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A Facial-Action Imposter: How Head Tilt Influences Perceptions of Dominance From a Neutral Face

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Abstract
Research on face perception tends to focus on facial morphology and the activation of facial muscles while ignoring any impact of head position. We raise questions about this approach by demonstrating that head movements can dramatically shift the appearance of the face to shape social judgments without engaging facial musculature. In five studies (total $N = 1,517$), we found that when eye gaze was directed forward, tilting one's head downward (compared with a neutral angle) increased perceptions of dominance, and this effect was due to the illusory appearance of lowered and V-shaped eyebrows caused by a downward head tilt. Tilting one's head downward therefore functions as an *action-unit imposter*, creating the artificial appearance of a facial action unit that has a strong effect on social perception. Social judgments about faces are therefore driven not only by facial shape and musculature but also by movements in the face's physical foundation: the head.

Keywords
face perception, nonverbal behavior, social perception, dominance, head tilt, open data, preregistered

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Facial expressions—that is, changes to facial appearance caused by facial-muscle activation—fundamentally shape social perceptions (Ekman & Oster, 1979; Hareli, Shomrat, & Hess, 2009; Knutson, 1996). Here, we propose a novel account of social perception from the face. We argue that head position plays a critical role in face perception by causing the appearance of the face to change—paralleling the consequences of facial expressions—without using facial musculature. Specifically, head position in the form of downward-pitch rotation, or tilt, can co-opt the psychology of facial-expression perception by creating the visual illusion of facial dynamics: Tilting the head downward causes the eyebrows to take on an apparent V shape and become lowered—the same appearance cues associated with Action Unit 4 (i.e., corrugator activation; Ekman & Friesen, 1978)—even when the face in fact remains neutral (see Fig. 1). As a result, although tilting the head downward does not involve Action Unit 4, it may function as an imposter of that action unit by causing the same appearance changes.

Although prior research has not examined whether tilting the head downward causes the appearance of illusory eyebrow movement, studies have shown that actual eyebrow movement in the form of corrugator activation (i.e., Action Unit 4) increases perceptions of social rank (Keating & Bai, 1986) and that neutral faces with artificially lowered and V-shaped brows are perceived as high ranking and as physically strong, threatening, or dominant (Neth & Martinez, 2009; Schmid-Mast & Hall, 2004; Toscano, Schubert, & Sell, 2014). However, these results are based on manipulations of facial features. We believe that these same changes in facial appearance naturally occur when the head is tilted down (assuming similar viewing conditions; Kappas, Hess, Barr, & Kleck, 1994), and shifts in head movement therefore indirectly influence social perceptions via facial appearance changes (see also Martinez, 2017). In sum, the proposed action-unit-imposter hypothesis posits that when the head is tilted down, the eyebrows appear to

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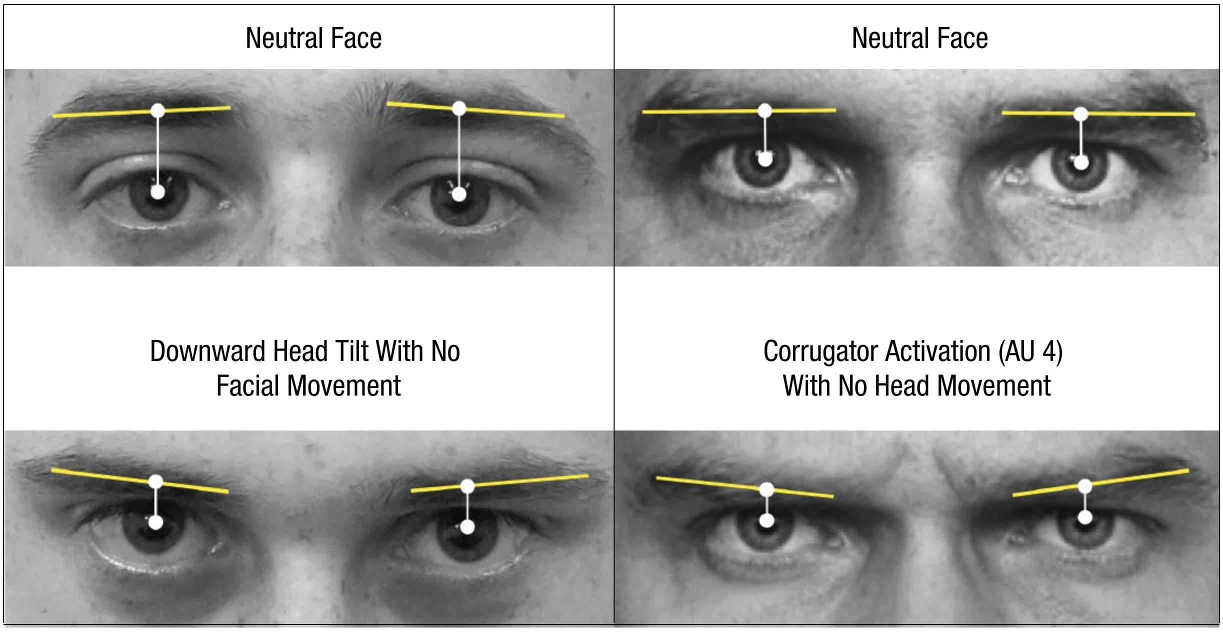

Fig. 1. Visualization of the mechanism proposed by the novel *action-unit-imposter* account. The top row shows neutral head and face images. The bottom row shows the same faces with a downward head tilt (left) and activation of Action Unit (AU) 4 (right). Both movements create the appearance of a V shape and lowering of the eyebrows. The images on the right are cropped photographs from the Facial Action Coding System, printed with permission from the Paul Ekman Group (Ekman & Friesen, 1978).

lower and take on a V shape (cues associated with Action Unit 4; see Fig. 1), and these changes in facial appearance cause observers to form perceptions of dominance. Head tilt therefore functions as an action-unit imposter, causing the same effect as a facial-muscle movement, on an inactive face.

Prior researchers have suggested that head movements contribute to perceptions of dominance, but the direction and mechanism underlying this effect remain elusive. Several scholars have suggested that tilting the head downward is a closed and contracted nonverbal movement that makes individuals appear smaller (Mignault & Chaudhuri, 2003; Rule, Adams, Ambady, & Freeman, 2012), thereby decreasing perceptions of dominance (Blaker & van Vugt, 2014; Marsh, Yu, Schechter, & Blair, 2009). Similarly, Lyons and colleagues (2000) suggested that tilting the head down might alter the apparent curvature of the mouth, increasing the extent to which a slightly smiling target is perceived as happy, an emotion that communicates warmth and affiliation and should therefore decrease perceptions of dominance. Yet other researchers have suggested exactly the opposite—that a downward head tilt increases perceptions of dominance by increasing the visible facial width-to-height (FWH) ratio (Hehman, Leitner, & Gaertner, 2013), a holistic facial metric associated with aggression and intimidation (Geniole, Denson, Dixson, Carré, & McCormick, 2015; but see Kosinski, 2017).

