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Research Article

Masculinized Faces are Perceived as More Dangerous but Are Not More Memorable

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ABSTRACT

Research shows that faces manipulated to appear more masculine are perceived as more dominant; however, these experiments have relied on forced-choice paradigms, which are susceptible to demand characteristics - situational aspects of the experiment that influence subject behavior towards the expected outcome. We addressed the problems of force-choice paradigms and improved upon a previous investigation by presenting individual faces for a longer duration, and by having men and women rate presented masculinized and feminized faces on their threat potential. Forty-eight participants (25 men) completed a face rating and recognition memory task. Facial photographs were morphed by ± 75% to create masculinized and feminized versions. Participants rated 40 morphed facial photographs (masculinized = 20, feminized = 20) on how dangerous each man would be if he was provoked. To control exposure time for the recognition memory phase, participants viewed each face in the rating phase for five seconds. Following the rating phase, participants completed a recognition memory phase in which they viewed another set of 40 faces (50% new, 50% old, 50% masculinized, 50% feminized). Participants indicated whether each face was 'old' or 'new' and rated how confident they were in their classification. We predicted higher danger ratings for masculinized faces and greater sensitivity for them in the recognition memory test. In line with our predictions, both men and women assigned higher threat ratings to masculinized men's faces; however, they did not demonstrate greater sensitivity for masculinized men's faces or greater confidence in their ratings.

Keywords: *Dominance, threat, facial masculinity*

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INTRODUCTION

Faces are a primary focus of attention during human interaction (Sell, Cosmides, Tooby, Sznycer, von Rueden, & Gurven, 2008). Observers evaluate faces on two orthogonal dimensions: dominance, the individuals' physical strength, and valence, the individuals' trustworthiness (Oosterhof & Todorov, 2008). Faces that have high levels of dominance, and low levels of valence are perceived as threatening (Oosterhof & Todorov, 2008). Experiments manipulating facial characteristics to assess observers' social impressions have found that manipulating the sexual dimorphism of faces affects observers' perceptions of others' trustworthiness (e.g., Penton-Voak, Perrett, Castles, Kobayashi, Burt, Murray, & Minamisawa, 1999; Perrett et al., 1998), dominance (Boothroyd, Jones, Burt, & Perret, 2007), and threat (Han et al., 2017).

Facial masculinity is associated with men's threat potential, and humans can accurately assess men's upper body strength when they are only presented with facial photographs (Sell et al., 2008), suggesting that individuals can make inferences of upper body strength solely from the face. Observers' dominance ratings are highly correlated with their estimates of upper body strength, suggesting that observers view these traits as being highly related (Toscano, et al., 2014). Objective measures of facial masculinity (determined using geometric morphometrics) are related to men's upper-body strength, suggesting that it is not only observers' perceptions of men's masculinity but also their craniofacial morphology that reliably indexes upper body strength (Van Dogen & Sprengers, 2012). Observers' ability to assess threat potential may extend beyond upper body strength and into other domains, such as their trait aggression, that may ensure success in aggressive dyadic competition. Men and women are better than chance at determining the winner of aggressive dyadic competition (i.e., Mixed Martial Arts matches), when they are only presented with images of the competitors faces, suggesting that they can extract information related to threat potential from the face (Little, Třebický, Havlíček, Roberts, & Kleisner, 2015). This would suggest that individuals are able to evaluate others' threat potential from their face alone. Therefore, individuals' facial masculinity may significantly impact others' decisions to interact with or avoid them.

Drawbacks of the Forced-Choice Paradigm

Most research on the effects of facial sexual dimorphism on individuals' dominance and threat attributions has relied on one experimental paradigm: the forced-choice paradigm. In these experiments, participants are presented with a masculinized and feminized version of the same man's face and must indicate which face appears more physically dominant (e.g., Watkins, DeBruine, & Jones 2010). Although these studies support the hypothesis that individuals have the capacity to assess threat from faces, the forced-choice paradigms used in these experiments are subject to demand characteristics biasing the results of the experiments. Demand characteristics are situational aspects of the experiment which may confound participants' responses (Whitehouse et al., 2002). In the above-mentioned forced-choice paradigms, participants were directed to focus on the traits of interest (i.e., the two manipulated facial photographs), which may have altered their decisions. In this type of experiment, participants can likely determine that the face in the pair which appears more masculine should be identified, or rated as more dominant, regardless of whether participants would perceive either face as dominant. Moreover, by providing the feminized version of the same man's face as a reference upon which participants base their comparisons, the results of these experiments can only demonstrate that, on average, masculinized men's faces are rated as more dominant than the feminized version of the same man's face, which confers low ecological validity relative to how dominance assessments would be made in naturalistic settings. Although some studies have presented morphed facial photographs to participants individually (e.g., Batres, Re, &

Perrett, 2015; Sherlock, Tegg, Sulikowski, & Dixson, 2017), most have relied on the forced-choice paradigm.

