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Original Article

Impressions of Dominance are Made Relative to Others in the Visual Environment

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Abstract: Face judgments of dominance play an important role in human social interaction. Perceived facial dominance is thought to indicate physical formidability, as well as resource acquisition and holding potential. Dominance cues in the face affect perceptions of attractiveness, emotional state, and physical strength. Most experimental paradigms test perceptions of facial dominance in individual faces, or they use manipulated versions of the same face in a forced-choice task but in the absence of other faces. Here, we extend this work by assessing whether dominance ratings are absolute or are judged relative to other faces. We presented participants with faces to be rated for dominance (*target* faces), while also presenting a second face (*non-target* faces) that was not to be rated. We found that both the masculinity and sex of the non-target face affected dominance ratings of the target face. Masculinized non-target faces decreased the perceived dominance of a target face relative to a feminized non-target face, and displaying a male non-target face decreased perceived dominance of a target face more so than a female non-target face. Perceived dominance of male target faces was affected more by masculinization of male non-target faces than female non-target faces. These results indicate that dominance perceptions can be altered by surrounding faces, demonstrating that facial dominance is judged at least partly relative to other faces.

Keywords: physical dominance, face perception, masculinity, formidability

Introduction

Aspects of facial appearance that convey impressions of physical dominance can influence human social interaction in many ways. For example, facial cues to dominance have an

effect on personality judgments and perceived emotional states (Oosterhof and Todorov, 2008). Perceived dominance is correlated with impressions of maturity, masculinity, and physical prowess, and dominant-looking faces appear less fearful and more threatening (Oosterhof and Todorov, 2008). Facial cues to dominance predict real-world voting behavior; people with faces that appear more dominant are more likely to attain leadership positions in politics (Olivola and Todorov, 2010; Rule et al., 2010) and the business world (Rule and Ambady, 2009, 2011). Humans are more likely to follow the gaze of dominant-looking individuals (Jones et al., 2010; Ohlsen, van Zoest, and van Vugt, 2013) and selectively attend to cues of social dominance (at least in men; Maner, DeWall, and Gailliot, 2008). Collectively, these studies highlight the significance of facial cues of dominance in human interactions.

Facial dominance may function as a cue to aggressiveness, resource holding potential, and physical formidability (Fink, Neave, and Seydel, 2007; Parker, 1974; Watkins, 2011). Injuries found in ancient human skeletons (such as skull fractures) suggest that physical conflict was abundant in our ancestral environment, likely leading to a great proportion of fatalities and thereby serving as a strong selection pressure on human psychology (Bowles, 2009; Walker, 2001). Physical dominance likely had a great influence on human mating behavior (Puts, 2010), with dominant males outcompeting rival conspecifics for access to females. Physical and verbal aggression correlate with testosterone levels (Archer, 1991; Mattsson, Schalling, Olweus, Low, and Svensson, 1980; Olweus, Mattsson, Schalling, and Low, 1980, 1988), and faces of people with high testosterone levels are perceived as more physically dominant (Moore et al., 2011). Second-to-fourth digit ratio, a putative indicator of pre-natal testosterone levels (Lutchmaya, Baron-Cohen, Raggat, Knickmeyer, and Manning, 2004), has also been found to correlate with facial dominance (Neave, Laing, Fink, and Manning, 2003). Given the relationships between perceived facial dominance and testosterone and between testosterone and aggression, it may be particularly important to attend to facial cues to physical dominance to avoid unfavorable confrontations with possible rivals. Indeed, impressions of dominance from facial images can be made with exposure to faces as short as 39 ms (Carre, McCormick, and Mondloch, 2009).

Recent studies have found that the perception of dominance can be influenced by personal and social context. For example, shorter men are more likely to perceive masculinized faces as dominant than taller men (Watkins, Fraccaro, et al., 2010), and men who scored lower in dominance on personality scales are more likely to perceive masculinized faces as dominant than men who scored higher in dominance (Watkins, Jones, and DeBruine, 2010). Likewise, shorter women and women who perceive themselves to be of low dominance are more sensitive to dominance cues in women's faces (Watkins, Quist, Smith, DeBruine, and Jones, 2011). Knowledge of weapon possession increases perception of the possessor's size, reflecting the strong mental association between threat and physical formidability (Fessler, Holbrook, and Snyder, 2012). Perception of an individual's dominance is also increased after observing others respond to that individual in a fearful way (Jones, DeBruine, Little, Watkins, and Feinberg, 2011).

