Emotion

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Online First Publication, August 6, 2020. http://dx.doi.org/10.1037/emo0000846

CITATION

Witkower, Z., & Tracy, J. L. (2020, August 6). How and Why Head Position Changes the Perception of Facial Expressions of Emotion. *Emotion*. Advance online publication. http://dx.doi.org/10.1037/emo0000846

AMERICAN PSYCHOLOGICAL ASSOCIATION

Emotion

ISSN: 1528-3542

http://dx.doi.org/10.1037/emo0000846

How and Why Head Position Changes the Perception of Facial Expressions of Emotion

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A large body of research on emotion communication has demonstrated that facial muscle movements (i.e., facial expressions) influence social perceptions made from faces. However, new research suggests that head position can also affect the way that faces are perceived, by systematically changing the appearance of the face. More specifically, according to the action-unit imposter account, tilting one's head downward causes the eyebrows to appear lower and take on a V shape—the same appearance cues associated with a particular facial muscle movement (corrugator activity, or Action Unit 4 [AU4]). Drawing on this account, four studies (two of which were preregistered) tested whether a downward head tilt intensifies perceptions of facial expressions of emotion that include V-shaped eyebrows from AU4 but weaken perceptions of expressions that do not. Supporting this hypothesis, findings showed that (a) when the head is tilted downward, anger expressions—which include V-shaped eyebrows from AU4—are perceived as more intense, whereas expressions of happiness, disgust, fear, and surprise—which do not include V-shaped eyebrows from AU4—are perceived as less intense; (b) visually apparent changes to the eyebrows caused by the action-unit imposter effect account for the effect of a downward head tilt on perceptions of anger; and (c) this head movement is spontaneously used by individuals seeking to encode facial expressions of anger. Together, findings suggest that head movements play an important role in communicating emotion expressions from the face, especially anger.

Keywords: emotion expression, emotion perception, anger, head tilt, action-unit imposter

Supplemental materials: http://dx.doi.org/10.1037/emo0000846.supp

Facial expressions play a crucial role in the communication of emotional information (Ekman, 1993; Ekman & Oster, 1979; Ekman & Rosenberg, 1997), but they are almost never perceived in isolation. Instead, observers view these expressions as they rest upon their physical foundation: the head. Prior research has shown that head tilt (i.e., head pitch rotation upward or downward) may also play a role in emotion communication as it can influence the perception of a variety of emotion expressions from the face. For example, an upward head tilt increases the recognition of positive facial emotion expressions, including happiness, amusement, and pride (Cordaro et al., 2019; Livingstone & Palmer, 2016; Tracy & Robins, 2004, 2007; Witkower & Tracy, 2019a). In contrast, a downward head tilt increases recognition of negative emotion expressions including sadness and shame (Keltner, 1995; Keltner & Buswell, 1997; Livingstone & Palmer, 2016; Mignault & Chaudhuri, 2003; Toscano, Schubert, & Giessner, 2018; Tracy, Robins, & Schriber, 2009; Witkower & Tracy, 2019a, 2019b).

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All these hypotheses were preregistered at https://osf.io/8rhwb along with the method, sample size, and analysis plan.

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Head tilt also has been found to influence perceptions of social rank and personality; an upward head tilt can convey superiority and *prestige*—a form of high rank characterized by warmth and the receipt of admiration and respect (Mignault & Chaudhuri, 2003; Witkower, Tracy, Cheng, & Henrich, 2020)—and a downward head tilt, when eye gaze is directed toward observers, conveys intimidation and *dominance*—a form of high rank characterized by aggression and threat (Hehman, Leitner, & Gaertner, 2013; Torrance, Holzleitner, Lee, DeBruine, & Jones, 2020; Toscano et al., 2018; Tracy, Mercadante, Witkower, & Cheng, 2020; Witkower, Hill, et al., 2020; Witkower & Tracy, 2019a, 2019b). Together, these findings suggest that tilting one's head upward increases perceived positive emotion and affiliation, whereas tilting one's head downward increases perceived negative emotion and antisocial or threatening intentions.

Although these effects are well documented, only recently have studies begun to examine the visual mechanisms that account for them. Most notably, the effects of downward head tilt on perceptions of dominance and intimidation from a neutral face have been explained by the *action-unit imposter* account: Tilting the head downward causes one's eyebrows to appear to lower and take on a V shape, the same appearance changes that occur from activation of the corrugator muscle, or Action Unit 4 (AU4; Ekman, Friesen, & Hager, 2002). Corrugator activation is in turn associated with anger and threat across cultures (Ekman et al., 1987; Tracy & Robins, 2008). Tilting the head downward while the face remains neutral and eye gaze is directed forward therefore leads to antisocial perceptions of threat, intimidation, and dominance by mimicking appearance cues—V-shaped eyebrows—that are associated with similar threat signals caused by facial muscle activity (Witkower & Tracy, 2019b). The result is that tilting one's head downward elicits perceptions associated with a particular facial muscle movement even when no facial muscle activity has occurred. Supporting this account, a recent series of studies found that changes to eyebrow V shape are the critical mechanism accounting for perceivers' tendency to identify a neutral face accompanied by a downward head tilt as dominant (Witkower & Tracy, 2019b).

These studies used a variety of methods to support this point; in several, the authors manipulated eyebrow appearance and visibility of head tilt and found that while eyebrow V shape was necessary and sufficient to form perceptions of dominance from a downward-tilted head, visibility of the head tilt itself was not. In another study, participants (i.e., "targets") were photographed twice: once holding their head at a neutral angle and once tilting their heads down. These images were subsequently shown to a separate sample of judges who rated their perceptions of targets' dominance. Targets with downward-tilted heads were judged to be more dominant than those who held their heads at a neutral angle, supporting previous results. More importantly, measurements taken from the photos showed that tilting one's head downward increased eyebrow V shape, and this change in V shape mediated the relationship between targets' head tilt and perceivers' judgments of targets' dominance. Overall, these findings suggest that a downward head tilt affects social perceptions by systematically changing the appearance of the face, in much the same way that movements of the facial musculature do.

The action-unit imposter effect has thus far been found to influence social perceptions of neutral faces, but the account has interesting implications for facial expressions of emotion. Given that both head movements and facial muscle activation affect social perceptions by changing the appearance of the face, these two sets of behaviors may, at times, interfere with one another to alter the way that facial expressions are perceived. Yet the muscles responsible for head pitch rotation (longus capitis, longus colli, sternocleidomastoids, and trapezius) are located in the neck and back—not in the face. As a result, although shifts in head angle change the appearance of the face, head tilt cannot be considered a facial expression: It does not involve facial muscle activity. What this suggests, then, is that if head tilt influences perceptions formed from facial expressions of emotion, tilting one's head might cause a facial expression of emotion to take on a different appearance and consequently communicate a different message, even while observers' perceptions are based on information that is apparent only in the face.

In particular, because a downward head tilt leads to perceptions of threat or dominance, a facial expression of emotion paired with a downward head tilt might be perceived as more antisocial than whatever emotional message would be conveyed by its facial muscle movements alone. If this is the case, tilting one's head downward might change the message sent by a given emotion expression in ways that vary by the particular facial expression. For an emotion expression like anger, which is already antisocial, the addition of a downward head tilt might increase the perceived intensity of the anger message. Given that anger expressions include V-shaped eyebrows from corrugator activation, a downward head tilt should artificially inflate the apparent intensity of corrugator activation by further increasing the apparent V shape of the eyebrows, which should in turn increase the perceived intensity of the anger expression.