The limitation of this paradigm represents a gap in the literature of perceived threat, preventing researchers from understanding if masculine faces are indeed perceived as formidable, which in turn affects downstream cognitive processes guiding their threat and dominance evaluations. If masculine faces reliably cue individuals' threat potential, then we would expect that observers should demonstrate an attentional bias, such that they would automatically allocate their attention to the processing of these masculinized faces which would result in these faces leaving a stronger trace in memory. In the current study, we seek to correct potential confounds of forced-choice paradigms (by directing attention less to the choice and more to relevant survival features; Little, et al., 2015). We posit that observers will allocate more selective attention to the processing of masculinized faces because they signal a threatening individual in the observer's environment. This bias would aid observers by prioritizing the processing of potentially dangerous individuals and enable them to engage in steps necessary to mitigate the threat.

Threat Advantage Hypothesis

One of the primary functions of attention is to direct limited cognitive resources toward features of the world that are most relevant to the organism (Fox, 2002). Because information selected for further processing guides individuals' actions, it is essential that attention is allocated to survival-relevant information (Fenske & Eastwood, 2003). Selective attention functions to prioritize any incoming information thought to be task relevant, and it is sensitive to biological stimuli that represent threat (Fox, 2002). Furthermore, when selective attention is directed towards a specific object or location, cognitive processing is prioritized for the object or spatial location versus other objects or locations (Carlson & Reinke, 2008).

The Threat Superiority Effect (TSE) refers to the ability to quickly attend to and identify sources of danger through an automatic attentional process (cf., Eastwood, Smilek & Merikle, 2001). Socially relevant cues, such as angry or fearful facial expressions elicit a TSE. Observers are faster to orient their attention to fearful rather than neutral or happy faces (Carlson & Reinke, 2008), and to find angry faces within a crowd of neutral and happy distractors (Ceccarini & Caudek, 2013). Together, these results provide evidence that individuals have an attentional bias for social cues of threat (e.g., Fox et al., 2002). Such an attentional bias spotlights threatening information, which helps observers to orient to and assess the danger of a situation and allows them to prepare to engage in actions to mitigate the threat (Öhman et al., 2001). In the current investigation, we predict a similar cognitive bias for masculine faces that cue threat potential of the individual (Little et al., 2015; Sell et al., 2008; Toscano et al., 2014; Van Dongen & Sprengers, 2012). Because physically dominant men represent a potential survival threat, we expect an attentional bias for the processing of masculinized faces at the cost of feminized ones, such that participants would demonstrate better recognition memory for masculinized faces because they allocated more attention to their initial processing.

Current Investigation

There are only a few studies evaluating the effects of facial sexual dimorphism while controlling for the effects of demand characteristics. Researchers have found that facial sexual dimorphism affects the amplitude and latency of event related potentials (ERPs) involved in face processing (Cellerino et al., 2007; Welling, Bestelmeyer, Jones, DeBruine, & Allan 2017). When evaluating the effects of selective attention, Jones, and colleagues (2010) have demonstrated that individuals were faster to identify the location of a target letter when primed with a masculinized face gazing toward the target location, suggesting that attentional allocation to the position that masculinized faces are gazing towards occurs at an automatic level. When researchers presented faces individually, they find that masculinized faces are rated as belonging to individuals who are older, taller, and more physically dominant than individually presented feminized ones (Batres et al., 2015; Sherlock et al., 2017). However, Sherlocke et al., (2017) did not find that masculinized faces affected by participants implicit responses to male dominance (Sherlock et al., 2017).

Albert and colleagues (2021) tested if men had the capacity to judge the physical dominance of men when their faces were presented individually and for a brief duration (i.e., 100 ms). These authors tested if participants demonstrated more accurate recognition memory for previously presented masculinized faces in a follow-up recognition memory test. They also evaluated how confident men were in their old/new classification judgements during the recognition memory phase. Men assigned higher dominance ratings to individually presented masculinized men's faces, despite a short presentation duration of 100 ms. However, observers did not differ in their classification accuracy for old and new feminized and masculinized faces. It could be that the exposure duration of 100 ms in Albert and colleagues was too short for participants to encode faces into long-term memory. Moreover, men were not more confident in their recognition memory for old masculinized men's faces.