Taken together, the aforementioned studies indicate that perceived dominance may not necessarily be a static, stable attribution; rather that it can be influenced by contextual cues. It is possible that judgments of a target individual's dominance are made without consideration of others in the environment. Alternatively, if perceived dominance is a proxy of physical formidability, it is conceivable that judgments of dominance could be altered by the apparent

dominance of others in the same environment. One can see how assessments of dominance made relative to others would be advantageous to making judgments of single faces in isolation. Physical contests have likely had a very large impact on human mating systems throughout history (Puts, 2010), and have been crucial to access to resources and territory (McDonald, Navarrete, and van Vugt, 2012). In an environment where physical altercation would be nearly inevitable (and where not competing would cost an individual access to potential mates and resources), judging possible opponents on a relative scale would allow for selectivity in prospective encounters. Furthermore, given the prominence of intergroup conflict in ancestral times (McDonald, Navarrete, and van Vugt, 2012), relative judgments of dominance would provide the opportunity to attempt to form bonds with the *most* dominant conspecifics, rather than just *any* dominant-looking person. Indeed, forming alliances with dominant-looking individuals may not be advantageous if that person is still below the average physical prowess of the local population. Assessments of dominance made relative to others in an environment would be more valuable in evaluating potential rivals and partners than judgments made independent of others.

Experimental research studying the effects of facial dominance has typically presented individual faces to be rated for dominance (e.g., from 1 = low to 7 = high; Burriss and Little, 2006; Mueller and Mazur, 1996; Neave et al., 2003). Alternatively, a single face can be manipulated to alter dominance (e.g., by masculinizing or altering the sexual maturity of the face), and two versions of the same face can be presented in a forced-choice task to assess which version appears more dominant (e.g., Swaddle and Reiersen, 2002; Watkins et al., 2011). One study examined how perceived dominance of a target face is affected by seeing prior stimuli of others responding to the face in a fearful manner (Jones et al., 2011). These methods present one face at a time (or two versions of the same face), yet to the authors' knowledge no studies have examined how perceived dominance is affected by other, separate identities in the same visual environment. Previous studies have found that pairing a target face with another face can affect how attractive the target appears (Little, Burriss, Jones, DeBruine, and Caldwell, 2008; Little, Caldwell, Jones, and DeBruine, 2011). Given the theoretical value in judging dominance relative to others, it is possible that perceived dominance of a target individual could be influenced by others in the visual surroundings.

In the current study, we assessed how judgments of dominance from faces are affected by the sex and masculinity of other faces in the visual environment. To this end, we simultaneously presented two distinct faces (a target face and a non-target face) to assess whether dominance judgments were made relative to other faces or if dominance is evaluated independently. Since masculine faces are perceived as more dominant compared to feminine faces within sex (Johnston, Hagel, Franklin, Fink, and Grammer, 2001; Perrett et al., 1998), we used masculinized and feminized versions of both male and female non-target faces to assess whether dominance level or sex of face had an impact on perceived dominance in the target face. If dominance is rated relative to others, target faces may appear less dominant when paired with a masculinized non-target face than when paired with a feminized face, irrespective of the sex of the non-target face. Furthermore, target faces may appear less dominant when paired with a male non-target face than a female non-target face, irrespective of the masculinity level of this face.

Materials and Methods

Stimuli

Facial photographs of 47 men (mean age = 25.25 years, $SD = 4.64$ years) and 83 women (mean age = 23.04 years, $SD = 3.81$ years) were obtained from a commercially available database (www.3d.sk). All individuals were Caucasian, had their hair pulled back, and were photographed under constant lighting and camera set-up. Face images were standardized on inter-pupillary distance. All faces were delineated with 189 points for use with Psychomorph (Tiddeman, Burt, and Perrett, 2001).

Ten male and 10 female face composites were created for experimental testing using a subset of the images described above. Each composite was created by averaging the faces of a random selection of three men or three women (Rowland and Perrett, 1995). No composites had visible facial hair. Composites are advantageous in face perception research, as they reduce the likelihood of unique facial characteristics or irregularities present in individual faces that may affect social perception.

Additionally, we created an average male face using all 47 men's faces and an average female face using all 83 women's faces. The inequality in the number of male and female faces was present in the original sample obtained, and we used all available faces in producing averages to capture the average face shape of both sexes in our sample (though previous studies have reported that adding additional faces makes little visual difference to face composites comprised of 16 faces or more in a homogeneous population; Langlois and Roggman, 1990). These averages served as "prototypes" to use in facial masculinity transforms. Each face composite was transformed in facial masculinity by applying $\pm 50\%$ of the shape difference between the male and female prototype (Tiddeman et al., 2001). The transformation process uses prototypes to define an axis upon which to alter a face. In this case, the composites were transformed by the vector differences in corresponding delineation points on the male and female prototypes. This created masculinized and feminized versions of the same face composite (see Figure 1). Similar transforms have been used to successfully manipulate perceived dominance in men's and women's faces (e.g. DeBruine, Jones, Crawford, Welling, and Little, 2010; Perrett et al., 1998; Watkins, Jones, et al., 2010; Watkins et al., 2011).