For a less antisocial, or even prosocial, emotion like happiness, the addition of a downward head tilt might completely shift the way the expression is interpreted such that it no longer communicates a prosocial message. Prosocial or positive emotion expressions do not include V-shaped eyebrows from corrugator activation, so adding a downward head tilt would introduce appearance cues that are atypical of the emotion being expressed, which should decrease the perceived intensity of the emotion. In other words, adding a downward head tilt should increase the perceived intensity of anger expressions but decrease the perceived intensity of expressions that are not antisocial and do not typically include V-shaped eyebrows, such as happiness, surprise, fear, and neutral.[1]

The Present Research

We conducted four studies (two of which were preregistered; https://osf.io/8rhwb) testing several hypotheses regarding the ways in which tilting one's head downward systematically changes the perception of facial expressions of emotion. We predicted that a downward head tilt would (a) increase perceptions of anger formed from an anger facial expression, and that this effect would be attributable to the increased appearance of V-shaped eyebrows, but (b) decrease the perceived intensity of emotion expressions that do not include V-shaped eyebrows from corrugator activation (i.e., fear, happiness, surprise, neutral). Together, these studies are the first to test how and why head movement can shift the messages sent by facial expressions of emotion.

Study 1

In Study 1, we tested whether a downward head tilt would increase the perceived intensity of anger but decrease the perceived intensity of other emotions. Based on our action-unit imposter account, we predicted that emotion expressions that do not include V-shaped eyebrows due to corrugator activation—in particular, surprise, fear, neutral, and happiness—would be perceived as less intense when paired with a downward head tilt given that this movement creates the artificial appearance of corrugator activity, or V-shaped eyebrows.

For disgust, our hypotheses were more exploratory. Although disgust does not prototypically include V-shaped eyebrows from corrugator activation, it does include activation of AU9 (levator labii superioris, alaeque nasi), which can cause the eyebrows to take on a V shape. However, AU9 is associated with several appearance cues in addition to those in the eyebrows, and these cues emerge predominately around the nose (e.g., pulling the skin alongside the nose upward, raising the infraorbital triangle, widening nostril wings) and mouth (e.g., pulling the center of the upper lip upward; Ekman et al., 2002). Given that tilting the head

[1] When referring to V-shaped eyebrows caused by corrugator activation, we mean unencumbered corrugator activation that is not altered by activation of the frontalis (i.e., AUs 1 or 2). This apparent V shape of the eyebrows caused by a downward head tilt is consistent with corrugator activation only if these additional action units are not present.

down alters perceptions by changing the V-shape appearance of the eyebrows but not of the nose or mouth (Witkower & Tracy, 2019b), it is likely that this head movement distinctively mimics the appearance of AU4 and not AU9. If this is the case, tilting one's head downward should increase the perceived intensity of an anger facial expression but not of a disgust facial expression. However, because AU9 does promote an eyebrow V shape, it is also possible that a downward head tilt might mimic the appearance cues of both AU4 and AU9 and consequently increase the perceived intensity of both anger and disgust. All these hypotheses were preregistered at https://osf.io/8rhwb along with the method, sample size, and analysis plan.

Method

Participants. One hundred sixty adults from Amazon Mechanical Turk participated in the current study; 14 of these failed an attention check and were not included in analyses, resulting in a final sample of 146 participants (46% male; age range = 19–66, median = 33 years). This sample exceeded the sample size necessary to uncover a moderate-sized effect (i.e., 65%) based on our preregistered power analysis using an alpha of .05, 80% power, and chance set at 50%.

Procedure. Participants completed seven randomly ordered trials in which they were shown two images side by side of the same facial expression: neutral, happiness, fear, anger, surprise, and disgust. In one of the two images, the head was positioned at a neutral angle, and in the other, the head was tilted down roughly 10–15°. For each pair of images, participants were asked to select the more intense version of the emotion that corresponded to the displayed expression such that they selected the image in which the person was experiencing more intense "surprise," "anger," "disgust," "fear," "happiness," and "calmness" (neutral).[2] We elected to use the word "calmness" instead of "neutral" to describe the neutral expression in order to avoid asking participants to select an image in which someone was experiencing "more intense neutral." This approach is consistent with prior studies that have considered responses of both "calm" and "neutral" to be accurate identifications of neutral expressions (Tottenham et al., 2009). This study was approved by the Behavioral Research Ethics Board at the University of British Columbia under the application H07-02274.

Stimuli. Six emotion expressions were posed and subsequently Facial Action Coding System (FACS)-coded by the first author, who is certified in the FACS: neutral (AU 0), surprise (AUs 1 + 2 + 5 + 25 + 26), anger (AUs 4 + 5 + 7 + 23), happiness (AUs 6 + 7 + 12),[3] disgust (AUs 9 + 10 + 25 + 26), and fear (AUs 1 + 2 + 4 + 5 + 20 + 25). Each expression was posed with the head at a neutral angle and then again with the head tilted down and eye gaze directed toward the camera (i.e., the addition of AUs 54 + 63). All photographs featured a male target in his mid-20s wearing a white shirt. Several photographs were taken for each expression until the expressions adequately matched prototypes from past research (Ekman et al., 2002; Langner et al., 2010; Olszanowski et al., 2015). All expressions, along with FACS codes for each image, are shown in Figure 1.

Results and Discussion

Seven binomial tests were conducted to assess whether participants selected the downward-head-tilted version of each expression as the more intense version of that expression at levels greater than chance (i.e., 50%). To account for multiple comparisons, highly conservative 99.99% confidence intervals were constructed around all estimates. As hypothesized, the anger expression was selected as conveying more intense anger when the head was tilted down compared to at a level angle, 83%, $p < .001$, 99.99% CI [.69, .93]. Also consistent with our hypotheses, the surprise expression was perceived as less intense surprise when the head was tilted down, 11%, $p < .001$, [.04, .24]; the fear expression was perceived as less intense fear when the head was tilted down, 26%, $p < .001$, [.13, .42]; the neutral expression was perceived as less calm when the head was tilted down, 7%, $p < .001$, [.01, .19]; and the happiness expression was selected as less intense happiness when the head was tilted down, 15%, $p < .001$, [.06, .30]. Finally, supporting the expectation that head tilt downward mimics AU4 but not AU9, the disgust expression was perceived as less intense disgust when the head was tilted down, 30%, $p < .001$, [.17, .47]; see Figure 2. In sum, these results supported our preregistered hypotheses: A downward head tilt increased the perceived intensity of the anger expression but decreased the perceived intensity of other expressions that do not include V-shaped eyebrows from corrugator activation (i.e., fear, surprise, neutral, disgust, and happiness).

Study 2

In Study 2, we tested our mechanistic explanation for the observed effect of downward head tilt on perceived intensity of anger expressions by manipulating the proposed visual mechanism: changes to eyebrow V-shape appearance (Witkower & Tracy, 2019b). First, to replicate the effect uncovered in Study 1, participants were shown a prototypical anger facial expression paired with either a downward head tilt or a head at a neutral angle and asked to select the more intense anger expression. Next, to test whether the action-unit imposter effect (i.e., the artificial appearance of eyebrows lowering and taking on a V shape, caused by a downward head tilt) is the visual mechanism responsible for any observed effect, we examined whether a downward head tilt would have a similar effect on perceptions of anger expressions when the critical hypothesized cue (i.e., eyebrow appearance) was held constant. If our mechanistic account is correct, a downward head tilt should *not* increase the perceived intensity of an anger expression if eyebrow shape and angle are held constant while the head is tilted downward (see Witkower & Tracy, 2019b). In other words, we hypothesized that visual changes to the eyebrows are

[2] We included an additional trial, not reported here, in which we showed participants a smiling expression with the head level and head tilted down and asked them to select the image in which the person was experiencing more intense "pleasure at the misfortune of another." This trial was included to address a separate theoretical question, outside the scope of the current article. For more details on results from this trial, see Witkower, Tracy, and Lange (2020) or contact the first author.