Our action-unit-imposter account, similar to the visible-FWH-ratio hypothesis and contrary to both the closed-and-contracted and mouth-curvature hypotheses, suggests that downward head tilt should increase perceptions of dominance from a neutral (i.e., completely inactive) face. Critically, however, our account offers a novel visual mechanism to explain this effect. In eight studies (five reported here and three reported in the Supplemental Material available online), we tested our action-unit-imposter account and provide the first empirical evidence that head movements can shape social judgments by creating the illusion of facial action and thereby altering the appearance of a neutral (i.e., inactive) face.[1]

Study 1

Method

Participants and procedure. One hundred twenty-five adults were recruited from Amazon Mechanical Turk (MTurk) to participate in the current within-subjects study; 24 of these failed an attention check and were not included in the analyses, resulting in a final sample of 101 participants (41% female; age range = 19–62, *Mdn* = 30 years). A power analysis indicated that our within-subjects design would require 55 participants to detect a moderate effect of head-tilt angle on perceptions of dominance ($f = .20$) with 80% power ($\alpha = .016$ for anticipated

Bonferroni correction with three groups, correlation among repeated measures = .5, no nonsphericity correction). However, given our goal of uncovering a robust effect to help resolve the conflicting predictions offered by extant theoretical accounts, we elected to approximately double that total sample size. Participants viewed three humanlike male avatars in a random order and judged the dominance of each.

Materials and measures.

Stimuli. Avatars were generated with Poser Pro (Smith Micro, 2014; see Fig. 2) to ensure precise manipulations of targets' head angle while preventing any incidental facial or body movements; all targets displayed neutral facial expressions (i.e., no facial-muscle activation). Each target was portrayed with the head tilted upward 10°, the head at a neutral angle (i.e., 0°), or the head tilted downward 10°. Eye gaze was directed toward participants in all stimuli because numerous studies have shown that a downward head tilt combined with eye gaze averted away from observers leads to perceptions of shame and submissiveness, essentially the opposite of dominance (e.g., Keltner, 1995; Shariff & Tracy, 2009; Tracy & Robins, 2008; Tracy, Robins, & Schriber, 2009). Furthermore, we validated this assumption in a preregistered study (see Study S1 in the Supplemental Material), which found that perceptions of dominance from a downward head tilt emerge only when eye gaze is directed toward observers (also see Toscano, Schubert, & Giessner, 2018).

Perceptions of dominance. Participants judged the dominance of each target using an abbreviated version of the Dominance scale ($\overline{\alpha}$ = .88; Cheng, Tracy, & Henrich, 2010), a validated measure of *dominance*, defined as the use of intimidation or threat to influence other people. This scale has been found to predict both perceived and actual influence (in the form of persuasion; Cheng, Tracy, Foulsham, Kingstone, & Henrich, 2013). The four

Fig. 2. Stimuli used in Study 1 (top row) and Study 2 (middle and bottom rows). From left to right, the poses illustrate downward head tilts, neutral head angles, and upward head tilts. In all images, targets posed with neutral facial expressions (i.e., no facial-muscle movement).

items constituting the abbreviated scale were chosen because they had the highest loadings on a dominance factor in initial studies validating the overall scale (see Cheng et al., 2010, and the Supplemental Material). These items were as follows: "This person would enjoy having control over others," "This person would be willing to use aggressive tactics to get their way," "This person would often try to get his way regardless of what people may want," and "This person would try to control others rather than permit them to control him." For each target, participants rated their agreement with each statement on a scale ranging from 1 (*not at all*) to 7 (*very much*).

Results

Our action-unit-imposter hypothesis predicted that the downward-head-tilting target should be perceived as more dominant than the upward-head-tilting or neutral targets because only the downward head tilt mimics the activation of Action Unit 4. The visible-FWH-ratio hypothesis predicts that both downward and upward head tilt should increase perceived dominance because both angles make the face appear wider relative to its height. The closed-and-contracted hypothesis predicts that downward head tilt, a contracted behavior, should decrease perceived dominance, whereas upward head tilt, an expansive behavior, should increase it. Similarly, the mouth-curvature hypothesis indirectly predicts that downward head tilt should decrease perceptions of dominance by virtue of increasing perceptions of happiness, an emotion expression that communicates warmth and affiliation.

A one-way repeated measures analysis of variance (ANOVA) uncovered a significant effect of head tilt on perceptions of dominance, $F(2, 200) = 28.99$, $p < .001$, $\eta_p^2 = .23$, indicating that a downward head tilt was judged to be significantly more dominant than a neutral angle or an upward tilt (see Fig. 3; *p*s < .001, *d*s = 0.79 and 0.39, respectively).[2] In addition, an upward head tilt was judged to be significantly more dominant than a neutral head angle, but the magnitude of this effect was less than half the size of that of the downward tilt versus neutral angle ($p < .001$, $d = 0.37$). An exploratory 3 (head tilt) × 2 (gender) ANOVA was conducted to assess whether the effect of head tilt on perceptions of dominance varied by participant gender. No interaction emerged, $F(2, 198) = 0.17$, $p = .84$, $\eta_p^2 = .002$.

Discussion

Consistent with the action-unit-imposter and visible-FWH-ratio hypotheses but inconsistent with the closed-and-contracted and mouth-curvature hypotheses, downward head tilt increased perceptions of dominance when compared with neutral head angle. Downward head tilt was also perceived as more dominant than upward head tilt, consistent with the action-unit-imposter account but not with the visible-FWH-ratio account.

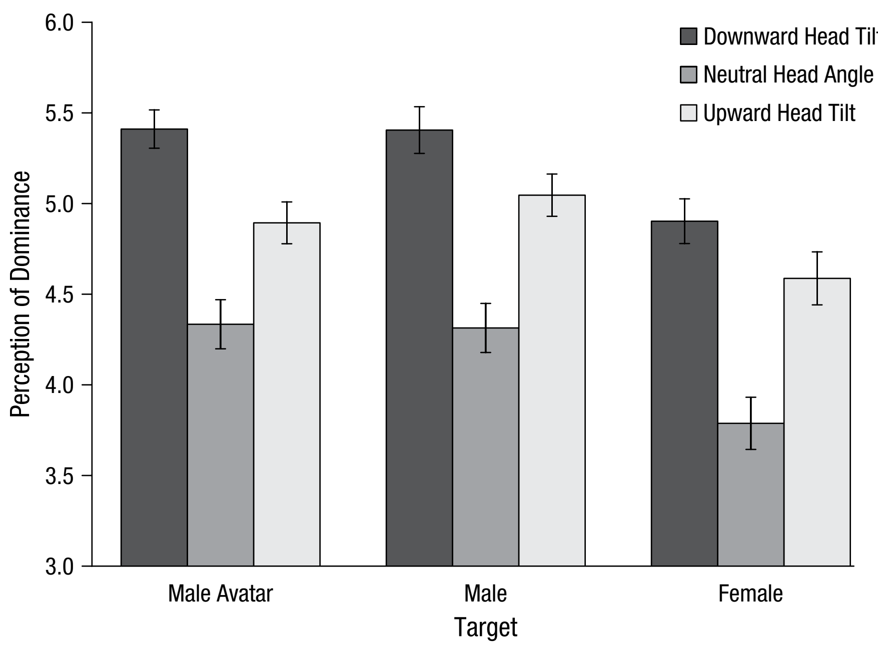

Fig. 3. Mean perception of dominance by head-tilt condition and target gender, separately for Study 1 (male avatars) and Study 2 (males and females). Error bars indicate ±1 *SEM*.

Study 2

Method

Study 2 was a preregistered attempt to replicate the results of Study 1 using human (rather than computer-generated avatar) targets of both genders and a between-subjects rather than within-subjects design (see osf.io/bmpj9/ for preregistration).

Participants and procedure. Six hundred seventeen adults from MTurk participated in the current between-subjects study; 47 of these failed an attention check and were not included in the analyses, resulting in a final sample of 570 participants (53% female; age range = 17–74, *Mdn* = 31 years). This exceeded the 524 participants necessary to uncover an effect size (f) of .25 in a 3 × 2 between-subjects ANOVA, on the basis of an alpha of .016 (anticipating a Bonferroni correction for three groups) and 90% power.