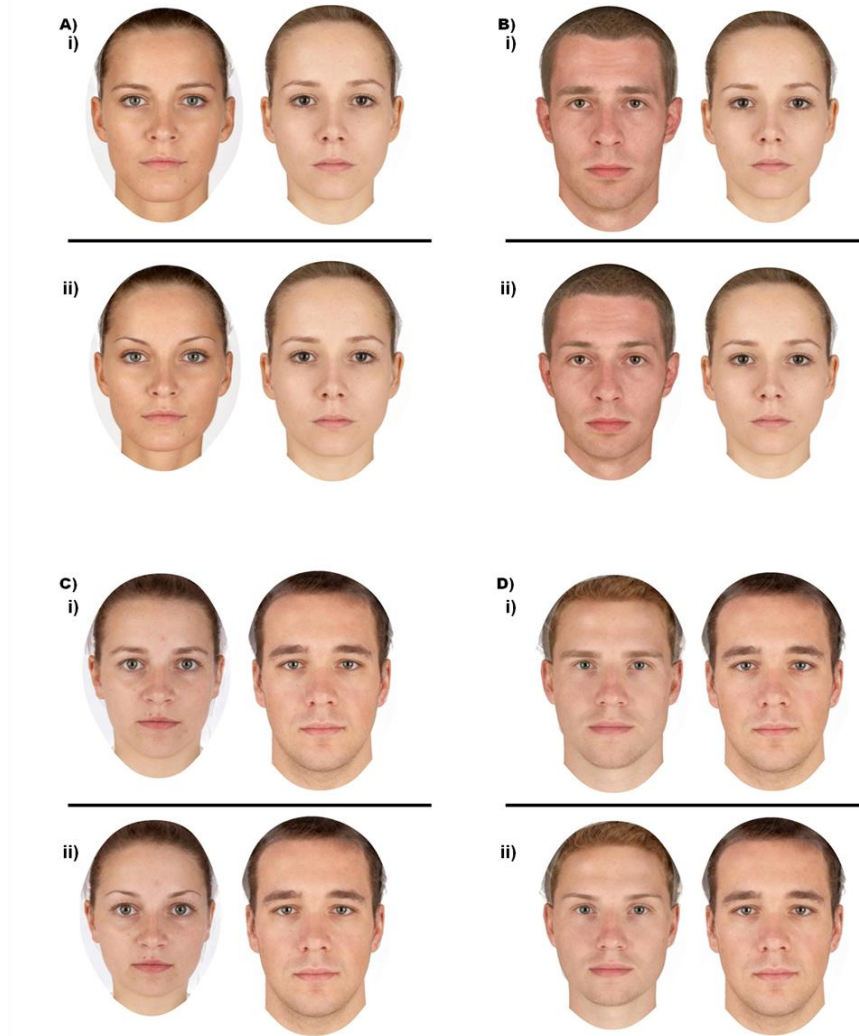
Participants and procedure

Forty-three participants (22 women, 21 men; mean age = 31.00 years, $SD = 11.47$ years) completed the study online. The study was approved by the institutional ethical review board. All participants indicated their sex and age and gave informed consent.

The experimental task presented viewers with two faces next to each other on a computer screen. The target face (the face being judged) was on the right, and was an unmanipulated composite. The non-target face (the face paired with the target) was presented on the left, and was a masculinized or feminized version of one of the face composites (see Figure 1). The target face was always presented on the right and the non-target face on the left to avoid any confusion on the participant's behalf.

Impressions of dominance

Figure 1. Examples of eight types of experimental trials. Each trial consisted of two faces. Target faces (right) were paired with non-target i) masculinized and ii) feminized non-target faces (left) on separate trials in four conditions: A) female target with female non-target face, B) female target with male non-target face, C) male target with female non-target face, and D) male target with male non-target face



Each target face was paired with four stimuli in four separate trials: a masculinized and feminized version of a randomly chosen male non-target face, and a masculinized and feminized version of a randomly chosen female non-target face. Thus, the entire test was comprised of 80 trials: 20 targets x 2 sexes of non-target face (male and female) x 2 degrees of masculinization of the non-target face (masculinized or feminized). In each trial, the face on the right was labeled “RIGHT” and the face on the left was labeled “LEFT.” Participants were asked to “Please take a look at these two faces. Please rate how physically dominant you think the person on the RIGHT is.” The term “physical dominance” was chosen to avoid confusion with other attributions, such as social dominance (Puts, Hodges, Cardenas, and Gaulin, 2007). The face pairings were presented in random order. Participants rated the dominance of the face on the right on a scale

from 1 (extremely submissive) to 7 (extremely dominant).

Analysis

For each participant, we averaged dominance ratings for each of the following categories: *sex of target face* (male or female), *sex of non-target face* (female or male), and *masculinity level of non-target face* (masculinized or feminized). Each participant therefore had eight averaged ratings of dominance in the analysis. Inter-rater reliability was high for each of these eight averaged ratings (average Cronbach's $\alpha = 0.92$).

We conducted a 2 (sex of target face) \times 2 (sex of non-target face) \times 2 (masculinity level of non-target face) \times 2 (participant sex, between-subjects) mixed-design ANOVA to determine how each of the categories influenced dominance ratings of the target face.