[3] Slight activation of AU7 (orbicularis oculi, pars palebralis) emerged, incidentally, in happiness expressions, in addition to AU6. This commonly occurs in intense happiness expressions as activated muscle fibers can spread to each other and cause coactivation.

Figure 1. FACS-coded emotion expressions, with the head at a neutral angle (left) and head tilted down (right), Study 1. See the online article for the color version of this figure.

necessary for a downward head tilt to increase perceptions of anger. We therefore preregistered the prediction that a downward head tilt would increase the perceived intensity of anger formed from an anger facial expression but would not have this effect when the head was tilted down but the eyebrows were artificially manipulated so as to not take on an increased V shape.

To further test this mechanistic account, we also examined whether manipulating *only* the critical hypothesized cue (i.e., eyebrow appearance changes) would increase the intensity of perceived anger, even if the head is *not* tilted downward. Findings in support of this prediction would suggest that the increased intensity of perceived anger from an anger expression paired with a downward head tilt cannot be attributed only to the observation of head movement but instead must be at least partly due to this movement's impact on facial appearance. In other words, we hypothesized that changes to the appearance of the eyebrows caused by a downward head tilt would be sufficient to increase the perceived intensity of anger expressions—even if head tilt is not visible. We preregistered all of these hypotheses along with the method, sample size, and analysis plan at https://osf.io/8rhwb.

Method

Participants. Two hundred fifty-nine adults from Amazon Mechanical Turk participated in the current study; eight of these failed an attention check and were not included in analyses, resulting in a final sample of 251 participants (49% male; age range = 18–71, median = 33 years). This sample exceeded the sample size necessary to uncover a small effect, based on our preregistered power analysis using an alpha of .05, 80% power, a moderate selection proportion (60%), and chance set at 50%.

Stimuli and procedure. Participants completed six trials in which they were shown two images side by side and asked to select the image in which the target individual was experiencing more intense anger. All images were derived from the anger expressions generated for Study 1, which were posed and FACS coded by the first author, who is certified in the FACS. These six trials allowed us to compare judgments of four different images, featuring a prototypical anger expression (Image A; AUs 4 + 5 + 7 + 23); a prototypical anger expression with the target's head tilted downward while maintaining eye gaze directed forward (Image B; AUs 4 + 5 + 7 + 23 + 54 + 63); a prototypical anger expression with the head titled down, eye gaze forward, and eyebrows replaced with those from the image where the target held his head at a neutral head angle (Image C; eyebrow replacement was performed with Adobe Photoshop); and a prototypical anger expression with the head at a neutral angle and eyebrows replaced with those from the image where the target held his head downward (Image D; see Figure 3). Images were edited by a graphic artist, blind to hypotheses, who ensured that replaced

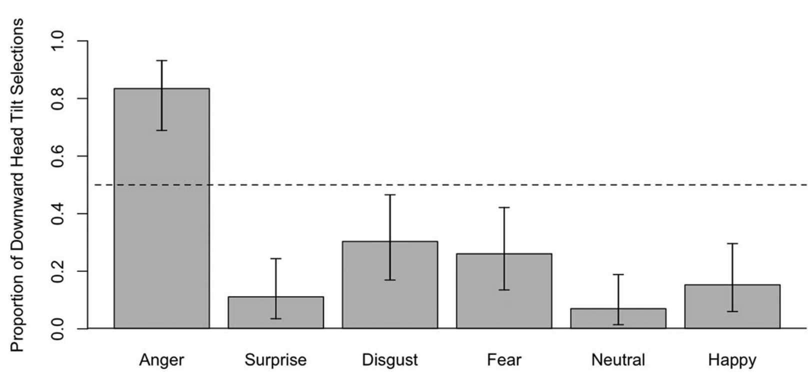

Figure 2. Proportion of downward-head-tilt selections for each emotion expression. Error bars illustrate 99.99% confidence intervals. Horizontal dashed line indicates chance level for each comparison (50%).

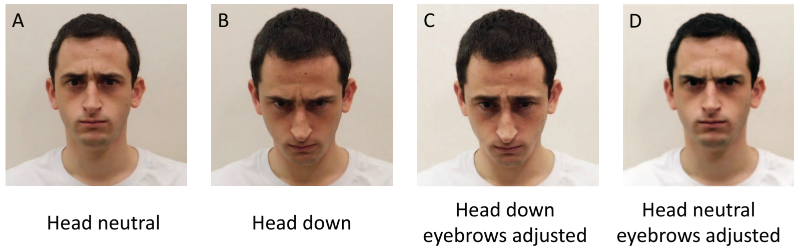

Figure 3. Four images used in Study 2. All four feature a prototypical anger facial expression, with the head at a neutral angle (Image A), the head tilted down (Image B), the head tilted down and eyebrows superimposed from Image A (Image C), and the head at a neutral angle and eyebrows superimposed from Image B (Image D). For primary preregistered analyses, anger perceptions made from Images B, C, and D were compared with those made from Image A. See the online article for the color version of this figure.

eyebrows appeared compatible with the face they were superimposed onto.[4]

In all primary comparisons, Image A was used as a baseline prototypical anger expression. By comparing Image A with Image B (prototypical anger with head tilted down), we were able to test whether a downward head tilt increases the perceived intensity of an anger expression. By comparing Image A with Image C (prototypical anger expression with head tilted down and eyebrows identical to those in Image A), we were able to test whether a downward head tilt increases the perceived intensity of anger even if the eyebrows are held constant across both images (i.e., not permitted to take on the apparent V shape they naturally do when the head is tilted downward)—in other words, whether other appearance cues caused by downward head tilt, besides the eyebrows, might contribute to the effects of this movement on anger perceptions. Finally, by comparing Image A to Image D (identical to Image A except that the eyebrows were identical to those in Image B, where the head was tilted down), we could test whether the change in eyebrow appearance caused by downward head tilt is sufficient to increase the perceived intensity of an anger expression, even when the head is not tilted. Together, these comparisons address the question of whether appearance changes to the eyebrows are necessary and sufficient for a downward head tilt to increase perceptions of anger.

Although we were primarily interested in only these three comparisons, participants made all possible comparisons between all images so that our hypotheses were less obvious to them. The three preregistered trials of interest were randomly intermixed among the additional trials. This study was approved by the Behavioral Research Ethics Board at the University of British Columbia under the application H07-02274.

Results

Primary preregistered analyses. Three binomial tests were conducted to assess which expression was perceived as a more intense version of anger at levels greater than chance (i.e., 50% because in each trial participants selected one of two images). Replicating the results of Study 1, the anger expression with a downward head tilt was perceived as more intense compared to the same facial expression with a neutral head angle, 87%, $p < .001$, 95% CI [.82, .91]. Next, we compared Images A and C and found that the downward-head-tilt anger expression was perceived as conveying significantly less intense anger than the neutral-head anger expression when both featured neutral-head-angle eyebrows, 9%, $p < .001$, [.06, .13]. Consistent with our hypothesis, this result suggests that although a downward head tilt increased the perceived intensity of an anger expression in the first analysis, it did not have this effect when the eyebrows were held constant (see Figure 4).[5]

Next, we compared Image A with Image D and found, as hypothesized, that superimposing the downward-head-tilt eyebrows onto a neutral-head-angle anger expression caused this expression to convey more intense anger than a neutral-head anger expression with normal eyebrows, 98%, $p < .001$, 95% CI [.96, .99]. This finding suggests that introducing appearance changes to the eyebrows that are naturally caused by a downward head tilt—but not any other appearance changes caused by a downward head tilt—increased the perceived intensity of an anger expression. Importantly, this result also indicates that the weaker intensity of perceived anger in Image C compared with Image A cannot be due to the artificial manipulation of eyebrows in Image C; here, the image with artificially manipulated eyebrows (Image D) sent the stronger signal of anger.