In a 3 (head tilt: downward vs. neutral vs. upward) × 2 (target gender: male vs. female) between-subjects design, participants viewed the head and neck of a human target portraying a neutral facial expression while holding his or her head either at a neutral angle, tilted upward, or tilted downward, always with gaze directed toward the viewer (see Fig. 2). Each participant was randomly assigned to view one of six single targets and indicate how dominant the target was perceived to be, using the same measure of dominance as in Study 1.

Stimuli. A male Caucasian actor and a female Caucasian actor, both in their mid-20s, posed for the three head-tilt positions following instructions from the first author. A research consultant who is a certified expert in the Facial Action Coding System (Ekman & Friesen, 1978) verified that the images displayed the intended head angle (up, down, or level) with eye gaze directed toward the camera and no additional facial-muscle behavior.

Results

Supporting our preregistered hypotheses, a 3 (head tilt) × 2 (target gender) ANOVA uncovered the predicted main effect of head tilt on perceptions of dominance, $F(2, 564) = 34.51$, $p < .001$, $\eta_p^2 = .11$, suggesting that a downward head tilt was judged to be significantly more dominant than a neutral head angle and an upward head tilt (*p*s ≤ .029, *d*s = 0.82 and 0.23, respectively; see Fig. 3). An upward head tilt was also judged to be significantly more dominant than a neutral head angle ($p < .001$, $d = 0.41$). A main effect of target gender also emerged, $F(1, 564) = 20.81$, $p < .001$, $\eta_p^2 = .04$, suggesting that the male target was judged to be significantly more dominant than the female target, $p < .001$, $d = 0.32$. However, no target-gender-by-head-tilt interaction emerged, $F(2, 564) = .033$, $p = .97$, $\eta_p^2 < .001$, suggesting that the magnitude of the head-tilt effects did not vary by gender of the displayer (for additional exploratory interaction models, see the Supplemental Material). Overall, these results replicate those of Study 1 and indicate that the downward-head-tilt effect is not restricted to a nonhuman avatar and generalizes across target gender.

Study 3

Our results thus far supported our action-unit-imposter hypothesis and the alternative visible-FWH-ratio hypothesis; our next studies pitted these against each other, while also providing stringent tests of the action-unit-imposter account. The action-unit-imposter account leads to several narrower predictions not shared with the visible-FWH-ratio hypothesis. First, the upper face (i.e., narrow band from the cheekbones to the brow ridge, excluding the forehead and mouth) alone should be sufficient to communicate dominance from a downward head tilt, given that the critical cues lie in the eyebrows and eyes. We therefore predicted that a downward head tilt would increase perceptions of dominance even when participants viewed this narrow band in isolation and, importantly, were prevented from seeing that the target's head was tilted. In contrast, the visible-FWH-ratio hypothesis predicts exactly the opposite; a face's height and width can be perceived only by observing the head's height and width, so the upper face in isolation should not increase dominance perceptions even if the head is tilted downward.

Second, the action-unit-imposter hypothesis suggests that the upper face is necessary for a downward head tilt to influence perceptions of dominance, given that the critical cue—changed eyebrow appearance—lies in that narrow band. We therefore further predicted that the effect of a downward head tilt on perceptions of dominance would not emerge if the upper face were visually occluded, even if the head's downward tilt were still visible. Study 3, preregistered at osf.io/bmpj9/, thus provided a stringent test of the action-unit-imposter account by testing two conservative predictions derived from it and pitting it against the visible-FWH-ratio account.

Method

Participants and procedure. Two hundred twenty-seven adults from MTurk participated in the current study; 18 of these failed an attention check and were not included in the analyses, resulting in a final sample of 209 participants (58% female; age range = 18–69, *Mdn* = 32

Fig. 4. Stimuli used in Study 3: upper-face-only condition (top row) and upper-face-occluded condition (bottom row). The images on the left display a neutral head angle, and the images on the right display a downward head tilt.

years). This exceeded the 171 participants necessary to uncover an effect size (f) of .25 in a 3 × 2 between-subjects ANOVA, on the basis of an alpha of .05 and 90% power. Because this was our first direct test of the action-unit-imposter hypothesis, we sought to increase power to reduce the likelihood of Type I errors. Each participant was randomly assigned to one of four conditions in which he or she viewed a single stimulus image and indicated perceptions of dominance using the same measure as in previous studies.

Stimuli. In this 2 (head tilt: downward vs. neutral) × 2 (stimulus type: upper face only vs. upper face occluded) between-subjects design, participants viewed the avatar target from Study 1 with his head either at a neutral angle or tilted downward 10°; these stimuli also varied in whether they consisted of the upper face only (i.e., narrow band consisting of eyes, eyebrows, and bridge of nose) or the whole head with the upper face occluded (see Fig. 4).

Results

A 2 (head tilt) × 2 (stimulus type) ANOVA uncovered a main effect of head tilt, $F(1, 205) = 21.74$, $p < .001$, $\eta_p^2 = .10$, which was qualified by a head-tilt-by-stimulus-type interaction, $F(1, 205) = 17.26$, $p < .001$, $\eta_p^2 = .08$ (see Fig. 5). Examining the effect of head tilt separately for each stimulus type revealed that, consistent with our preregistered hypotheses, when participants viewed the upper face in isolation, a large effect of head tilt emerged on perceptions of dominance, $F(1, 112) = 38.46$, $p < .001$, $\eta_p^2 = .26$, $d = 1.17$, indicating that a downward head tilt was perceived as significantly more dominant than a neutral head angle even when only the upper face was visible (see Fig. 5). Also consistent with our hypotheses, when the upper face was occluded, no effect of head tilt emerged on dominance perceptions, $p = .71$, $d = 0.07$. (It is also noteworthy that an unpredicted simple effect of facial occlusion on dominance emerged within the neutral-head-angle condition, $p = .003$, $d = 0.37$. Importantly, this effect is not relevant to the question of why downward head tilt increases dominance perceptions; we suspect that it is because certain masculine facial features are apparent only when the full face is visible, such as prominent cheekbones and facial hair.)

Discussion

These results suggest that the upper face is both necessary and sufficient for a downward head tilt to influence perceptions of dominance. This finding is inconsistent with the visible-FWH-ratio account; even when participants could not perceive visible FWH ratio in the upper-face-only condition, they judged the target as more dominant when his head was tilted downward. We also verified this conclusion in Study S2, which is reported in the Supplemental Material: When visible FWH ratio was artificially reduced by elongating the face of a target tilting his head downward, greater dominance perceptions continued to emerge, even though visible FWH ratio was smaller than in the neutral condition. The results of Study 3 are also inconsistent with prior research highlighting the importance of the mouth in these perceptions (Lyons et al., 2000); here, downward head tilt influenced perceptions of dominance even when mouth curvature was not visible and did not affect perceptions of dominance when the mouth was visible but the upper face was not. Together, these findings are consistent with our hypothesis that tilting one's head downward mimics the activation of facial

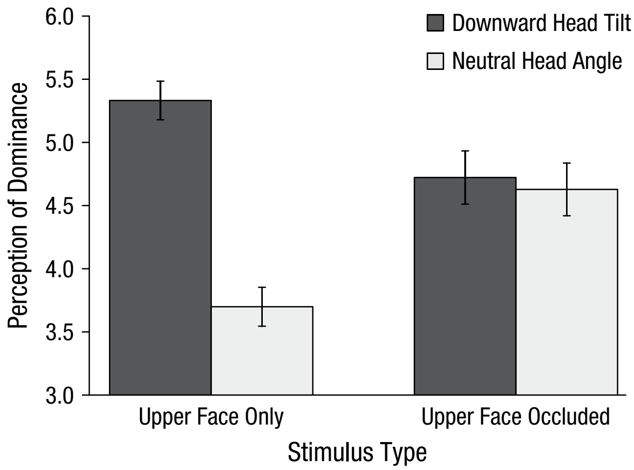

Fig. 5. Mean perception of dominance by head-tilt condition and stimulus type in Study 3. Error bars indicate ±1 *SEM*.

muscles to create the illusory appearance of Action Unit 4, consequently increasing perceptions of dominance.