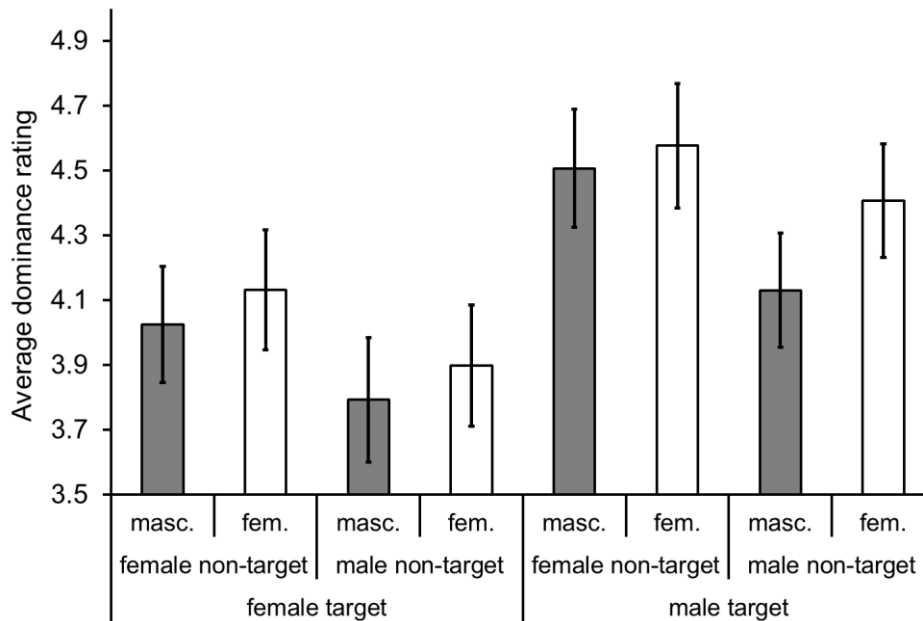
Results

A 2x2x2x2 ANOVA revealed a main effect of the sex of target face, $F(1,41) = 13.71, p < .01, \eta_p^2 = 0.25$, with men being rated as more dominant ($M = 4.42$ out of 7, $SD = 0.49$) than women ($M = 3.95, SD = 0.63$). There was also a main effect of the sex of non-target face, $F(1,41) = 11.07, p < .01, \eta_p^2 = 0.21$, with dominance ratings of the target face being lower when the non-target face was male ($M = 4.07, SD = 0.50$) than female ($M = 4.30, SD = 0.46$). There was a main effect of the masculinity of non-target face, $F(1,41) = 18.73, p < .01, \eta_p^2 = 0.31$, with lower dominance ratings of the target face when the non-target face was masculinized ($M = 4.11, SD = 0.43$) than when it was feminized ($M = 4.25, SD = 0.42$; see Figure 2 for illustration of main effects). There was no significant two-way interaction between any of the variables, and no between-subjects effect of participant sex (all $F_s[1, 41] \leq 4.04$, all $p_s > .05$). There was a significant three-way interaction between sex of target face, sex of non-target face, and masculinity of non-target face, $F(1,41) = 8.39, p < .01, \eta_p^2 = 0.17$.

To interpret the three-way interaction, we ran separate 2x2 ANOVAs (sex of non-target \times masculinity of non-target face) for male and female target faces. Both sex of non-target face ($F[1,41] = 10.57, p < .01, \eta_p^2 = 0.21$) and masculinity of non-target face ($F[1,41] = 6.01, p = .02, \eta_p^2 = 0.13$) had significant effects on dominance ratings when the target face was female, with target faces being rated as less dominant with male non-target faces and with masculinized versions of non-target faces. There were no significant interactions between sex of non-target face and masculinity of non-target face when the target sex was female, nor was there a between-subject effect of participant sex (all $F_s[1, 41] \geq 3.42$, all $p_s > .05$).

Sex of non-target face ($F[1,41] = 9.74, p < .01, \eta_p^2 = 0.19$) and masculinity of non-target face ($F[1,41] = 18.81, p < .01, \eta_p^2 = 0.31$) both had significant effects when the target face was male, with target faces being rated as less dominant when paired with male non-target faces and with masculinized versions of non-target faces. There was also a significant interaction between sex of non-target face and masculinity of non-target face when the target face was male, $F(1,41) = 10.03, p < .01, \eta_p^2 = 0.20$, with the difference in dominance ratings between masculinized and feminized versions of the non-target face being greater when the non-target face was male than female, $t(42) = 3.22, p < .01$, Cohen's $d = 0.68$ (see Figure 2). There were no other significant interactions, nor was there a between-subjects effect of participant sex when target faces were male (all $F_s[1, 41] \leq 1.30$, all $p_s > .05$).

Figure 2. Dominance scores across eight different conditions with standard error bars



Note: All factors are within-subjects

Discussion

The results of the current study indicate that non-target faces in the visual environment influence dominance perceptions of target faces. Target faces were rated as less dominant when the non-target face was male than when it was female. Furthermore, target faces were perceived as less dominant when the non-target face was masculinized than when it was feminized.