Exploratory analyses. Although the three comparisons reported above—comparing each image to a neutral-head-angle anger expression—were the preregistered primary tests of our hypotheses, we also examined three additional comparisons, which were preregistered as exploratory analyses. First, participants judged the intensity of anger conveyed by a neutral-head-angle anger expression with eyebrows superimposed from a downward-head-tilt anger expression (Image D) with that of a downward-head-tilt anger expression with natural eyebrows (Image B). This comparison tests whether there is any residual effect of a down-

[4] We inadvertently neglected to instruct this graphic artist to ensure that alterations were not made to the appearance of the eyebrows in the process of photo editing. As a result, given that his main goal was to ensure that copied eyebrows appeared compatible with the face they were superimposed onto, it is possible that minor alterations were made to brow furrowing. Based on the images shown in Appendix A, such changes were barely perceptible; nonetheless, we endeavored to address this possible limitation in Study 3.

[5] In fact, the effect reversed, with perceptions of anger *decreasing* in response to the tilted head. Importantly, this reversal did not emerge in Study 3, which utilized a wider variety of targets, so we are hesitant to interpret it any further.

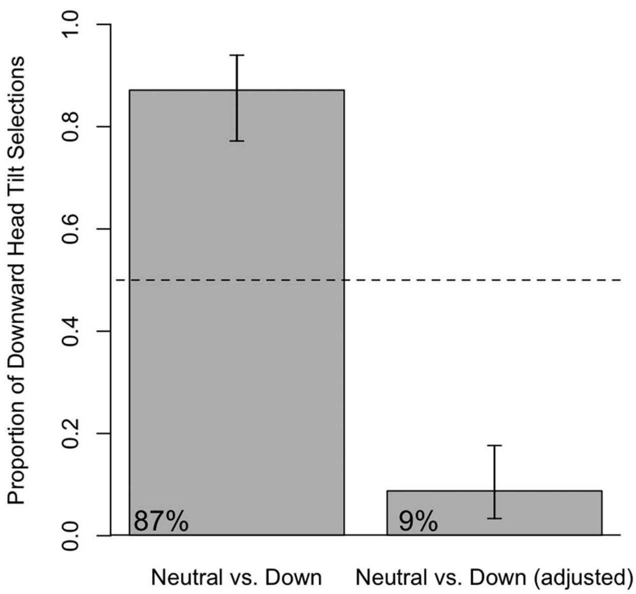

Figure 4. Proportion of selections indicating that the downward-head-tilt expression conveys more intense anger compared with a neutral-head-angle anger expression when there is no adjustment to the eyebrows (left bar) compared to when the eyebrows were artificially manipulated to appear identical to those in a neutral-head-tilt anger expression (right bar). Horizontal dashed line indicates chance level for each comparison (50%).

ward head tilt on the perceived intensity of anger after holding the downward-head-tilt eyebrows constant. Participants identified the neutral-head-angle expression as conveying more intense anger, 76%, $p < .001$, 95% CI [.70, .81], suggesting, somewhat surprisingly, that a downward head tilt decreased perceptions of anger when both images included downward-head-tilt eyebrows.

Second, participants judged the intensity of anger conveyed by a downward-head-tilt anger expression with eyebrows superimposed from a neutral-head-tilt anger expression (Image C) versus that of a downward-head-tilt anger expression with natural eyebrows (Image B). This comparison tests whether eliminating the appearance changes to the eyebrows associated with downward head tilt decreases the perceived intensity of anger when holding all other features of a downward head tilt constant. Participants identified the downward-head-tilt expression with natural eyebrows as expressing more intense anger, 97%, $p < .001$, 95% CI [.94, .99], suggesting that eliminating changes to the appearance of the V-shaped eyebrows naturally associated with a downward head tilt substantially decreased the perceived intensity of anger.

Finally, participants judged the anger conveyed by a downward-head-tilt anger expression with eyebrows from the neutral-head expression superimposed (Image C) with that of a neutral-head-angle anger expression with downward-head-tilt eyebrows superimposed (Image D). This comparison tests whether participants would judge a face with heightened V-shaped eyebrows as conveying more intense anger than a face with V-shaped eyebrows due to corrugator activity but not heightened by head tilt, even when both are presented with incongruent head-tilt information. It is noteworthy that this comparison directly pits eyebrow V shape and head tilt against each other, forcing participants to choose either the face with the stronger downward head tilt or the face with the stronger eyebrow V shape. Participants very reliably chose the neutral-head-angle expression, with the stronger V-shaped eyebrows, as expressing more intense anger, 97%, $p < .001$, 95% CI [.94, .99].

Discussion

Overall, the results of Study 2 provide strong support for our preregistered hypotheses: A downward head tilt increased the perceived intensity of an anger expression, and this effect was due to changes in the appearance of the eyebrows. Specifically, a downward head tilt increased perceptions of anger formed from an anger expression, but if eyebrows were not permitted to take on a V shape when the head was tilted down, this head movement no longer increased the perceived intensity of anger. Furthermore, when the eyebrows from a downward-head-tilted anger expression were superimposed onto a neutral-head anger expression, the latter was perceived as expressing more intense anger even when no other appearance changes associated with a downward head tilt were included. These findings indicate that appearance changes to the eyebrows formed from a downward head tilt (i.e., the action-unit imposter effect; Witkower & Tracy, 2019b) are necessary and sufficient to increase perceptions of anger formed from a prototypical anger expression.

However, we did observe one unexpected effect. When the eyebrows of a neutral-head anger expression were superimposed onto a downward-head-tilted anger expression, perceptions of anger were *decreased* compared to a natural neutral-head-angle anger expression. Although there are several possible explanations for this result (see online supplemental materials for discussion), we sought to replicate in Study 3 before further interpreting it. In Study 3, we also aimed to address a central limitation of Study 2: its reliance on a single target to convey all expressions, raising the possibility that these results are attributable to something distinctive about that individual.

Study 3

Studies 1 and 2 provide strong support for our preregistered hypotheses: A downward head tilt increased the perceived intensity of an anger expression, and this effect was due to changes in the appearance of the eyebrows. In Study 3, we replicated the methodology of Study 2 but included six different targets who varied in gender in order to test whether observed effects generalize beyond the single target used in Studies 1 and 2.

Method

Participants. Two hundred fifty-one adults from Amazon Mechanical Turk participated in the current study; nine of these failed an attention check and were not included in analyses, resulting in a final sample of 242 participants (58% male; age range = 19–77, median = 35 years).[6] This sample exceeded the size necessary to uncover a small effect, based on our power analysis from Study 2, using an alpha of .05, 80% power, a moderate selection proportion (60%), and chance set at 50%.

Stimuli. Six targets (two women, four men) posed an anger expression with their heads at a neutral angle and a second anger

[6] Two participants reported inaccurate ages (e.g., 53,719 years old); their responses for this question were removed.

expression with their heads tilted down roughly 10–15°. Five of these individuals were recruited for the current study, and the sixth was the same individual used in Study 2 but with altered images reedited. As was the case in Study 2, all expressions included activation of AU4 and eye gaze directed toward the camera. Targets were asked to remove jewelry and eyewear (if possible), wore a plain white t-shirt, and were photographed while sitting down.