To improve upon Albert et al. (2021), we made several changes to the current research. First, we changed the rating task. In the previous experiment, participants were asked to rate the physical dominance of each face using a 7-point Likert-type rating scale. Although physical dominance ratings are closely related to threat ratings (Han et al., 2017), we elected to use a more explicit measure of participants' perceptions of the photographed men's threat potential. Therefore, in the current experiment participants were asked to rate, on a 7-point Likert-type rating scale, how dangerous each man would be if he was provoked. Second, participants were exposed to each face for a longer fixed duration (5s) to give participants the time needed to encode the face into long-term memory. Third, the previous experiment was also limited in that Albert et al. (2021) only evaluated men's ratings of, and recognition memory for, masculinized men's faces. Sex differences in strength make women more vulnerable to aggression and thus suggest greater female sensitivity to threat (Lassek & Gaulin 2009). Therefore, in the current experiment both sexes participated.

Hypothesis

We predicted that participants would assign higher ratings of danger to masculinized men's faces when they are presented individually. We also expected that women would be more sensitive to facial sexual dimorphism and assign higher danger ratings to masculinized men's faces than male participants.

Recent research has shown that naïve observers are more likely to remember the faces of untrustworthy individuals in a recognition memory test, perhaps because remembering such individuals would promote future avoidance of them (Mattarozzi, Todorov, & Codispoti 2015). Untrustworthy individuals are perceived as more threatening (Oosterhof & Todorov, 2008). Here, we expected that both sexes would be more accurate when indicating that they had seen a face from the rating phase when it was masculinized than when it was feminized, and more confident in their recognition memory for masculinized faces, because masculinized faces appear more threatening and should be more salient at encoding.

METHODS

Sample Size Estimation and Participants

The experiment was approved by the Boston University IRB in accordance with the declaration of Helsinki for the ethical treatment of human subjects. Sample size was determined before analysis, which was performed only after all data were collected. A power analysis using G*Power 3.1.9.7 (Faul, Erdfelder,Buchner, & Lang, 2009; d =.49, α = .05, and Power 1 - β = .80), using the results of participants' reaction time from Jones et al (2010), revealed that a minimum sample of 28 participants was necessary. We exceeded the minimum sample size by collecting data from 48 participants.

Participants were 48 students (male = 25) from Boston University between the ages of 18 and 28 (M = 21.42, SD = 2.66). The ethnic composition of the sample was: Caucasian (26; 54%), South Asian (8; 17%), Asian (7; 15%), Latin American (6; 13%), Black (1; 2%). Eleven of these individuals (23%) identified with multiple ethnicities. Participants were recruited through online job ads for Blinded Institution students. Participants were paid 30.00 USD.

Materials

Photographs

Stimuli were facial photographs of white males. Fifty-seven of these facial photographs were from the Blinded Face Set and 33 from the London Face Set (DeBruine & Jones, 2017). For the Blinded Face Set, as part of a larger study on health and human mating, 167 men between the ages of 18 and 39 (M = 22.71 SD = 4.71) were photographed from a standardized distance of two meters with a neutral facial expression. The men from the London Face Set (DeBruine & Jones, 2017) were between the ages of 18 and 48 (M = 27.51, SD = 7.41). For both face sets, participants were photographed with a neutral facial expression. Photographs were originally 4608 × 3456 pixels in size. These were cropped and resized to match the photographs of the London Face Set which was 1350 × 1350 (DeBruine & Jones, 2017). Between the Blinded Face Set and the London Face Set, a total of 90 facial photographs were transformed (DeBruine & Jones, 2017).

Stimulus Creation

We used Psychomorph (version 6) to delineate the shape of the face by placing 189 landmark points along contours of major facial features. Next, we aligned the position of the pupils of each photographed face on the same *x-y* plane. Then, we used the male and female prototype facial photographs, provided by DeBruine and Jones (2017), to manipulate the sexual dimorphism of the 2D face shape of the facial photographs. These prototype male and female facial photographs were created by averaging the x-y points for all males' facial photographs together, and all female facial photographs together to create the prototypical male and female facial photographs. To create the masculinized and feminized versions of the facial photographs, 75% of the linear differences in the 2D shape between symmetrized versions of the male and female prototype faces were added to or subtracted from each original photograph (e.g., Jones, DeBruine, Main, Little, Welling, Feinberg, & Tiddeman, 2010). This process generated two faces per original facial photograph, resulting in 180 morphed faces (i.e., 90 masculinized and 90 feminized male faces). Images were then masked around the outline of the face so that hair and clothing cues were not visible.