Perceived physical dominance is thought to represent the resource acquisition and holding potential of conspecifics (Parker, 1974; Sell et al., 2009; Watkins, 2011). It may therefore be useful for dominance to be perceived relative to others in an environment, rather than judged on an absolute scale. Given the inevitability of physical altercation throughout human history, it may not have been suitable for a perceiver to base decisions to confront others exclusively on whether a potential opponent is more formidable than oneself. Instead, it may have been advantageous for the perceiver to also consider whether they were relatively more likely to defeat the target opponent than another. Furthermore, knowledge of dominance rank within an environment would allow individuals to advantageously select others to form alliances with. Aligning with formidable allies may not be beneficial if that partner's potential enemies are even more daunting. Indeed, previous studies indicate that perception of physical dominance is influenced by contextual cues such as perceiver size and dominance, as well as third-party reactions towards a target (Jones et al., 2011; Watkins, Fraccaro, et al., 2010; Watkins, Jones, et al., 2010; Watkins et al., 2011). The current results extend this work by showing that dominance perception of a target individual is influenced by the apparent dominance of others in the visual environment.

The current results show that, given a target male face, masculinization of the non-target face had a greater effect when the non-target face was male rather than female. This interaction

was not present when the target face was female. The interaction found with male target faces could be further evidence of assessments of dominance being made on a relative basis. Men are typically larger than women (Gaulin and Boster, 1985) and are stronger than women beyond what can be accounted for by size alone (Abe, Kearns, and Fukunaga, 2003; Lassek and Gaulin, 2009; Mayhew and Salm, 1990). The force of a physical blow (e.g., a punch in humans) increases as a cubic function of mass, yet the ability to resist a blow increases as a square function at most (Gaulin and Sailer, 1984). This means that men can inflict greater physical damage than women at a force disproportionate to size differences alone. Women therefore pose less risk to people in physical combat compared to men. It follows that the perceived dominance of male targets would be less affected by the masculinization of female non-targets than of male non-targets. These findings suggest that the effect of non-target faces on perceived dominance incorporates information on the relative dominance of men and women, as well as level of masculinity within these sexes.

The current study design asked participants to rate *physical* dominance. Though some previous studies of dominance have asked participants to simply rate “dominance” (Burriss and Little, 2006; Watkins, Fraccaro, et al., 2010; Watkins, Jones, et al., 2010; Watkins et al., 2011), other studies have attempted to divide dominance into physical dominance (size, strength, etc.) and social dominance (social status, popularity, etc.; Puts et al., 2007). Evolutionary theory suggests that physical dominance may be a more salient cue for men’s intrasexual competition, whereas social dominance may be more important to women (Andersson, 1994; Puts, 2010). This difference could lead to separate effects of facial masculinization (associated with perception of physical size and strength) on perceived dominance in men and women. Indeed, previous studies have found that masculinizing men’s faces increases the perception of both physical and social dominance, whereas masculinizing women’s faces increases perceived physical dominance and feminizing women’s faces increases perceived social dominance (Watkins, Jones, et al., 2010; Watkins et al., 2011). The current study found no significant differences between dominance ratings for male and female participants, though future research could attempt to disentangle physical and social dominance, and examine how each is influenced by non-target faces.

There was no significant difference in dominance ratings between male and female participants in any condition. Judgments of dominance of target faces were affected by the sex of the non-target face (at least when the target face was male); thus it is perhaps surprising that there were no interactions with participant sex. Assessments of physical dominance may be more relevant in an intrasexual context rather than an intersexual context (that is, men compete and form alliances more frequently with other men and women with other women), and so one might expect that dominance ratings are influenced by the sex of the perceiver. It is possible that the experimental task and setting allowed participants to make objective judgments of dominance without regard for their own physical dominance. That is, participants may have rated the dominance of targets relative to the non-target faces, but may not have judged dominance in relation to themselves. Such objectivity would produce effects regarding the experimental stimuli, but not the perceiver. Future studies could examine the role of perceiver sex in similar experiments by creating tasks that encourage participants to rate dominance in relation to themselves.

It is possible that perceived dominance was affected by low-level shape contrast effects.

Contrast illusions are well-documented in psychological literature (see Aglioti, Desouza, and Goodale, 1995; Franz and Gegenfurtner, 2008; Glover, 2002). Dominance perception is based in part on differences in facial shape (Jones et al., 2010; Perrett et al., 1998), in that squared, angular facial features may enhance the perception of dominance. Shape perception can also be influenced by exposure to other shapes (Regan and Hamstra, 1992). It is unlikely, however, that the results of the current study are due entirely to these types of low-level processing. Although judgments of shape are relatively straightforward, dominance perceptions of target male faces were affected by masculinity for male non-target faces, but not female non-target faces. The interactions between the sex of the target face, sex of the non-target face, and masculinity level of the non-target face suggest that the effects of non-target faces on dominance judgments of targets in the current study were more complex than would be expected by simple low-level shape contrast effects.