A new graphic artist was recruited and asked to create stimuli similar to those used in Study 2 (see Figure 5). For each target, the artist used the anger expression with the head at a neutral angle (Image A) and the anger expression with the head tilted down (Image B) to create two new images with Adobe Photoshop. Specifically, to create Image C, the artist began with the anger expression in which the target's head was tilted downward (Image B) and replaced the eyebrows in that image with the eyebrows (including furrowing around the glabela) from the image in which the target held his or her head at a neutral head angle (Image A). To create Image D, the artist began with the anger expression in which the target's head was held at a neutral angle (Image A) and replaced the eyebrows in that image with the eyebrows (including furrowing around the glabela) from the image in which the target tilted his or her head down (Image B; see Figure 5).

More specifically, for each target, the eyebrows and glabela of both anger expressions were selected using the "lasso" tool. A new layer consisting of only the eyebrows and glabela was generated. Using these layers, the eyebrows from the downward-head-tilt expression were positioned directly on top of the neutral-head-angle expression, whereas the eyebrows from the neutral-head-angle expression were positioned directly on top of the downward-head-tilt expression. The eyebrows from the original photograph layer were removed. Next, the "auto-blend layers" function was applied to the eyebrow and original photograph layers, fusing the two images together. The clone and blur tools were used to adjust discolored areas and to improve blending until the images were satisfactory to the artist. The final image thus consisted of eyebrows that appeared compatible with the face they were superimposed onto, but with the unique shape of each eyebrow and furrowing near the glabela retained from the original image (see Figure 5; also see Appendix B; for all stimuli used in the current study, please contact the first author.)

Procedure. Participants completed 18 trials, in a randomized order, in which they were shown two images side by side and asked to select the image in which the target was experiencing more intense anger. For each of the six targets, participants completed the three primary preregistered comparisons described in Study 2 (Image A vs. Image B; Image A vs. Image C; Image A vs. Image D). The additional exploratory trials included in Study 2 were not included in the current study to reduce participant burden. Participants made all three comparisons for all six targets.

Results

We conducted binomial tests to assess which expression was perceived as a more intense version of anger for each condition, at levels greater than chance (i.e., 50% because in each trial, participants selected one of two images). For all analyses, we first aggregated across all targets and perceivers. Analyses with a cross-classified multilevel model did not meaningfully change the pattern reported below (for full reporting of this model, see online supplemental materials).

First, replicating the results of Studies 1 and 2 and supporting our hypotheses, when Image A was compared with Image B, the anger expression with a downward head tilt was perceived as conveying more intense anger compared to the anger expression with a neutral head angle, 86%, $p < .001$, 95% CI [.85, .88]. This effect did not vary by target gender, $\chi^2 = 0.08$, $p = .77$, [−0.05, .03]; see Figure 6. Second, when comparing Images A and C, the downward-head-tilt anger expression was perceived as conveying slightly more intense anger than the neutral-head anger expression when both featured neutral-head-angle eyebrows, 58%, $p < .001$, [.55, .61]. This effect varied slightly by target gender, $\chi^2 = 4.43$, $p = .04$, [.004, .11], such that the effect was slightly weaker for male, 56%, $p < .001$, [.53, .59], compared to female, 62%, $p <$

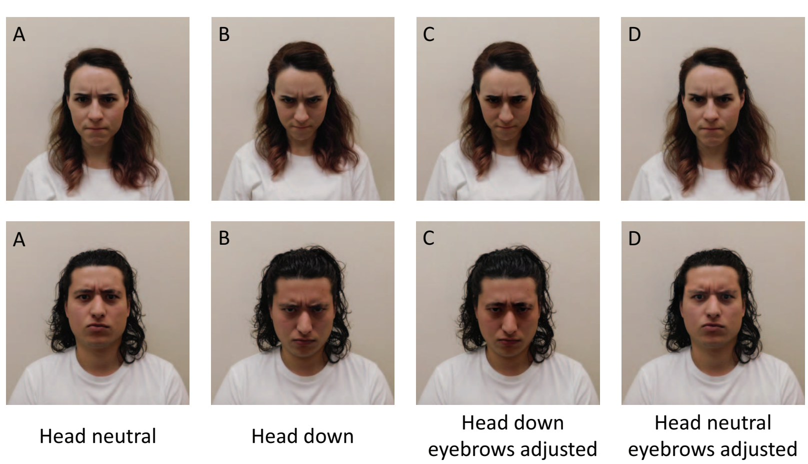

Figure 5. Stimuli featuring two of the targets included in Study 3. All images feature a prototypical anger facial expression, with the head at a neutral angle (Image A), the head tilted down (Image B), the head tilted down and eyebrows superimposed from Image A (Image C), and the head at a neutral angle and eyebrows superimposed from Image B (Image D). See the online article for the color version of this figure.

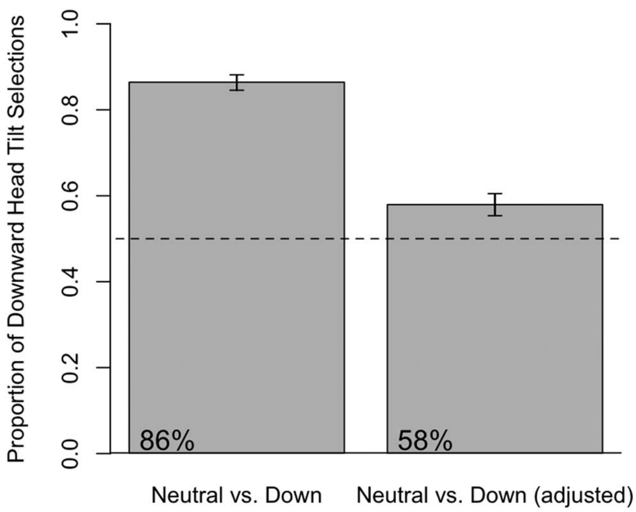

Figure 6. Proportion of selections indicating that the downward-head-tilt expression conveys more intense anger compared with a neutral-head-angle anger expression when there is no adjustment to the eyebrows (left bar) compared to when the eyebrows were artificially manipulated to appear identical to those in a neutral-head-tilt anger expression (right bar). Horizontal dashed line indicates chance level for each comparison (50%).

.001, [.57, .66], targets. Importantly, however, for both male and female targets, the magnitude of this effect (56% and 62%, respectively) was much smaller than the effect emerging from the previous analysis in which the head was tilted down but the eyebrows were not altered (86%), suggesting that the effect of a downward head tilt on perceptions of anger is largely driven by naturally occurring changes in eyebrow appearance.

Third, further supporting our hypotheses, when comparing Image A with Image D, we found that superimposing the downward-head-tilt eyebrows onto a neutral-head-angle anger expression caused this expression to convey more intense anger than a neutral-head anger expression with natural eyebrows, 88%, $p <$ .001, 95% CI [.86, .90]. This effect also varied slightly by target gender, $\chi^2 = 10.98$, $p < .001$, [.03, .10], such that the effect was slightly stronger for female, 92%, $p < .001$, [.89, .94], compared to male, 86%, $p < .001$, [.84, .88], targets. Again, however, for both male and female targets, the overall pattern remained the same: Superimposing the downward-head-tilt eyebrows onto a neutral-head-angle anger expression caused this expression to convey more intense anger. This finding suggests that introducing appearance changes to the eyebrows that are naturally caused by a downward head tilt—but not any other appearance changes caused by a downward head tilt—increased the perceived intensity of an anger expression, and this effect was consistent across target gender. Importantly, this result also indicates that the decrease in intensity of perceived anger in Image C compared with Image A cannot be due to the artificial manipulation of eyebrows in Image C; here, the image with artificially manipulated eyebrows (Image D) sent the stronger signal of anger.