Study 4

Although the results of Study 3 are consistent with the action-unit-imposter hypothesis and not other extant hypotheses, they leave open several questions. In particular, the observed effects might be attributable to alternative appearance changes to the upper face caused by downward head tilt, such as increased sclera below the iris or heightened salience of directed eye gaze when the lower face is hidden. To test our hypothesis that dominance perceptions form from the illusory appearance of lowered and V-shaped eyebrows—cues associated with Action Unit 4 rather than these other changes—in Study 4 (preregistered at osf.io/bmpj9/), we examined whether the effect would emerge when the critical hypothesized cues were held constant while other upper-face features (e.g., sclera) were allowed to vary naturally. If tilting the head downward causes increased perceptions of dominance by acting as an action-unit imposter and not by virtue of other changes that naturally co-occur, the effect should not emerge when eyebrows are held constant while the head is tilted downward. In this study, we also conducted a second test of this hypothesis using a different experimental design and a new measure of dominance perceptions.

Method

Participants and procedure. Two hundred forty-one adults from MTurk participated in the current study; 51 of these failed an attention check and were not included in the analyses, resulting in a final sample of 190 participants (58% female; age range = 19–74, *Mdn* = 34 years). This sample exceeded the 70 participants necessary to uncover a moderate-size effect ($f = .25$) in a 3 × 2 repeated measures ANOVA, on the basis of an alpha of .016, 80% power, no correlation among repeated measures, and no correction for sphericity.

In this two-part study, participants first viewed six stimuli (i.e., two different targets displaying neutral head angle, downward head tilt, and downward head tilt with eyebrows artificially adjusted to appear neutral; see Fig. 6) in a random order and rated the dominance of each using the same measure as in previous studies.

Second, participants were shown two of these images side by side and asked to select the image of the target who is "likely to be a leader because he is willing to use aggression and intimidation to get his way." This item was pretested for its validity as a single-item measure of perceived dominance; results suggested that it successfully captured perceptions of dominance from full-body nonverbal displays previously demonstrated to communicate dominance (Witkower, Tracy, Cheng, & Henrich, in press; Witkower, Hill, Pun, Baron, & Tracy, 2019). Participants completed this forced-choice item for all possible comparisons within each target (i.e., six times total). This secondary procedure was included to test whether similar results would emerge when participants directly compared images, responded in a forced-choice manner, and used a different measure of perceived dominance, allowing us to examine whether results generalize across perception-assessment methods and analytic approach (i.e., using continuous rating scales as well as a forced-choice method).

Stimuli. To test whether tilting the head downward increases perceptions of dominance by altering the visual appearance of the eyebrows, we developed stimuli in which the eyebrows were artificially manipulated independently of head-tilt angle. To do so, we used photographs of both a human and an avatar (a) displaying a neutral head angle and (b) tilting the head downward approximately 10°. Using Adobe Photoshop, we copied the eyebrows from the neutral-head-angle version of both targets and used them to replace the eyebrows that naturally appeared on their respective downward-head-tilt photographs. The resulting downward-head-tilt stimuli included all features that naturally emerge with a downward head tilt (e.g., increased sclera) with the exception of the eyebrows, which were instead identical in appearance to those in the neutral-head-angle condition (see Fig. 6).

Results

To determine whether it would be appropriate to aggregate analyses across targets, we conducted a 3 (condition: neutral head angle, downward head tilt, downward head tilt with eyebrows artificially adjusted to appear

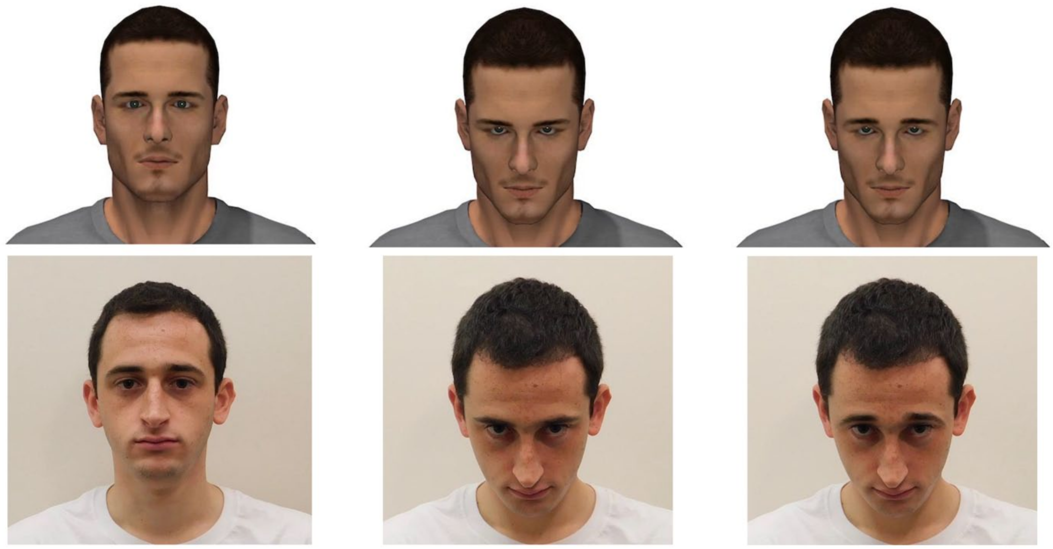

Fig. 6. Stimuli used in Study 4: avatar (top row) and human (bottom row) displaying a neutral head angle (left column), downward head tilt (middle column), and downward head tilt with eyebrows replaced with those from the neutral-head-angle condition (right column).

neutral) × 2 (target: human vs. avatar) within-subjects ANOVA on perceptions of dominance using the continuous rating scale and found no evidence of a target-by-condition interaction, $F(2, 378) = 0.53$, $p = .59$, $\eta_p^2 = .003$. We therefore collapsed across targets in the remaining analyses. Supporting our preregistered hypothesis, a one-way ANOVA revealed a significant effect of condition on perceptions of dominance (using the 7-point scale), $F(2, 378) = 91.79$, $p < .001$, $\eta_p^2 = .33$. Pairwise comparisons indicated that a downward head tilt (with no adjustment to the eyebrows) led to greater perceptions of dominance than a neutral head angle ($p < .01$, $d = 0.80$). In contrast, a downward head tilt with the eyebrows adjusted to appear neutral did not increase perceptions of dominance compared with a neutral head angle ($p > .99$, $d = -0.06$). This pattern of results was consistent for both targets—human: *d*s = 0.75 and 0.01, *p*s < .001 and > .99, respectively; avatar: *d*s = 0.73 and −0.08, *p*s < .001 and .80, respectively. Finally, a downward head tilt with eyebrows adjusted was perceived as less dominant than a downward head tilt with no adjustment to the eyebrows ($p < .001$, $d = 0.90$). Again, this effect emerged for the human target ($d = 0.68$, $p < .001$) and the avatar ($d = 0.77$, $p < .001$). These results suggest that a downward head tilt increases perceptions of dominance only if the eyebrows are permitted to take on a V-shaped appearance (see Fig. 7; also see Study S3 in the Supplemental Material).