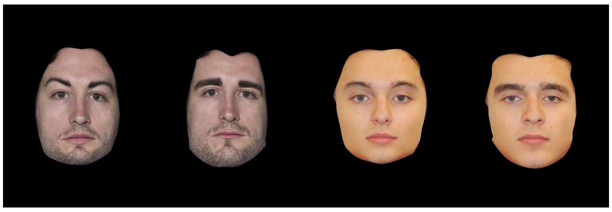

Fig. 1: Example images of feminized and masculinized faces from the London Face Set (Left) and the Nipissing University Face Set (Right).

Dominance Subscale of the International Personality Item Pool

Participants completed the dominance subscale of the International Personality Item Pool (IPIP; Goldberg, 1999), an 11-item measure of social dominance. The scale score has been used to test if men's dominance perceptions of masculinized faces are affected by their perceptions of their own physical dominance (Watkins, et al., 2010). The internal consistency of the scale was acceptable (α =.71).

Design

The experiment followed a 2 (Morph Type: masculinized face, feminized face) × 2 (Participants' Sex: male, female) mixed subjects' design. For the rating phase, participants' threat rating served as the dependent variable for the task. For the recognition memory phase, participants' sensitivity and confidence ratings served as the dependent variables for the task.

Procedure

Participants were tested individually. All participants had normal or corrected to normal vision. No participants were excluded due to poor visual acuity. All testing took place at a single computer station (Lenovo ideacentre). We used a chin rest to ensure that all participants sat 57 cm from the computer monitor. Participants viewed the facial photographs on a Lenovo 24 LED FHD computer monitor, with a 60Hz refresh rate. Psychophysics toolbox 3 (version 3.0.15) with Matlab (2020a) was used to present stimuli and record participants' responses.

Rating Phase

Participants completed 40 trials of the rating phase. Participants rated an equal number of unique masculinized and feminized face images which were randomly selected from the 180 face images. Face image presentation was completely randomized. Each trial began with the presentation of a fixation cross in the center of the screen for 500 *ms*. The fixation cross subtended 0.57° of visual angle vertically and horizontally. This was followed by the presentation of a face for 5*s*. Participants were instructed to study each face as best as they could for the 5s, because they would be completing a recognition memory phase after the rating phase. Following the presentation of the face, participants were presented with a Likert-type rating scale and asked how dangerous that man would be if he was provoked, ranging 1 (not at all dangerous) to 7 (very dangerous).

Recognition Phase

Following the rating phase, participants completed 40 trials of a recognition memory task. Participants were presented with 40 unique face identities on the screen one at a time. Half of these faces were randomly selected from the faces presented during the rating phase ("targets"). The other half were new faces ("lures") not previously presented in the rating phase. These faces were randomly selected from the remaining 140 face images not used during the rating phase. Half of the targets were masculinized faces, while the other half were feminized faces. The two types were also equally divided among the new face lures. Face image presentation order was completely randomized. After the presentation of each face, participants were asked to indicate whether they recognized the image from the rating phase. Participants pressed '4' on the keypad to indicate a correct target and '6' to indicate a new lure. Each face remained on the screen until they made their decision. Following their decision, participants rated how confident they were in their old/new classification using a 10-point Likert rating scale ranging from 1 (not at all confident) to 10 (very confident). After rating their confidence, the next trial began.

Analysis

Analysis was conducted in R (version 4.0.3; R core team). For the rating phase, we used the *lmer* function from the package, lme4 (Bates et al., 2015) to conduct two linear mixed effects linear regressions with maximum likelihood estimation to evaluate the effects of Morph Type on observers' threat ratings. We specified our random effects as cue image (level 1) nested in subject (level 2). In Model 1, Morph Type (i.e., masculinized, or feminized) of the photographs, Sex, and their self-reported dominance, along with their interactions were the fixed effects. In Model 2 we added participants' self-reported dominance as a fixed effect. Participants' threat ratings (1 = not at all dangerous to 7 = very dangerous) was the dependent variable for both regressions. To analyze significant interactions, we used the *lsmean* function of the *lsmeans* package (Lenth, 2016). To assess the amount of variance explained by our fixed and random effects, we computed Pseudo R^2 using the *r.squaredGLMM* function from the *Multi-Model Inference (MuMIn)* package (Barton & Barton, 2019).