Discussion

The results of Study 3 generally replicate those of Study 2 and thus provide further support for our hypotheses: A downward head tilt increased the perceived intensity of an anger expression, and this effect was due in part to changes in the appearance of the eyebrows. Specifically, a downward head tilt increased perceptions of anger formed from an anger expression, but when the eyebrows were not permitted to take on a V shape while the head was tilted down, this head movement increased the perceived intensity of anger to a much lesser extent. Furthermore, when the eyebrows from a downward-head-tilted anger expression were superimposed onto a neutral-head anger expression, the latter was perceived as expressing more intense anger even when no other appearance changes associated with a downward head tilt were included. The results of Study 3 also indicate that the effects uncovered in Study 2 generalize beyond the single target included in that study and across target gender.

However, we did observe one unexpected effect. When the eyebrows of a neutral-head anger expression were superimposed onto a downward-head-tilted anger expression, perceptions of anger slightly *increased* compared to a neutral-head-angle anger expression. This effect is inconsistent with Study 2, in which only a single target was used, raising the possibility that the Study 2 result might be due to something idiosyncratic about the face of that target. Indeed, when we analyzed the data separately for the male target in Study 3 who was also included in Study 2, we uncovered the same (unexpected) pattern as in Study 2: When comparing Images A and C, the downward-head-tilt anger expression was perceived as conveying *less* anger than the neutral-head anger expression when both featured neutral-head-angle eyebrows (38%, $p < .001$, 95% CI [.32, .45]; for separate results for each target, see online supplemental materials). In contrast, for the remaining five targets, comparing Images A and C showed that the downward-head-tilt anger expression was perceived as conveying similar or only slightly more anger than the neutral-head anger expression when both featured neutral-head-angle eyebrows. Together, these findings therefore suggest that a downward head tilt increased perceptions of anger formed from an anger expression, but when the eyebrows of a downward-head-tilt anger expression are edited so as to *not* take on a more intense V shape, this head movement has a substantially weaker effect (and, for one target, the opposite effect) on perceptions of anger.

Study 4

Given the finding from Studies 1, 2, and 3 that a downward head tilt increases the perceived intensity of anger but decreases the perceived intensity of other emotion expressions, we next sought to test whether individuals spontaneously use this head movement when seeking to express anger, more so than when seeking to express other emotions. Study 4 thus moved beyond examining perceptions of posed expressions to assess how people actually behave when seeking to communicate these emotions, thereby addressing the question of whether head tilt is relevant to the encoding of anger expressions as well as to the decoding of those expressions. More specifically, we examined behaviors shown by targets in the Warsaw Set of Emotional Facial Expression Pictures (WSEFEP; Olszanowski et al., 2015)—a facial expression database featuring images of individuals who engaged in a task that involved reliving emotional experiences before being photographed (Stanislavski, 1989). Targets were trained in how to move their face, but not their head, and in all cases were asked to try to experience the emotion while being photographed. These photos are thus likely to represent the behaviors individuals actually show when feeling a particular emotion, as well as those they think might help communicate the emotion. We predicted that these individuals would spontaneously tilt their heads downward more while posing anger expressions compared to when posing all other emotion expressions, even though they were given no instructions to do so.

Method

The Warsaw Set of Emotional Facial Expression Pictures. The WSEFEP is a high-quality, FACS-coded, peer-reviewed facial expression database (Olszanowski et al., 2015). It includes images of 30 Polish-speaking individuals displaying seven expressions each (anger, disgust, fear, happiness, sad, surprise, and neutral), for a total of 210 images. Similar to other expression databases, individuals were instructed on how to configure their face for each expression. Unlike other expression databases, however, displayers in the WSEFEP also recalled emotional experiences—along with the physical or physiological sensations associated with those emotion experiences—and engaged in a series of physical activities (e.g., sighing and holding the head in hands for sadness) to help elicit each emotion experience prior to being photographed (Stanislavski, 1989); the researchers used this technique to increase the authenticity of expressions. As a result, displayers "were inclined not to pose but instead express felt emotions, which were elicited during photo sessions" (Olszanowski et al., 2015, p. 2). In fact, these individuals were first educated on key elements essential for displaying desired expressions, then engaged in training workshops, then practiced at home, and then finally performed the emotion elicitation task in order to evoke each emotion before being photographed. The final photographs can therefore be considered to be relatively authentic expressions, which were selected based on FACS activity and recognizability.

Stimuli and procedure. All images from the WSEFEP (30 unique targets displaying six emotion expressions and one neutral expression) were prepared for the study by a research assistant blind to the hypotheses. Images were prepared for a team of two nonverbal behavior coders, also blind to hypotheses. They were prepared such that coders were shown two images of a single target individual side by side: The target posing a neutral expression was presented on the left, and the target posing an emotion expression (i.e., anger, disgust, fear happy, sad, or surprise) was presented on the right (for a total of 180 trials pairing each emotion expression with the corresponding neutral expression; see Figure 7 for an example). All faces were blurred to obscure facial features and mask the specific expression being displayed. For all stimuli, coders were explicitly told that the image on the left featured a target displaying a neutral head angle,[7] which could be used as a comparison, and that their task was to code the head angle portrayed by the target on the right side.

The two coders then coded the degree of upward (interrater Cronbach's alpha = .71) and downward (interrater Cronbach's alpha = .88) head tilt of the expressive head in all stimuli, using a rating scale that ranged from 0 (*no behavior visible*) to 3 (*strong behavior apparent*). Composite scores for each head tilt direction (i.e., up and down) for each expression were computed by averaging across the two coders' ratings for each trial. Downward head tilt was the primary dependent variable of interest, but upward tilt was also coded in order to mask our hypotheses. All trials were presented to coders in a random order. This study was approved by the Behavioral Research Ethics Board at the University of British Columbia under the application H07-02274.

Results

We constructed two multilevel models to predict downward head tilt angle and upward head tilt angle from emotion expression (dummy coded, with anger expressions as the reference group), along with random intercepts for targets.[8] Analyses were conducted using the lme4 and lmerTest packages in R (Bates, Sarkar, Bates, & Matrix, 2007; Kuznetsova, Brockhoff, & Christensen, 2017). The formula for each multilevel model is as follows:

Level 1 model:

$$\textit{Head tilt angle}_{ij} = \beta_{0j} + \beta_{1j}d_{1ij} + \beta_{2j}d_{2ij} + \beta_{3j}d_{3ij} + \beta_{4j}d_{4ij} + \beta_{5j}d_{5ij} + e_{ij}$$

Level 2 model:

$$\begin{aligned} \beta_{0j} &= \gamma_{00} + u_{0j} \\ \beta_{1j} &= \gamma_{10} \\ \beta_{2j} &= \gamma_{20} \\ \beta_{3j} &= \gamma_{30} \\ \beta_{4j} &= \gamma_{40} \\ \beta_{5j} &= \gamma_{50} \\ e_{1j} &\sim N(0, \sigma^2) \\ u_{0j} &\sim N(0, \tau_{00}) \end{aligned}$$

First, a multilevel model predicting downward head tilt from emotion expression, including random intercepts for targets, indicated that targets tilted their heads downward to a significantly greater extent when posing anger expressions compared to all other expressions, including disgust, $b = -0.40$, $t(145) = -2.48$, $p = .01$, fear, $b = -1.56$, $t(145) = -9.70$, $p < .001$, happiness, $b = -1.46$, $t(145) = -9.08$, $p < .001$, sadness, $b = -1.00$, $t(145) = -6.19$, $p < .001$, and surprise, $b = -0.97$,

[7] We did not code or measure the head tilt in neutral displays, but there is good reason to assume that no tilt was present. These images are reliably perceived as neutral (Olszanowski et al., 2015), and slight head movements (as few as 10° either up or down) would likely have a strong effect on social perceptions even of neutral faces; prior research has shown that this movement causes neutral faces to be perceived as threatening, high status, and dominant (Hehman et al., 2013; Mignault & Chaudhuri, 2003; Witkower & Tracy, 2019b; Witkower, Tracy, et al., 2020).