Turning to the forced-choice response item, we conducted a series of binomial tests (with chance set at 50% for the two response options) to determine which condition led to the greatest perceptions of dominance. Overall, targets displaying a downward head tilt without their eyebrows adjusted were selected as more dominant than those displaying a neutral head angle (76%, $p < .001$, 95% confidence interval, or CI = [71%, 80%]). In contrast, targets with a downward head tilt and eyebrows adjusted were selected as dominant less often than those with a neutral head angle (23%, $p < .001$, 95% CI = [19%, 28%]) and less often than targets with a downward head tilt and naturally shifting eyebrow appearance (8%, $p < .001$, 95% CI = [6%, 11%]). These results parallel those from the first part of the study based on continuous ratings and again support our hypothesis that a downward head tilt increases perceptions of dominance only if the eyebrows are permitted to naturally take on an apparent V shape. Although we did not expect to observe a decrease in dominance perceptions in the artificially manipulated eyebrow condition compared with the neutral-head-angle condition, this result might be due to participants misperceiving a different muscle activation (i.e., frontalis, pars medialis; Action Unit 1, a movement associated with sadness; Ekman & Friesen, 1978; Langner et al., 2010; Olszanowski et al., 2015), which did not actually occur, when directly comparing the two head-tilt conditions right next to each other.

Study 5

Studies 3 and 4 produced robust and convergent results but used artificially manipulated head and facial features. Although experimental manipulations are often considered the best way to test hypotheses about

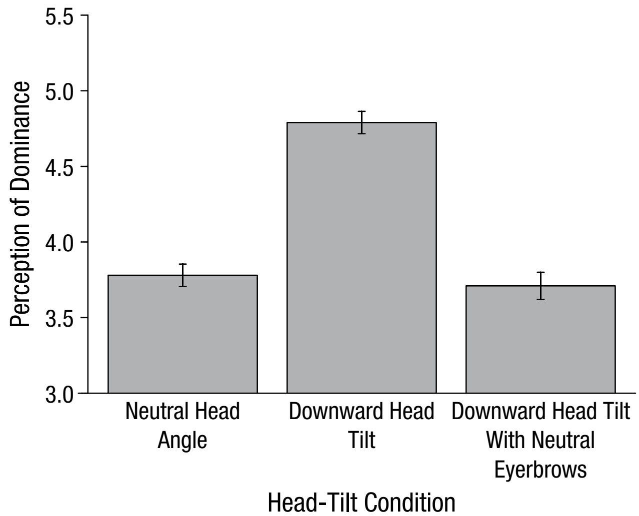

Fig. 7. Mean perception of dominance by head-tilt condition in Study 4. Mean ratings for each target are presented in Figure S5 in the Supplemental Material. Error bars indicate ±1 *SEM*.

mediating mechanisms (Spencer, Zanna, & Fong, 2005)—in this case, that downward head tilt causes the illusory appearance of lowered and V-shaped eyebrows, which in turn increases perceptions of dominance—both studies used somewhat unnatural or partially occluded stimuli, which might have contributed to the results. Study 5 tested our hypothesized mediational model using unaltered images.

Method

We manipulated head tilt in a diverse sample of targets and tested (a) whether a downward head tilt led to the appearance of a more V-shaped brow compared with a neutral head angle, (b) whether a downward head tilt increased perceptions of dominance compared with a neutral head angle, and (c) whether the latter effect was mediated by apparent eyebrow angle.

Participants and procedure. In the current yoked design, we recruited two samples of participants: targets, who were photographed posing with neutral expressions while tilting their heads downward and holding them at a neutral angle, and judges, who viewed photos of targets and rated perceptions of dominance. One hundred forty undergraduates from The University of British Columbia participated as targets. After entering the lab, targets were seated in a chair facing a Nikon Coolpix B500 HD camera mounted on a tripod. The tripod was adjusted so that the camera was at equal height with each target's eye level. All photographs were taken in the same room with targets seated in the same chair, using the same camera, and under the same lighting conditions. Targets were asked to sit up straight with their backs against the back of the chair while two photos were taken. First, they were asked to maintain a neutral facial expression while looking into the camera. If they failed to maintain a neutral expression, research assistants prompted them to do so. Next, targets were asked to tilt their heads downward between 10° and 15° while maintaining a neutral expression and looking into the camera. Targets were provided with visual examples of head-pitch rotation (with a neutral expression) to help clarify the instructions when necessary. Targets who failed to maintain a neutral expression in the upper face and lower face (a considerably large number; maintaining a completely neutral face is fairly difficult for untrained participants), had an eyebrow or part of the face that was not visible in photographs, or failed to follow instructions (e.g., tilted the head upward in the neutral condition) were excluded.

After these exclusions, we were left with 61 targets displaying two head angles (122 photographs in total); these individuals varied in ethnicity (15 White/Caucasian, 36 East Asian, 2 Hispanic/Latino, 2 Middle Eastern, 6 other/unknown/missing) and gender (73% female). Importantly, all exclusions were made before we recruited judges or showed the images to judges and before we coded the eyebrow angles of images (see below).

Next, 451 judges were recruited from MTurk; 65 of these failed an attention check and were not included in the analyses, resulting in a final sample of 386 judge participants (58% female; age range = 19–74, *Mdn* = 34 years). Judges were shown 20 randomly selected images from the set of 122 photos featuring the 61 targets either tilting their heads down or holding their heads at a neutral angle. Judges indicated how dominant each target was using the single item that was used and validated in Study 4: "This person is likely to be a leader because he/she is willing to use aggression and intimidation to get his/her way." We elected to use the single-item measure and recruit a large sample of judges but show each judge only 20 of the 221 images to reduce the amount of time necessary to complete the study and thereby avoid data-quality degradation while still maximizing power.

Eyebrow-angle coding. Four research assistants coded the apparent angle of each eyebrow in photos of all targets using a novel coding procedure that produced high interrater reliability (left eyebrow: $\alpha = .97$, right eyebrow: $\alpha = .96$). Images were presented on separate slides in Microsoft PowerPoint after being cropped for equal sizing across all targets. For each face, two horizontal lines were created (line height = 0.00 in., line width = 0.50 in., line thickness = 1 point). Eyebrow coders were asked to adjust these lines to cover the eyebrows and rotate each line until it accurately characterized each eyebrow (see Fig. 8) "as if it were a line of best fit characterizing a scatterplot." Coders were permitted to alter the visual qualities of the target image to help isolate the eyebrows, if necessary (e.g., brightness, contrast), but not the shape or size of the image.

Given that our hypotheses pertained to the appearance cues associated with corrugator activation (i.e., Action Unit 4), the medial and central parts of the eyebrow were our primary focus; in some images, the lateral part of the eyebrow (i.e., the "tail") was at a different angle from the medial part, but in such cases, coders were instructed to ignore the tail and instead focus on fitting the line to the thickest part (i.e., main portion) of the eyebrow. The final angle of each eyebrow was measured by the deviation in the angle from the initial horizontal line. Angles of the left and right eyebrows were highly correlated in both conditions ($r = -.75$, $p < .001$, 95% CI = [−.82, −.66]), so we assessed brow V shape by averaging both eyebrows' angles after multiplying the apparent right eyebrow (i.e., perceiver's perspective) by −1, so higher numbers indicate greater downward angle of both brows, or perceived V shape. The distribution of eyebrow angle for each head-tilt condition is presented in Figure 9.