To analyze the results of the recognition memory phase, we conducted two repeated measures, analysis of variance (ANOVA) using the *ez* package (Lawrence, 2016). Morph Type (i.e., masculinized, or feminized) served as the within subjects' effect for the first ANOVA. For the second ANOVA, Morph Type (masculinized, or feminized) and Presentation Condition (Old, or New) served as within subjects' effects. Sex served as the between subjects' effect in both ANOVAs. For ANOVAs, we report the generalized eta square as our estimate of effect size (Bakeman, 2005). The d' score for masculinized and feminized faces were calculated for each participant. This measure was computed based on the hit (H) and false alarm (FA) rates, where $d' = z(H) - z(FA)$ (Macmillan & Creelman, 1991; Stanislaw & Todorov, 1999). d' score served as the dependent variable for the first repeated measures ANOVA. Participants' mean confidence ratings for correct trials in the recognition memory task served as the dependent variables in the second repeated measures ANOVA.

RESULTS

Rating

The main effect of Morph Type and Sex were both significant, as was their interaction (Model 1). Masculinized faces were rated as more dangerous than feminized ones, and women assigned higher ratings of danger than did men (Table 1). To explore the significant Morph Type × Participants' Sex interaction, we conducted pairwise contrasts using the *lsmeans* function of the *lsmeans* package. Men and women did not differ in their dangerousness ratings for masculinized faces (z = 0.10, p = .99), but women rated feminized faces as being more dangerous than did men (z = -4.02, p = .003).

After adding participants' self-reported dominance to the model, (Model 2), the main effect of Morph Type was still significant; however, the main effect of Participants' Sex and Self-reported Dominance were not, and neither were any of the interactions. Please see Table 1 for the means and standard deviations of participants' threat ratings by Morph Type, and Table 2 for the fixed effects and interactions of the linear models.

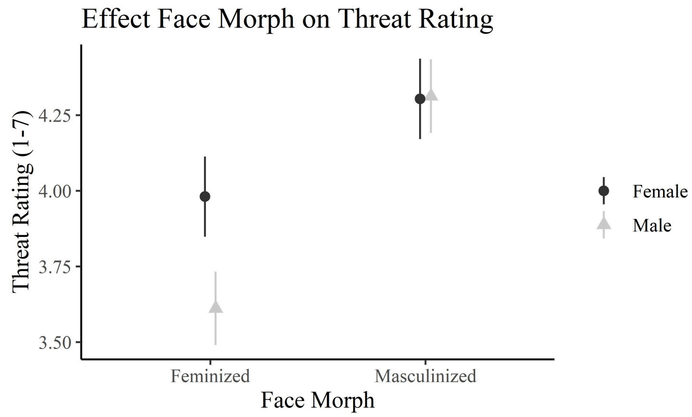

Fig. 2: Men and women's threat ratings of masculinized and feminized faces.

Table 1: Fixed effects, standard errors and 95% confidence intervals for models testing the effects of Morph Type, and Sex (Model 1) and trait dominance (Model 2), on participants' ratings of the photographed man's perceived danger.

Model 1		*b*	*SE*	*df*	*t*	*p*	LL	UL	R^2m	R^2c	ICC
	(Intercept)	3.61	0.06186	1849.55	58.38	<.001	3.49	3.73	0.04	0.59	0.55
	Morph Type	0.70	0.0781	869.505	8.984	<.001	0.55	0.86			
	Sex	0.37	0.09164	1866.27	4.032	<.001	0.19	0.55			
	Morph Type × Sex	-0.38	0.11729	989.927	-3.227	<.001	-0.61	-0.15			
Model 2											
	(Intercept)	3.39	0.48	1316.81	7.01	<.001	2.44	4.34	0.07	0.58	0.55
	Morph Type	1.80	0.62	643.33	2.92	<.001	0.59	3.01			
	Sex	-0.06	0.63	1331.72	-0.09	.93	-1.29	1.18			
	Dominance	0.08	0.16	1317.52	0.52	.61	-0.23	0.39			
	Morph Type × Sex	-0.71	0.81	756.85	-0.88	.38	-2.31	0.88			
	Morph Type × Dominance	-0.34	0.20	649.17	-1.66	.10	-0.73	0.06			
	Sex × Dominance	0.25	0.22	1332.33	1.15	.25	-0.18	0.69			
	Morph Type × Sex × Dominance	0.06	0.29	763.96	0.23	.82	-0.50	0.62			

Recognition Memory

Participant's recognition accuracy was 73% and their mean confidence rating in their accuracy was 6.26. To assess if observers demonstrated better recognition memory for masculinized men's faces, we conducted a 2 (Morph Type: Masculinized, Feminized) × 2 (Sex: Male, Female) mixed factorial ANOVA in which observers' sensitivity (d') served as the dependent variable. Neither the main effect of Sex, $F\ (1, 45) = 0.05$, $p = .83$, $\eta_G^2 < .001$, nor the main effect of Condition, F (1, 45) = 0.002, p = .96, $\eta_G^2 < .001$, were significant. The Sex by condition interaction was not significant, F (1, 45) = 0.002, p = .96, $\eta_G^2 < .001$.

