 2007).

Next, using Adobe Photoshop, a spherizing function that compresses or stretches the midface was applied to each face

in 10% increments between −50% and +50% to generate 10 manipulated versions of each angry face that varied in facial WHR, which was measured and recorded for each version. Each 10% change altered facial WHR by approximately 0.016 units. All images were presented to participants using Superlab and appeared approximately 21 cm wide by 24 cm high. Participants were shown 11 versions (1 unmanipulated, 10 manipulated) of each angry face plus equivalent manipulated and unmanipulated versions of each expressers's neutral face (for a total of 396 faces) in a task modeled after that of Carré and colleagues (Carré et al., 2009) and were instructed to rate each face according to how aggressive each person would be if provoked. The images were presented in randomized order for 39 ms each, during which a 7-point Likert-type scale (1 = *not aggressive at all*, 7 = *very aggressive*) appeared on the screen.

## Results

An intraclass correlation coefficient was again applied to the measurements of the three independent raters who calculated facial WHR. The measurements were highly internally consistent ($R = .987$) and the average of the raters' measurements for each face was again computed. To test our hypothesis that angry expressions increase facial WHR, we first calculated a paired samples *t*-test using the expressers as the units of analysis (Marsh et al., 2009) that compared facial WHR in unaltered angry expressions and neutral expressions. The results confirmed that angry expressions ($M = 2.03$, $SD = 0.12$) increase an expresser's facial WHR relative to neutral expressions ($M = 1.83$, $SD = 0.10$), $t(17) = 8.39$, $p < .001$, $\eta^2 = .81$.

To confirm that this is a feature specific to angry faces, we also measured the facial WHR of the stimulus males posing three other expressions for which closed-mouth versions are available in the NIMSTIM set (fear, happiness, and sadness) using identical techniques to those described earlier and obtaining similarly high reliability among coders ($R$s = .99, .95, .96). Results confirmed that fear expressions reduce facial WHR relative to neutral ($M = 1.64$, $SD = 0.13$), sadness results in no net change ($M = 1.84$, $SD = 0.16$), and happiness modestly increases facial WHR ($M = 1.90$, $SD = 0.14$). Comparing each of these expressions to both neutral and angry expressions, we found that facial WHR was greater for anger than for any other expression (all $p$s < .01, Bonferroni corrected) but that no other expression increased facial WHR relative to neutral (all $p$s > .05, Bonferroni corrected; Figure 2). Fear was the only expression that significantly reduced facial WHR relative to neutral, $t(17) = 8.97$, $p < .001$, Bonferroni corrected, $\eta^2 = .83$.

To test whether differences in observers' estimates of aggressiveness for angry and neutral faces can be predicted using the difference in facial WHR for these faces, we then calculated the difference (anger − neutral) in facial WHR for each expresser and the difference in perceived aggression (anger − neutral) for each expresser. (These calculations were computed only for unaltered angry expressions.) We then calculated the correlation between these difference scores. The result of this correlation, $r(17) = .54$, indicated that the extent to which angry expressions change facial WHR can explain nearly one third ($R^2 = .29$) of the increased aggressiveness attributed to individuals expressing anger.

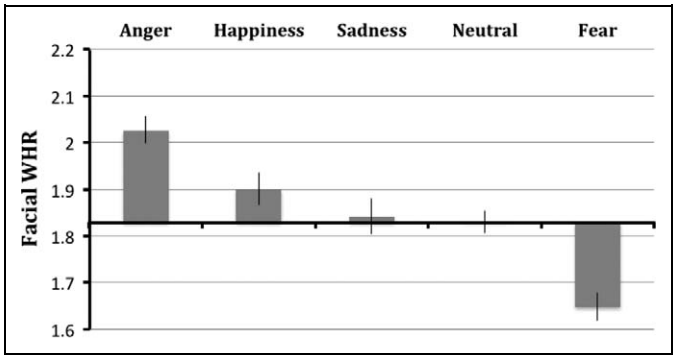


**Figure 2.** Average facial WHR across five facial expressions (error bars represent standard error of the mean).

Finally, we assessed whether digitally manipulating the facial WHR ratio of angry faces affects perceived aggression. This was accomplished by calculating the correlation between facial WHR and perceived aggression across the 11 variants of each expresser's face. The average of these correlations, $r(17) = .50$, $p < 0.05$, confirms that the perceived aggressiveness of an angry expression is yoked to changes in the expression's facial WHR; in other words, a face expressing anger will appear more aggressive the greater its facial WHR even when the presence of various AUs is held constant.

## Discussion

The idea that emotional facial expressions like anger are universally displayed (with cultural and regional variations) and thus likely part of our biological makeup has become broadly accepted (Elfenbein & Ambady, 2002; Peleg et al., 2006; Russell, 1995), and a variety of efforts have been made to identify the functions facial expressions serve that have maintained them in the human behavioral repertoire. Some have focused on physiological functions, for example, that expressions change the amount or temperature of the air flowing through the sinuses (Susskind et al., 2008; Zajonc, 1985) or change the expresser's field of view (Susskind et al., 2008). Others have focused on social functions served by expressive behavior (Fridlund, 1991; Marsh, Adams, & Kleck, 2005; Shariff & Tracy, 2011), a focus that is compatible with evidence that the display of emotional expressions is closely linked to the expresser's social context (Fridlund, 1991; Kraut & Johnston, 1979).