Results

Several multilevel models were constructed to test the indirect effect of head tilt on perceived dominance via changes to eyebrow V shape (see Fig. 10). First, a multilevel model predicting eyebrow V shape from targets' head-tilt condition (0 = head neutral, 1 = head down) and random intercepts for targets indicated that targets who portrayed a downward head tilt had a greater V shape in their eyebrow angle, $b = 5.92$, 95% CI = [5.09, 6.76], $t(59) = 13.96$, $p < .001$ (for mean eyebrow V shape in each head-tilt condition, see Fig. 9). This effect remained robust after including random slopes for head-tilt condition and controlling for target ethnicity and gender (see Table 1).

Next, a multilevel model predicting perceived dominance from head-tilt condition and random intercepts for judges indicated that the total effect of downward head tilt on perceptions of dominance was significant, $b = 0.33$, 95% CI = [0.24, 0.41], $t(7411) = 7.38$, $p < .001$. This effect remained robust after analyses controlled for target ethnicity and target gender (see Table 1). In addition, a multilevel model predicting perceived dominance from head-tilt condition and eyebrow V shape, along with random intercepts for judges, indicated that V-shaped eyebrows led to increased perceptions of dominance, controlling for the effect of head tilt, $b = 0.03$, 95% CI = [0.02, 0.04], $t(7396) = 6.20$, $p < .001$. This effect was strengthened after analyses controlled for target ethnicity and target gender (see Table 1).

We found that the direct effect of head tilt on perceptions of dominance while controlling for eyebrow V shape was significant but partially attenuated, $b = 0.17$, 95% CI = [0.07, 0.27], $t(7396) = 3.26$, $p < .001$. Finally, the indirect effect of head tilt on perceptions of dominance via eyebrow V shape was significant, $b = 0.16$, 95% CI = [0.11, 0.22], $p < .01$.

Follow-up models outlining the *a* and *b* pathways while estimating additional random slopes and covariates, or using different analyses (e.g., repeated measures ANOVA), did not change the statistical significance or the direction of other pathways in the model (see Table 1; also see the Supplemental Material). In sum, the results of Study 5 indicate that tilting the head downward causes the eyebrow angle to take on an apparent V shape, and V-shaped eyebrows are related to increased perceptions of dominance.

General Discussion

The current research provides the first evidence that tilting one's head downward causes the eyebrows to lower and take on a V shape, creating the illusion of corrugator activity, or Action Unit 4, and this illusory movement in turn increases perceptions of dominance when eye gaze is directed forward. Across five studies, we found that tilting one's head downward functions as an action-unit imposter, generating the appearance of facial-muscle activity that has a strong impact on social perceptions when no such activity exists. This finding emerged from studies showing that (a) the effect of a downward head tilt on dominance perceptions cannot be attributed to alternative mechanisms such as a closed-and-contracted appearance, apparent mouth curvature, or increased visible FWH ratio; (b) the upper face—where the eyebrows and eyes are localized—is necessary and sufficient for perceptions of dominance to emerge from a downward head tilt; (c) tilting the head downward while holding eyebrow angle constant prevents the effect from emerging; and (d) tilting the head downward changes the appearance of the eyebrows by causing them to take on an apparent V shape, and we found that these visual changes are associated with increased dominance perceptions, even after controlling for head tilt.

These findings also provide the first evidence that head movement alters the appearance of the face systematically by creating the illusion of facial-muscle activity. Head movement is therefore likely to influence facial communication and emotion expressions, broadly speaking. Although some people might consider the head a source of noise that can obscure facial visibility,

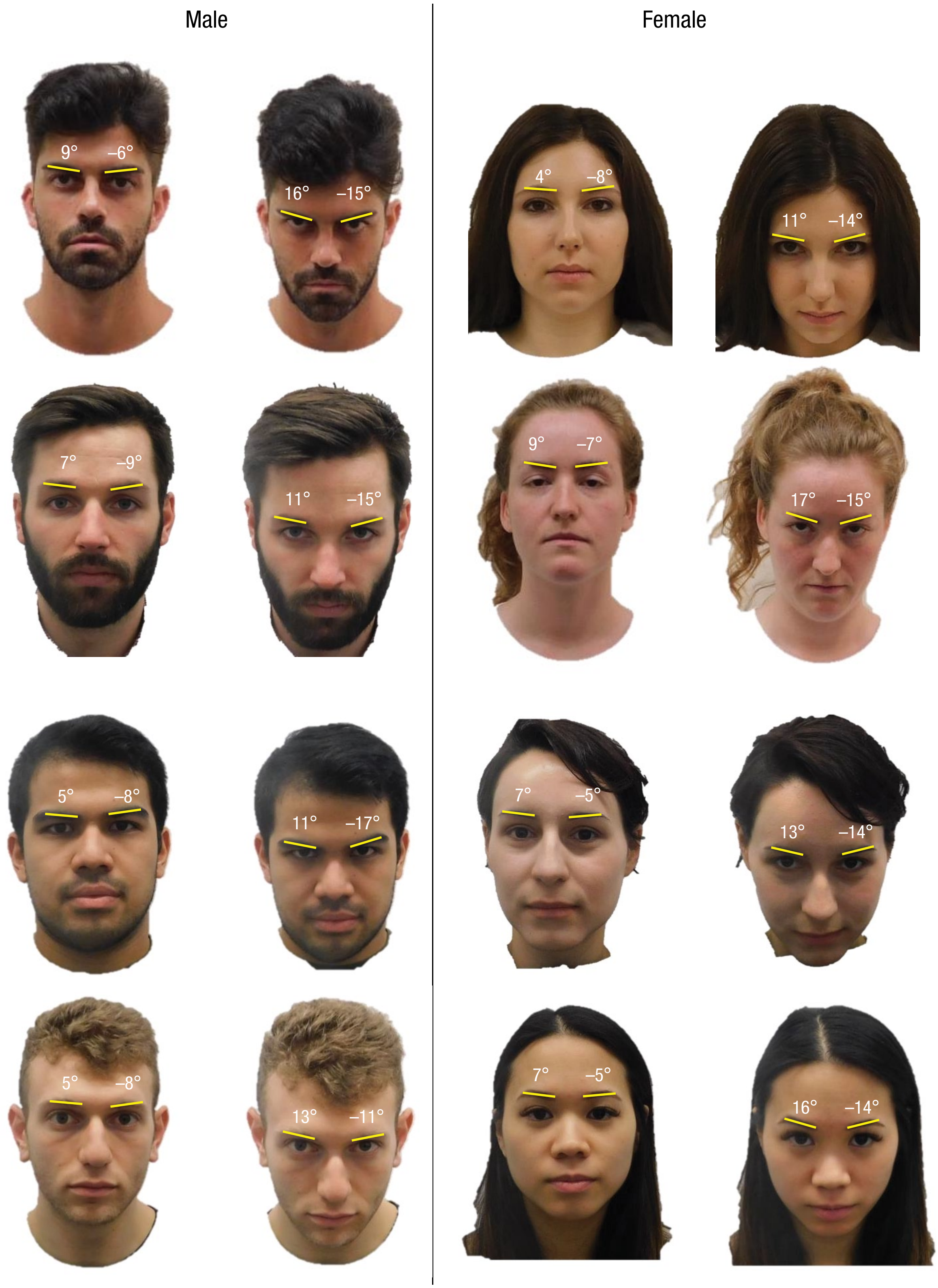

Fig. 8. Examples of male and female eyebrow-angle-coded faces. These images are examples; they do not portray actual participants from Study 5 because those individuals did not consent to the publication of their likeness.