The effects found here suggest that dominance judgments of target faces are made relative to other faces in the visual area. This is not to say that such effects reflect a simple contrast of one face against another. Previous research has found that the rated attractiveness of a target face of the opposite sex is increased by pairing it with an attractive face of the same sex as the perceiver (Little et al., 2008). Conversely, pairing a target face of the opposite sex with an attractive face of the same sex as the target decreases rated attractiveness of the target (Little et al., 2011). These studies demonstrate that attractiveness is not judged entirely in terms of contrasts (otherwise, placing an attractive face next to a target would consistently diminish the target's attractiveness), but rather that context mediates the effect of pairing a target face with an attractive or unattractive face. In the current study, pairing a target face with a masculinized non-target face did not consistently reduce the apparent dominance of the target face. Instead, the apparent dominance of a target male face was relatively less affected by the masculinity of non-target female faces than non-target male faces. Conversely, no such interaction was found when the target face was female. These findings may reflect the fact that men are significantly more powerful than women on average (Abe et al., 2003; Lassek and Gaulin, 2009; Mayhew and Salm, 1990), and thus the apparent dominance of a female non-target has somewhat less bearing than a male non-target on the perceived dominance of a male face. The cognitive complexity revealed by such an interaction suggests that the effects reported here are not due entirely to simply contrasting one face next to another, as then masculinization of both male and female non-target faces should have similar effects on the apparent dominance of male and female targets. Instead, it would appear the effects found here may require extra cognitive processing to assess dominance of a target face in relation to both the sex and masculinity of the non-target face. Such complexity may be expected if dominance judgments are constructive in making decisions about approaching or avoiding potential allies or foes.

The task used in the current study simply asked participants to rate the dominance of a target face, while not specifying the role of the non-target face. Recent studies have demonstrated that hypothetical opponents are perceived as less formidable by male raters who are in the company of male friends than by male raters who are alone (Fessler and Holbrook, 2013), and dominance contests often take the form of intergroup battle, especially amongst men (McDonald et al., 2012). It is therefore conceivable that the presence of dominant individuals would enhance the apparent dominance of another if they were perceived to be cohorts who may fight together. The results indicate that dominant non-target faces reduced the apparent

dominance of target faces in the current study, suggesting that participants were not interpreting the two faces as members of the same “team.” Instead, it would appear that participants rated physical dominance in relation to the non-target face. Future studies could elucidate how the presence of one face alters the apparent dominance of another face when the faces are placed in the context of competition or cooperation.

The methodology used in this study saw the target face presented on the right side of two faces. Fixing the target at the right side was done to avoid confusion as to what face the participant was to rate. There are possible limitations to this method. Given the consistency of side order, participants may have been able to ignore the face on the left (the non-target face). Indeed, side biases in visual perception could lead an individual to attend to one side relatively more than the other, as is found in other cognitive tasks (Uttl and Pilkenton-Taylor, 2001; Geldmacher, Doty, and Heilman, 1994). The participants in the current task, however, were explicitly instructed to view both faces before rating the target face. The results indicate that target faces were rated relative to non-target faces, suggesting that participants did indeed process both faces as instructed. The decision to present target faces consistently on one side follows previously established methods (Little et al., 2008, 2011); however, future research could present target faces on both sides in randomized order.

Studies examining perceived dominance have typically presented faces one at a time (Burriss and Little, 2006; Watkins et al., 2011). The current findings suggest that perceived dominance is affected by the presence of other faces. Previous research using single-image ratings of dominance have been extremely valuable in establishing the role of dominant appearance in social interaction and mate selection (see Watkins, 2011). The current work extends those findings by revealing that dominance is not judged in isolation, but rather is affected by the others in the population. Researchers could build off the current findings by creating experimental paradigms with multiple faces. For example, recent research has demonstrated that dominance judgments of business leaders’ faces correlate with company profit (Rule and Ambady, 2008). Ostensibly, this relationship may be strengthened if dominance judgments of a target leader were made relative to other business leaders. Likewise, judgments of fighting ability (Sell et al., 2009) may be more accurate when rating a face in comparison to other possible opponents.

The current study is the first to assess how perceived dominance is influenced by dominance cues in surrounding faces. The results here suggest that non-target faces play a large role in perception of a target face, and indicate that evaluations of dominance are not made in absolute terms, but are made in relation to faces around them.

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References

- Abe, T., Kearns, C. F., and Fukunaga, T. (2003). Sex differences in whole body skeletal muscle mass measured by magnetic resonance imaging and its distribution in young Japanese adults. *British Journal of Sports Medicine*, 37, 436-440
- Aglioti, S., Desouza, J. F. X., and Goodale, M. A. (1995). Size contrast illusions deceive the eye but not the hand. *Current Biology*, 5, 679-685.