[8] Including random slopes for each emotion expression led to a singular fit, so random slopes were removed from all models (Barr, Levy, Scheepers, & Tily, 2013). Follow-up cross-classified multilevel models including random effects for coders were constructed and uncovered the same fixed-effect pattern. Given that only two coders assessed head angle, we could not appropriately estimate cross-rater variability, so we report multilevel models with observations nested within targets as our main analysis (for full reporting of cross-classified multilevel models, see online supplemental materials). An additional model with target gender included as a Level 2 covariate did not alter the effect. For model comparisons between the model reported in the article and a "targets-only" model, or a model including target gender as a covariate, see online supplemental materials.

Figure 7. Example of stimuli used in Study 4. These images do not portray actual targets from Study 4 as we were not able to obtain permission to reproduce those; these are images of a target not featured in those stimuli, with his face blurred in the same way we did for the actual images used in the study. Nonverbal behavior coders were told that the image on the left was a neutral expression and were asked to code the degree of head tilt upward and downward of the image on the right. See the online article for the color version of this figure.

$t(145) = -5.99$, $p < .001$. The intercept was also significant, $b = 1.68$, $t(111.45) = 12.02$, $p < .001$, suggesting that the downward-head-tilt intensity for targets expressing anger was significantly greater than zero. In fact, the intensity of downward head tilt during expressions of anger was above the midpoint of the scale (which ranged from 0 to 3), and nearly two standard deviations greater than zero ($M = 1.68$, $SD = .92$), suggesting that displayers posing anger expressions, following an anger elicitation task, tended to spontaneously tilt their heads downward. Furthermore, these individuals tilted their head downward with a greater intensity when portraying anger compared to when portraying all other emotions (see Figure 8).

Next, a multilevel model predicting upward head tilt from emotion expression, including random intercepts for targets, indicated that targets tilted their heads upward significantly less when posing anger expressions compared to expressions of fear, $b = 0.86$, $t(145) = 6.89$, $p < .001$, and happiness, $b = 0.40$, $t(145) = 4.03$, $p < .001$. No differences in upward-head-tilt intensity emerged between anger expressions and disgust, $b = -0.02$, $t(145) = 0.17$, $p = .87$, sadness, $b = 0.11$, $t(145) = 1.17$, $p = .24$, or surprise expressions, $b = 0.05$, $t(145) = 0.50$, $p = .62$. Furthermore, the intercept was not significant, $b = 0.05$, $t(171.75) = 0.70$, $p = .49$, suggesting that the upward-head-tilt intensity for targets expressing anger was not significantly different than zero. These results indicate that targets did not tend to tilt their heads upward when expressing anger and therefore that their use of downward head tilt during anger expressions was not an artifact of greater head movement in both directions (see Figure 9).

General Discussion

The current research provides the first evidence that (a) a downward head tilt increases the perceived intensity of anger expressions but decreases the perceived intensity of other emotion expressions that do not include AU4, (b) this effect is attributable to the changing appearance of eyebrows that occurs with a down-

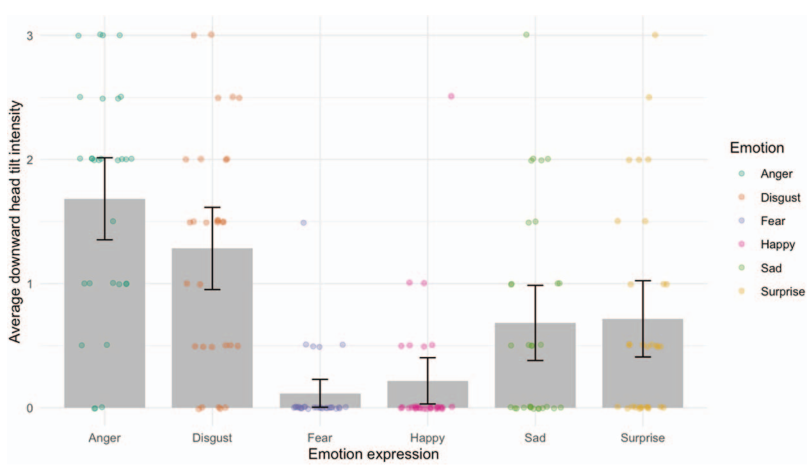

Figure 8. Average downward-head-tilt intensity displayed during the posing of each emotion expression. Error bars are 95% confidence intervals. Dots represent the average downward-head-tilt intensity for each target. Coders rated head movements on a scale ranging from 0 to 3. See the online article for the color version of this figure.

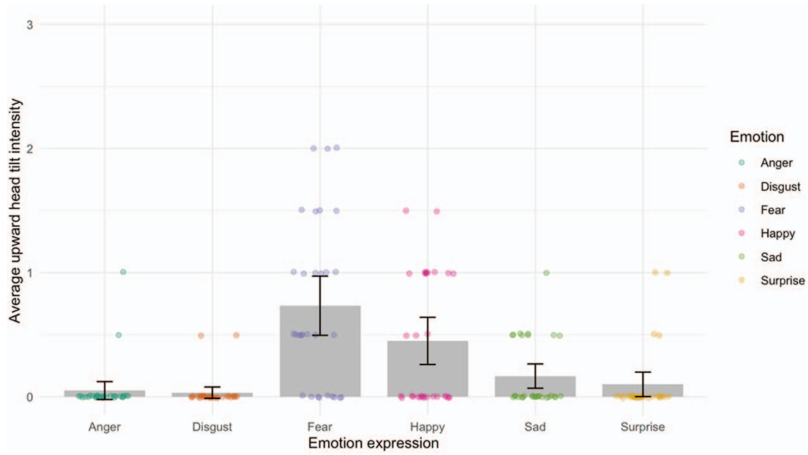

Figure 9. Average upward-head-tilt intensity displayed during the posing of each emotion expression. Error bars are 95% confidence intervals. Dots represent the average upward-head-tilt intensity for each target. Coders rated head movements on a scale ranging from 0 to 3. See the online article for the color version of this figure.

ward head tilt, and (c) individuals spontaneously display a downward head tilt when showing facial expressions of anger, and this tendency is substantially greater for anger than for expressions of other emotions. Together, these findings suggest that head movement impacts the communication of emotion via the face, and its specific effect depends on the emotion being expressed. Furthermore, these effects occur because head tilt changes the appearance of the face without altering facial muscle activation. Therefore, one implication of these results is that assessing only facial muscle movements when examining facial expressions of emotion may not adequately capture the emotional message that is actually conveyed by that face, unless the head is also considered.

These findings also have important implications for our understanding of anger expressions in particular. Prototypical anger expressions are often recognized at rates greater than 70% by individuals across cultures (e.g., Ekman et al., 1987; Olszanowski et al., 2015; Tracy et al., 2009), yet roughly 85% of participants in our first three studies identified a prototypical anger expression as conveying substantially less anger than a version of the same facial expression that included a downward head tilt. Future research might therefore consider incorporating a downward head tilt into anger-expression stimuli to increase the potency of expected effects.