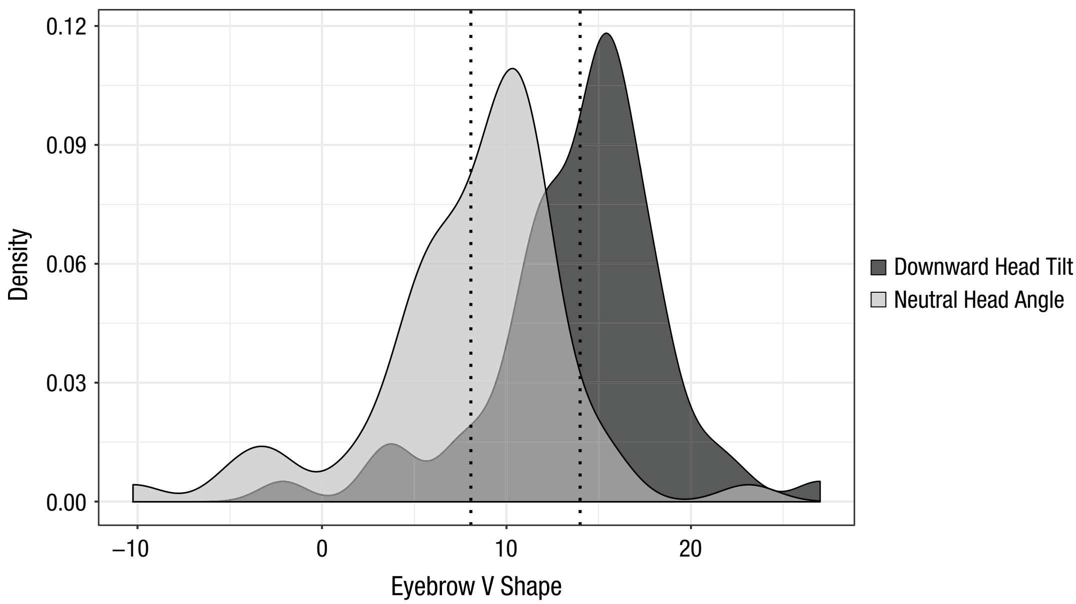

Fig. 9. Kernel-density plot visualizing the distribution of eyebrow-V-shape angle for all participants in each head-tilt condition in Study 5. Vertical dashed lines indicate the mean for the neutral-head-angle condition (left) and the downward-head-tilt condition (right).

it should instead be considered a platform for communicating interpersonal information via the face without activating facial muscles. Supposedly neutral faces may be less inexpressive than they are often assumed to be.

Prior studies have shown that dynamic emotion expressions, which often include head movement, can enhance emotion communication (Cunningham & Wallraven, 2009; de la Rosa, Giese, Bülthoff, & Curio, 2013). Future research should examine whether these findings might be partly attributable to the action-unit-imposter effect; expressions that include corrugator activation (e.g., anger; Ekman & Friesen, 1978) might be perceived as more intense when paired with a downward head tilt because of the enhancement of appearance cues associated with Action Unit 4 (see Witkower, Tracy, & Lange, 2019). Similarly, facial coding (by humans or automated systems) might be unduly influenced by head tilt; the presence or intensity of Action Unit 4 could be misidentified in stimuli featuring a downward-tilted head. Future research should also assess whether these effects emerge as strongly when heads and faces are viewed live in 3-D. One study found that individuals spontaneously tilt their heads down when asked to appear intimidating in a real-life 3-D setting, likely because of the same mechanism (Hehman et al., 2013), but this remains an important issue for future work.

One limitation of this research is that we did not assess the full range of head-tilt angles, instead relying largely on 10° shifts. However, 10° represents one of the smallest experimental manipulations of head-tilt angle that has been examined, making our approach

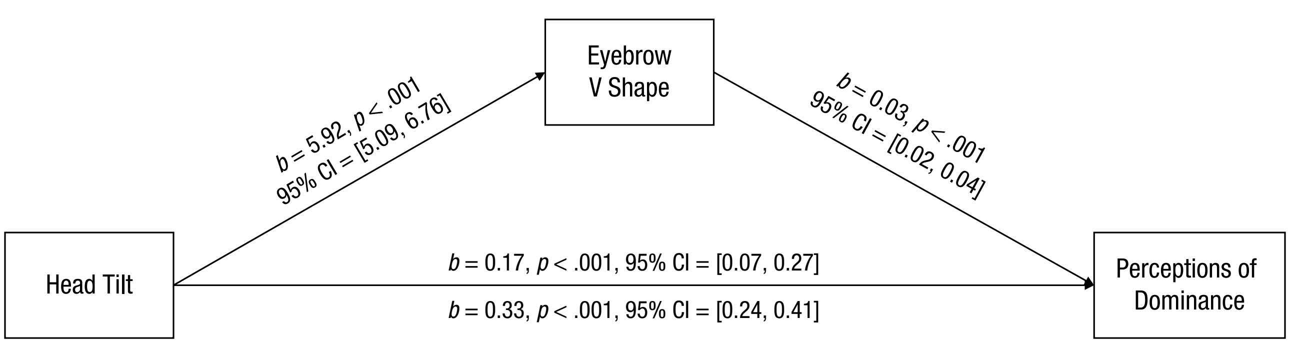

Fig. 10. Effect of manipulated head tilt on perceptions of dominance via changes to the apparent V-shape of the eyebrows. For the path between head tilt and perceptions of dominance, the total effect is presented below the arrow, and the direct effect when the mediator is controlled for is presented above the arrow. CI = confidence interval.

Table 1. Results of Multilevel Models Indicating That Head-Tilt Angle Predicts Perceptions of Dominance via Eyebrow Angle (Study 5)

Model and variable	Head tilt to eyebrow V shape (*a* path)	Eyebrow V shape to perceptions of dominance (*b* path)	Head tilt to perceptions of dominance without controlling for eyebrow V shape (*c* path)	Head tilt to perceptions of dominance controlling for eyebrow V shape (*c*′ path)
Baseline model	5.92 [5.09, 6.76]	0.03 [0.02, 0.04]	0.33 [0.24, 0.41]	0.17 [0.07, 0.27]
Model 2: baseline + target ethnicity	5.72 [4.98, 6.45]	0.04 [0.03, 0.05]	0.33 [0.24, 0.41]	0.12 [0.02, 0.23]
Model 3: Model 2 + target gender	5.72 [4.98, 6.45]	0.03 [0.02, 0.05]	0.33 [0.24, 0.41]	0.12 [0.02, 0.23]

Note: The table shows unstandardized coefficients after random slopes and pertinent covariates were included in the models, with 95% confidence intervals in brackets. For additional modeling information, see the Results section of Study 5.

quite conservative. Furthermore, these subtle shifts likely correspond to signaling in everyday life, thus increasing ecological validity.

In conclusion, this research provides the first evidence that tilting one's head downward increases perceptions of dominance by changing the appearance of the face without altering facial musculature. Social judgments of faces are thus based on perceptions formed from the face as well as movements of the head, making it critical that studies on face perception and facial expressions consider the head, the physical foundation of the face.

Action Editor

Alice J. O'Toole served as action editor for this article.

Author Contributions

Z. Witkower developed the study concept. Both authors contributed to the study designs. Testing and data collection were performed by Z. Witkower, who also analyzed and interpreted the data under the supervision of J. L. Tracy. Z. Witkower drafted the manuscript, and J. L. Tracy provided critical revisions. Both authors approved the final manuscript for submission.

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Open Practices

All data have been made publicly available via the Open Science Framework and can be accessed at osf.io/bmpj9. The studies were preregistered at osf.io/bmpj9. The complete Open Practices Disclosure for this article can be found at http://journals.sagepub.com/doi/suppl/10.1177/0956797619838762. This article has received the badges for Open Data and Preregistration. More information about the Open Practices badges can be found at http://www.psychologicalscience.org/publications/badges.