- Andersson, M. (1994). *Sexual selection*. Princeton, NJ: Princeton University Press.
- Archer, J. (1991). The influence of testosterone on human aggression. *British Journal of Psychology*, 82, 1-28.
- Bowles, S. (2009). Did warfare among ancestral hunter-gatherers affect the evolution of human social behaviors? *Science*, 324, 1293-1298.
- Burriss, R. P., and Little, A. C. (2006). Effects of partner conception risk phase on male perception of dominance in faces. *Evolution and Human Behavior*, 27, 297-305.
- Carre, J. M., McCormick, C. M., and Mondloch, C. J. (2009). Facial structure is a reliable cue of aggressive behavior. *Psychological Science*, 20, 1194-1198.
- DeBruine, L. M., Jones, B. C., Crawford, J. R., Welling, L. L. M., and Little, A. C. (2010). The health of a nation predicts their mate preferences: Cross-cultural variation in women's preferences for masculinized male faces. *Proceedings of the Royal Society B: Biological Sciences*, 277, 2405-2410.
- Fessler, D. M. T., and Holbrook, C. (2013). Friends shrink foes: The presence of comrades decreases the envisioned physical formidability of an opponent. *Psychological Science*, 24, 797-802.
- Fessler, D. M. T., Holbrook, C., and Snyder, J. K. (2012). Weapons make the man (larger): Formidability is represented as size and strength in humans. *PLoS One*, 7, e32751.
- Fink, B., Neave, N., and Seydel, H. (2007). Male facial appearance signals physical strength to women. *American Journal of Human Biology*, 19, 82-87.
- Franz, V., and Gegenfurtner, K. (2008). Grasping visual illusions: Consistent data and no dissociation. *Cognitive Neuropsychology*, 25, 920-950.
- Gaulin, S., and Boster, J. (1985). Cross-cultural differences in sexual dimorphism: Is there any variance to be explained? *Ethology and Sociobiology*, 6, 219-225.
- Gaulin, S. J. C., and Sailer, L. D. (1984). Sexual dimorphism in weight among the primates: The relative impact of allometry and sexual selection. *International Journal of Primatology*, 5, 515-535.
- Geldmacher, D. S., Doty, L., and Heilman, K. M. (1994). Spatial performance bias in normal elderly subjects on a letter cancellation task. *Cognitive and Behavioral Neurology*, 7, 275-280.
- Glover, S. (2002). Visual illusions affect planning but not control. *Trends in Cognitive Sciences*, 6, 288-292.
- Johnston, V. S., Hagel, R., Franklin, M., Fink, B., and Grammer, K. (2001). Male facial attractiveness: Evidence for hormone-mediated adaptive design. *Evolution and Human Behavior*, 22, 251-267.
- Jones, B. C., DeBruine, L. M., Little, A. C., Watkins, C. D., and Feinberg, D. R. (2011). "Eavesdropping" and perceived male dominance rank in humans. *Animal Behaviour*, 81, 1203-1208.
- Jones, B. C., DeBruine, L. M., Main, J. C., Little, A. C., Welling, L. L. M., Feinberg, D. R., and Tiddeman, B. P. (2010). Facial cues of dominance modulate the short-term gaze-cuing effect in human observers. *Proceedings of the Royal Society B: Biological Sciences*, 277, 617-624.
- Langlois, J. H., and Roggman, L. A. (1990). Attractive faces are only average. *Psychological Science*, 1, 115-121.

- Lassek, W. D., and Gaulin, S. J. C. (2009). Costs and benefits of fat-free muscle mass in men: Relationship to mating success, dietary requirements, and native immunity. *Evolution and Human Behavior*, *30*, 322-328.
- Little, A. C., Burriss, R. P., Jones, B. C., DeBruine, L. M., and Caldwell, C. A. (2008). Social influence in human face preference: Men and women are influenced more for long-term than short-term attractiveness decisions. *Evolution and Human Behavior*, *29*, 140-146.
- Little, A. C., Caldwell, C. A., Jones, B. C., and DeBruine, L. M. (2011). Effects of partner beauty on opposite-sex attractiveness judgments. *Archives of Sexual Behavior*, *40*, 1119-1127.
- Lutchmaya, S., Baron-Cohen, S., Raggatt, P., Knickmeyer, R., and Manning, J. T. (2004). 2nd to 4th digit ratios, fetal testosterone and estradiol. *Early Human Development*, *77*, 23-28.
- Maner, J. K., DeWall, C. N., and Gailliot, M. T. (2008). Selective attention to signs of success: Social dominance and early stage interpersonal perception. *Personality and Social Psychology Bulletin*, *34*, 488-501.
- Mattsson, A., Schalling, D., Olweus, D., Low, H., and Svensson, J. (1980). Plasma testosterone, aggressive-behavior, and personality dimensions in young male delinquents. *Journal of the American Academy of Child and Adolescent Psychiatry*, *19*, 476-490.
- Mayhew, J. L., and Salm, P. C. (1990). Gender differences in anaerobic power tests. *European Journal of Applied Physiology*, *60*, 133-138.
- McDonald, M. M., Navarrete, C. D., and van Vugt, M. (2012). Evolution and the psychology of intergroup conflict: The male warrior hypothesis. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *367*, 670-679.
- Moore, F. R., Al Dujaili, E. A. S., Cornwell, R. E., Smith, M. J. L., Lawson, J. F., Sharp, M., and Perrett, D. I. (2011). Cues to sex- and stress-hormones in the human male face: Functions of glucocorticoids in the immunocompetence handicap hypothesis. *Hormones and Behavior*, *60*, 269-274.
- Mueller, U., and Mazur, A. (1996). Facial dominance of West Point cadets as a predictor of later military rank. *Social Forces*, *74*, 823-850.
- Neave, N., Laing, S., Fink, B., and Manning, J. T. (2003). Second-to-fourth digit ratio, testosterone and perceived male dominance. *Proceedings of the Royal Society of London Series B: Biological Sciences*, *270*, 2167-2172.
- Ohlsen, G., van Zoest, W., and van Vugt, M. (2013). Gender and facial dominance in gaze cuing: Emotional context matters in the eyes that we follow. *Plos One*, *8*, e59471.
- Olivola, C. Y., and Todorov, A. (2010). Elected in 100 milliseconds: Appearance-based trait inferences and voting. *Journal of Nonverbal Behavior*, *34*, 83-110.
- Olweus, D., Mattsson, A., Schalling, D., and Low, H. (1980). Testosterone, aggression, physical, and personality dimensions in normal adolescent males. *Psychosomatic Medicine*, *42*, 253-269.
- Olweus, D., Mattsson, A., Schalling, D., and Low, H. (1988). Circulating testosterone levels and aggression in adolescent males: A causal analysis. *Psychosomatic Medicine*, *50*, 261-272.
- Oosterhof, N. N., and Todorov, A. (2008). The functional basis of face evaluation. *Proceedings of the National Academy of Sciences of the United States of America*, *105*, 11087-11092.
- Parker, G. A. (1974). Assessment strategy and evolution of fighting behavior. *Journal of Theoretical Biology*, *47*, 223-243.