We also found that a downward head tilt decreased the perceived intensity of all emotion expressions other than anger, but, interestingly, the magnitude of this decrease was smaller for disgust than several other emotions. Similarly, in Study 4, a downward head tilt was displayed with greater intensity during expressions of anger compared to all other emotion expressions, but individuals posing disgust also tilted their heads down somewhat and significantly more than when posing all other emotions besides anger. These results suggest that, in addition to mimicking the appearance of AU4, a downward head tilt might also mimic the appearance of other action units that similarly cause the eyebrows to take on a V shape—such as AU9, which is displayed during expressions of disgust. Importantly, AU9 includes several appearance changes in addition to V-shaped eyebrows (e.g., pulling the skin alongside the nose upward, raising the infraorbital triangle, widening nostril wings), whereas AU4 more exclusively causes the eyebrows to take on a V-shaped appearance. Downward head tilt does not create these other facial appearance changes, and our findings suggest that this head movement has the largest implications for perceptions of anger, likely for this reason (Witkower & Tracy, 2019b). In fact, when downward head tilt was added to the prototypical disgust expression, it was perceived as conveying *less* intense disgust than when the head was at a neutral angle.

It is noteworthy that the current findings advance previous research on the action-unit imposter effect in several ways. First, we show that a downward head tilt affects the communication of emotions from facial expressions, in addition to trait perceptions of neutral faces, as has been found previously (Witkower & Tracy, 2019b). Second, we show that a downward head tilt does not influence recognition for all emotion expressions in a similar way; instead, it increases recognition of anger but decreases recognition of other emotions. Third, we show that these effects are due, at least in part, to the action-unit imposter effect. Fourth, we show that a downward head tilt is used to express—and not only interpret—anger. The present findings thus demonstrate that the action-unit imposter mechanism has important implications for emotion communication, in addition to the previously established communication of dominance from a neutral (i.e., nonemotional) face.

Another important implication of the present research is that a downward head tilt might be relevant not only to reliable perceptions of anger (i.e., consensus among viewers, as was demonstrated in Studies 1 through 3) but also to *accurate* perceptions of anger (i.e., valid judgments based on the criterion of an encoder's felt emotional experience, as was demonstrated in Study 4). Indeed, drawing on a Brunswikian lens model framework (Brunswik, 1956; also see Hall, Horgan, & Murphy, 2019), the present findings suggest that a downward head tilt is likely to be both a valid cue of anger and a cue utilized to form perceptions of anger. Future studies might adopt this approach to test whether downward head tilt mediates accurate interpersonal communication of anger.

One limitation of the current research is that we examined the effect of only one head movement on the perceived intensity of emotion expressions, and only with eye gaze directed forward. Several other head movements are also likely to have implications for emotion perception, including an upward head tilt (Coulson, 2004; Livingstone & Palmer, 2016; Mignault & Chaudhuri, 2003; Tracy & Robins, 2007; Witkower & Tracy, 2019a), head yaw (Hess, Adams, & Kleck, 2004), and head roll (Bee, Franke, & Andreé, 2009; Krumhuber et al., 2007). In fact, findings from one prior study suggest that head yaw (i.e., horizontal head movement, consistent with the "no" gesture), when paired with an averted eye gaze, can *decrease* recognition of anger and increase recognition of fear by communicating an avoidance orientation (Hess et al., 2004). Given the opposite pattern uncovered in the present work, downward head tilt appears to have a notably different effect on emotion communication than head yaw and therefore is likely to capitalize on a different visual mechanism. As demonstrated here, the effect of downward head tilt can be explained with the action-unit imposter account, but future research is needed to explore the visual mechanisms responsible for other related effects.

A second limitation of the current research is that only one White male target was used to express emotions in both Studies 1 and 2. However, this limitation is partially addressed by Study 3, which included six targets who varied in gender. Furthermore, in Study 4, 30 Polish-speaking targets, varying in gender, spontaneously displayed downward head tilting while displaying anger, suggesting that the tendency to use this head movement generalizes at least to some extent. Nonetheless, examining the effect of head tilt on emotion expression recognition across a broader range of targets who vary in ethnicity and age is an important direction for future research.

Another important direction for future research is to examine whether the addition of a downward head tilt to a prototypical anger expression might increase perceptions of a broader array of antisocial messages beyond anger. For example, anger is theoretically intertwined with dominance; dominant strategists are likely to engage in outbursts of anger and capitalize on anger to elicit fear in subordinates (Cheng, Tracy, & Henrich, 2010). Given that facial expressions of anger elicit perceptions of dominance (Hareli, Shomrat, & Hess, 2009; Tiedens, 2001), it is likely that the combination of a downward head tilt and an anger facial expression would also increase perceptions of dominance. As noted above, prior work has shown that the combination of a downward head tilt and a neutral facial expression is strongly perceived as conveying dominance; future work is needed to determine whether the images examined here, featuring an anger expression and a downward head tilt, elicit even stronger dominance perceptions or whether the distinct-emotion signal conveyed by the anger facial expression dilutes any other antisocial message.

In conclusion, a downward head tilt can cause important shifts in the perception of emotions from facial expressions, and this occurs as a result of the action-unit imposter effect. The present findings thus suggest that research on facial expressions of emotion, particularly anger, should pay close attention to the physical foundation of the face: the head.

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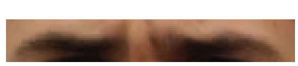
Appendix A

Close-Up Images of Eyebrows from All Experimental Conditions Included in Study 2

Left side: unaltered eyebrows, prior to Photoshop manipulation (i.e., head-neutral and head-down anger expression; Images A and B, respectively). Right side: eyebrows that were slightly edited after being superimposed onto a downward-tilted and neutral head with anger facial expression (Images C and D, respectively). Images were edited by a graphic artist who took certain artistic liberties to ensure that the superimposed eyebrows appeared compatible with the face they were superimposed onto.

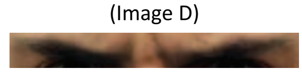
Head neutral
(Image A)



Head tilt down after Image A
eyebrows superimposed
(Image C)

Head tilt down
(Image B)

Head neutral after Image B
eyebrows superimposed
(Image D)



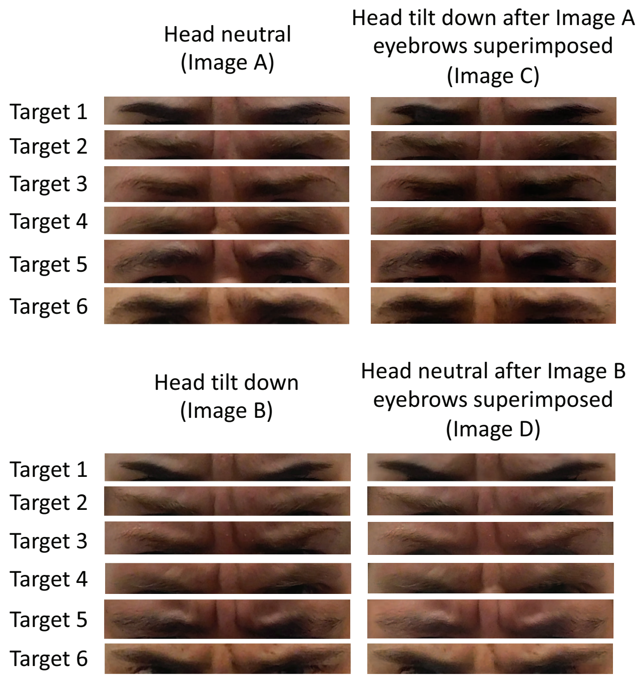
See the online article for the color version of this figure.

(*Appendices continues*)

Appendix B

Close-Up Images of Eyebrows from All Experimental Conditions Included in Study 3

Left side: unaltered eyebrows, prior to Photoshop manipulation (i.e., head-neutral and head-down anger expression; Images A and B, respectively). Right side: eyebrows that were slightly edited after being superimposed onto a downward-tilted and neutral head with anger facial expression (Images C and D, respectively). Images were edited by a graphic artist who ensured that the superimposed eyebrows appeared compatible with the face they were superimposed onto but did so without altering the appearance of furrowing around the glabela.



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Received December 9, 2019
Revision received April 6, 2020
Accepted May 8, 2020 ■