Notes

1. In all studies, we included additional exploratory items, but our primary preregistered hypotheses (see osf.io/bmpj9/) were focused on perceptions of dominance, so only those results are presented. For the full set of measures included, please contact the first author.

2. In all studies, Bonferroni-corrected pairwise comparisons were conducted whenever more than two conditions were present. Effect-size estimates for repeated measures were calculated on the basis of the work by Morris (2008).

References

Blaker, N. M., & van Vugt, M. (2014). The status-size hypothesis: How cues of physical size and social status influence each other. In J. T. Cheng, J. L. Tracy, & C. Anderson (Eds.), *The psychology of social status* (pp. 119–137). New York, NY: Springer.

Cheng, J. T., Tracy, J. L., Foulsham, T., Kingstone, A., & Henrich, J. (2013). Two ways to the top: Evidence that dominance and prestige are distinct yet viable avenues to social rank and influence. *Journal of Personality and Social Psychology*, *104*, 103–125.

Cheng, J. T., Tracy, J. L., & Henrich, J. (2010). Pride, personality, and the evolutionary foundations of human social status. *Evolution & Human Behavior*, *31*, 334–347.

Cunningham, D. W., & Wallraven, C. (2009). Dynamic information for the recognition of conversational expressions. *Journal of Vision*, *9*(13), Article 7. doi:10.1167/9.13.7

de la Rosa, S., Giese, M., Bülthoff, H. H., & Curio, C. (2013). The contribution of different cues of facial movement to the emotional facial expression adaptation aftereffect. *Journal of Vision*, *13*(1), Article 23. doi:10.1167/13.1.23

Ekman, P., & Friesen, W. V. (1978). *Facial Action Coding System: The manual*. Salt Lake City, UT: Research Nexus.

Ekman, P., & Oster, H. (1979). Facial expressions of emotion. *Annual Review of Psychology*, *30*, 527–554.

Geniole, S. N., Denson, T. F., Dixson, B. J., Carré, J. M., & McCormick, C. M. (2015). Evidence from meta-analyses of the facial width-to-height ratio as an evolved cue of threat. *PLOS ONE*, *10*(7), Article e0132726. doi:10.1371/journal.pone.0132726

Hareli, S., Shomrat, N., & Hess, U. (2009). Emotional versus neutral expressions and perceptions of social dominance and submissiveness. *Emotion*, *9*, 378–384.

Hehman, E., Leitner, J. B., & Gaertner, S. L. (2013). Enhancing static facial features increases intimidation. *Journal of Experimental Social Psychology*, *49*, 747–754.

Kappas, A., Hess, U., Barr, C. L., & Kleck, R. E. (1994). Angle of regard: The effect of vertical viewing angle on the perception of facial expressions. *Journal of Nonverbal Behavior*, *18*, 263–280.

Keating, C. F., & Bai, D. L. (1986). Children's attributions of social dominance from facial cues. *Child Development*, *57*, 1269–1276.

Keltner, D. (1995). Signs of appeasement: Evidence for the distinct displays of embarrassment, amusement, and shame. *Journal of Personality and Social Psychology*, *68*, 441–454.

Knutson, B. (1996). Facial expressions of emotion influence interpersonal trait inferences. *Journal of Nonverbal Behavior*, *20*, 165–182.

Kosinski, M. (2017). Facial width-to-height ratio does not predict self-reported behavioral tendencies. *Psychological Science*, *28*, 1675–1682.

Langner, O., Dotsch, R., Bijlstra, G., Wigboldus, D. H., Hawk, S. T., & van Knippenberg, A. D. (2010). Presentation and validation of the Radboud Faces Database. *Cognition & Emotion*, *24*, 1377–1388.

Lyons, M. J., Campbell, R., Plante, A., Coleman, M., Kamachi, M., & Akamatsu, S. (2000). The Noh mask effect: Vertical viewpoint dependence of facial expression perception. *Proceedings of the Royal Society B: Biological Sciences*, *267*, 2239–2245.

Marsh, A. A., Yu, H. H., Schechter, J. C., & Blair, R. J. (2009). Larger than life: Humans' nonverbal status cues alter perceived size. *PLOS ONE*, *4*(5), Article e5707. doi:10.1371/journal.pone.0005707

Martinez, A. M. (2017). Visual perception of facial expressions of emotion. *Current Opinion in Psychology*, *17*, 27–33.

Mignault, A., & Chaudhuri, A. (2003). The many faces of a neutral face: Head tilt and perception of dominance and emotion. *Journal of Nonverbal Behavior*, *27*, 111–132.

Morris, S. B. (2008). Estimating effect sizes from pretest-posttest-control group designs. *Organizational Research Methods*, *11*, 364–386.

Neth, D., & Martinez, A. M. (2009). Emotion perception in emotionless face images suggests a norm-based representation. *Journal of Vision*, *9*(1), Article 5. doi:10.1167/9.1.5

Olszanowski, M., Pochwatko, G., Kuklinski, K., Scibor-Rylski, M., Lewinski, P., & Ohme, R. K. (2015). Warsaw set of emotional facial expression pictures: A validation study of facial display photographs. *Frontiers in Psychology*, *5*, Article 1516. doi:10.3389/fpsyg.2014.01516

Rule, N. O., Adams, R. B., Jr., Ambady, N., & Freeman, J. B. (2012). Perceptions of dominance following glimpses of faces and bodies. *Perception*, *41*, 687–706.

Schmid-Mast, M. S., & Hall, J. A. (2004). Who is the boss and who is not? Accuracy of judging status. *Journal of Nonverbal Behavior*, *28*, 145–165.

Shariff, A. F., & Tracy, J. L. (2009). Knowing who's boss: Implicit perceptions of status from the nonverbal expression of pride. *Emotion*, *9*, 631–639.

Smith Micro. (2014). Poser Pro 2014 [Computer software]. Watsonville, CA: Author.

Spencer, S. J., Zanna, M. P., & Fong, G. T. (2005). Establishing a causal chain: Why experiments are often more effective than mediational analyses in examining psychological processes. *Journal of Personality and Social Psychology*, *89*, 845–851.

Toscano, H., Schubert, T. W., & Giessner, S. R. (2018). Eye gaze and head posture jointly influence judgments of dominance, physical strength, and anger. *Journal of Nonverbal Behavior*, *42*, 285–309.

Toscano, H., Schubert, T. W., & Sell, A. N. (2014). Judgments of dominance from the face track physical strength. *Evolutionary Psychology*, *12*(1). doi:10.1177/147470491401200101

Tracy, J. L., & Robins, R. W. (2008). The automaticity of emotion recognition. *Emotion*, *8*, 81–95.

Tracy, J. L., Robins, R. W., & Schriber, R. A. (2009). Development of a FACS-verified set of basic and self-conscious emotion expressions. *Emotion*, *9*, 554–559.

Witkower, Z., Hill, A., Pun, A., Baron, A., & Tracy, J. L. (2019). *Two cross-cultural and early-emerging signals of social rank: Prestige and dominance are associated with distinct nonverbal displays across diverse populations and among young children*. Manuscript in preparation.

Witkower, Z., Tracy, J. L., Cheng, J. T., & Henrich, J. (in press). Two signals of social rank: Prestige and dominance are associated with distinct nonverbal displays. *Journal of Personality and Social Psychology*.

Witkower, Z., Tracy, J. L., & Lange, J. (2019). *Illuminating the schade: Uncovering a distinct expression of schadenfreude*. Manuscript in preparation.