- Perrett, D. I., Lee, K. J., Penton-Voak, I., Rowland, D., Yoshikawa, S., Burt, D. M., . . . Akamatsu, S. (1998). Effects of sexual dimorphism on facial attractiveness. *Nature*, *394*, 884-887.
- Puts, D. A. (2010). Beauty and the beast: Mechanisms of sexual selection in humans. *Evolution and Human Behavior*, *31*, 157-175.
- Puts, D. A., Hodges, C. R., Cardenas, R. A., and Gaulin, S. J. C. (2007). Men's voices as dominance signals: Vocal fundamental and formant frequencies influence dominance attributions among men. *Evolution and Human Behavior*, *28*, 340-344.
- Regan, D., and Hamstra, S. J. (1992). Shape discrimination and the judgment of perfect symmetry: Dissociation of shape from size. *Vision Research*, *32*, 1845-1864.
- Rowland, D. A., and Perrett, D. I. (1995). Manipulating facial appearance through shape and color. *IEEE Computer Graphics and Applications*, *15*, 70-76.
- Rule, N. O., and Ambady, N. (2008). The face of success: Inferences from chief executive officers' appearance predict company profits. *Psychological Science*, *19*, 109-111.
- Rule, N. O., and Ambady, N. (2009). She's got the look: Inferences from female chief executive officers' faces predict their success. *Sex Roles*, *61*, 644-652.
- Rule, N. O., and Ambady, N. (2011). Face and fortune: Inferences of personality from Managing Partners' faces predict their law firms' financial success. *Leadership Quarterly*, *22*, 690-696.
- Rule, N. O., Ambady, N., Adams, R. B., Jr., Ozono, H., Nakashima, S., Yoshikawa, S., and Watabe, M. (2010). Polling the face: Prediction and consensus across cultures. *Journal of Personality and Social Psychology*, *98*, 1-15.
- Sell, A., Cosmides, L., Tooby, J., Sznycer, D., von Rueden, C., and Gurven, M. (2009). Human adaptations for the visual assessment of strength and fighting ability from the body and face. *Proceedings of the Royal Society B: Biological Sciences*, *276*, 575-584.
- Swaddle, J. P., and Reiersen, G. W. (2002). Testosterone increases perceived dominance but not attractiveness in human males. *Proceedings of the Royal Society of London Series B: Biological Sciences*, *269*, 2285-2289.
- Tiddeman, B., Burt, M., and Perrett, D. (2001). Prototyping and transforming facial textures for perception research. *IEEE Computer Graphics and Applications*, *21*, 42-50.
- Uttl, B., and Pilkenton-Taylor, C. (2001). Letter cancellation performance across the adult life span. *The Clinical Neuropsychologist*, *15*, 521-530.
- Walker, P. L. (2001). A bioarchaeological perspective on the history of violence. *Annual Review of Anthropology*, *30*, 573-596.
- Watkins, C. (2011). Dominant themes. *Psychologist*, *24*, 550-551.
- Watkins, C. D., Fraccaro, P. J., Smith, F. G., Vukovic, J., Feinberg, D. R., DeBruine, L. M., and Jones, B. C. (2010). Taller men are less sensitive to cues of dominance in other men. *Behavioral Ecology*, *21*, 943-947.
- Watkins, C. D., Jones, B. C., and DeBruine, L. M. (2010). Individual differences in dominance perception: Dominant men are less sensitive to facial cues of male dominance. *Personality and Individual Differences*, *49*, 967-971.
- Watkins, C. D., Quist, M. C., Smith, F. G., DeBruine, L. M., and Jones, B. C. (2011). Individual differences in women's perceptions of other women's dominance. *European Journal of Personality*, *26*, 79-86.