Among emotional facial expressions, those associated with anger appear to be particularly tightly linked to social context (Horstmann, 2003). Expressions consisting of lowered and knitted brows and a compressed or furled lips signal, in essence, "Back off, or I'll attack!" to viewers (Fridlund, 1994). Such a signal would be most effective in the context of evolved mechanisms for detecting social threat; that such mechanisms exist is supported by accumulating evidence (Roelofs, Hagenaars, & Stins,

2010; Short et al., 2011). Because the emotion anger is closely linked to reactive aggression (Blair, 2012), it is reasonable that the associated expression would signal the intention to attack. The results we report suggest that angry, aggressive facial displays may be effective in communicating aggressive potential because the particular appearance they take mimics an essential component of the baseline facial morphology of highly aggressive individuals: a relatively high facial WHR. In doing so, these data represent the first attempt to link the previously separate existing literatures demonstrating that both angry facial expressions and high facial WHR increase perceived dominance and aggressiveness.

It has previously been demonstrated that viewers' perceptions of aggression-relevant traits like trustworthiness can be shifted by digitally compressing facial WHR in neutral faces (Stirrat & Perrett, 2010); the present research shows that a comparable visual change can be achieved through muscle movements, as demonstrated in Study 1, when participants instructed to look aggressive naturally increased their facial WHR. Moreover, these movements achieve the same change in viewer perceptions of aggressiveness. In Study 2, males showing neutral expressions had facial WHR measurements similar to those of average male college students' facial proportions in prior research ($M = 1.83$, as compared to $M = 1.86$ in Carré & McCormick, 2008), but anger expressions increased those same individuals' average facial WHR such that they were close to those of the most aggressive varsity hockey players ($M = 2.03$, as compared to a maximum of approximately 2.07 in Carré & McCormick, 2008). The extent to which the angry facial expression increases facial WHR is tightly coupled to changes in viewers' perceptions of aggressive readiness. Nearly one third of the increase in perceived aggression in response to faces displaying anger can be attributed to objectively measured changes in facial WHR. We also digitally manipulated facial WHR in angry faces, demonstrating using an independent methodology that the degree to which an angry expression changes an individual's facial WHR predicts the extent to which the expression effectively communicates aggressive potential. It should be noted that the magnitudes of the correlations observed between perceived aggression and facial WHR in Study 2 ($r$s = .50 and .54) were comparable to those obtained in similar studies using static faces (e.g., $r$s = .59 and .70, Carré et al., 2009; $r = .64$, Short et al., 2012).

That perceptions of facial morphology and expressive behavior are mutually influential is well established (Hess, Adams, & Kleck, 2009). A large body of literature attests to the notion that individuals whose facial morphology resembles the appearance of particular facial expressions (Oosterhof & Todorov, 2009; Todorov, 2008), age groups (Zebrowitz & Montepare, 1992), or even animals (Zebrowitz et al., 2011) are judged in keeping with their appearances. We are arguing for an effect that reflects a somewhat different relationship between physiognomy and expressive behavior, which is that certain expressive behaviors may have emerged or been maintained in the behavioral repertoire because they simulate visually informative social cues. For example, postural status cues, across multiple species, increase the apparent physical size of the individual performing the display, reflecting the tight coupling between physical size and social status in many species (Marsh et al., 2009). This is a case in which the expressive display evolved to simulate the morphological appearance rather than the other way around (i.e., it is unlikely that larger animals are perceived as possessing high social status because large size mimics status cues). This makes it theoretically possible that other nonverbal cues follow a similar pattern—a static morphological feature becomes the basis for the appearance of an expressive cue.

We also found preliminary evidence for individual differences in participants' facial behavior as a function of their baseline facial morphology. Participants with lower baseline facial WHR were those who more effectively reconfigured their features to appear morphologically aggressive. Thus, even a person who is not naturally aggressive looking can momentarily appear as though he or she is. Research on agonistic cues indicates that this pattern occurs across species: Individuals within a species with lower aggressive potential may be more apt to use nonverbal displays of aggressive ability and intent (Arnott & Elwood, 2010; Goodwin et al., 1997; Hughes, 2000). Expressive behavior can in this way function as a low-cost strategy for increasing the expresser's chance of prevailing in (or preventing) an aggressive encounter. Future studies may be able to determine whether this tendency is also present among humans who express anger: That individuals with lower facial WHR at baseline use angry expressions more frequently or effectively in agonistic encounters.

Although whether a particular adaptive function of any modern human behavior led to that behavior's evolutionary selection can never be definitively determined, our research suggests that the anger expression provides modern expressers with a means of conveying heightened aggressive potential by mimicking a naturally occurring and valid cue to aggressive readiness, a change that has the potential to provide distinct adaptive advantages in some contexts.

## Authors' Note

Data collected in support of this article can be obtained by contacting the first author.

## Declaration of Conflicting Interests

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