Table 2: Means and standard deviation of participants sensitivity (d') of faces based on Sex and face morph masculinized/feminized.

		Male	**Female**
Feminized	Mean	0.06	-0.07
	SD	1.24	1.03
Masculinized	Mean	-0.12	0.13
	SD	1.58	1.22

Table 3: Means and standard deviation of participants hit and false alarm rate, based on face morph (masculinized, feminized) and participant sex.

		Male	**Female**
Hit Rate Feminized	Mean	80.00	79.55
	SD	14.43	18.12
Hit Rate Masulinized	Mean	76.80	77.73
	SD	18.65	13.78
False Alarm Feminized	Mean	30.00	31.82
	SD	18.71	18.16
False Alarm Masculinized	Mean	35.20	31.93
	SD	18.06	15.77

For our analysis of participants' confidence ratings, we filtered our data to include only correct classifications. Next, we conducted a 2 (Morph Type: Masculinized, Feminized) × 2 (Presentation Condition: Old, New) × 2 (Sex: male, female) mixed factorial ANOVA in which observers' confidence served as the dependent variable. Only the main effect of Presentation Condition, F (1,46) = 10.83, p = .002, $\eta_G^2 = .14$, was significant. Whereas the main effect of Morph Type, F (1,46) = 0.18, p =.67, $\eta_G^2 <.001$, and Sex, F (1,46) = 1.38, p =.25, $\eta_G^2 <.001$ were not. None of the interactions were significant, all Fs (1,46) < .73, all ps >.39, $\eta_G^2 <.001$. Participants were significantly more confident in their classification of old faces ($M_{old} = 2.76$, $SD_{old} = 0.65$) than new ones ($M_{old} = 2.76$, $SD_{old} = 0.65$).[1] To explore the significant main effect of Condition we used Tukey's HSD post hoc tests.

[1] When we include incorrect trials (i.e., trials where participants incorrectly classify the face as old or new) in the mixed factorial ANOVA, the results remain largely the same. Only the main effect of Presentation Condition, F (1,46) = 10.99, p = .002, $\eta G^2 = .09$, was significant. Whereas the main effect of Morph Type, F (1,46) = 1.30, p =.26, ηG^2 =.005, and Sex, F (1,46) = 0.003, p =.95, $\eta G^2 <.001$ were not. None of the interactions were significant, all Fs (1,46) < .87, all ps >.39, $\eta G^2 <.001$.

Table 4: Means and standard deviation of participants confidence (1=not at all confident 10 = very confident) in their accuracy of faces based on whether they are old/new and masculinized/feminized.

		Male	**Female**
Mean	Feminized Old	7.92	7.87
	Masculinized Old	7.80	7.70
	Feminized New	7.04	6.78
	Masculinized New	6.36	6.83
SD	Feminized Old	1.38	1.82
	Masculinized Old	1.87	1.40
	Feminized New	1.90	1.78
	Masculinized New	1.87	1.56

DISCUSSION

Extant research has demonstrated that masculinized faces are rated as less trustworthy (Buckingham et al., 2006; Little, Roberts, Jones & DeBruine, 2012), more dominant (Todorov et al., 2015; Watkins et al., 2010) and threatening (Han et al., 2017) than feminized faces. Correlational studies analyzing the relationship between men's facial masculinity and behavior have demonstrated that men with more masculine faces tend to be stronger (Sell et al., 2008; Toscano et al., 2014) and are perceived as stronger and more physically dominant (Sell et al., 2008; Toscano et al., 2014). However, to date, most experiments manipulating the sexual dimorphism of faces on peoples' social perceptions have relied on force-choice paradigms, which are susceptible to demand characteristics (Whitehouse et al., 2002).

Albert et al., (2021) tested the effect of facial sexual dimorphism on men's threat perception in a way that reduced the effects of demand characteristics by presenting faces individually, rather than in pairs, and only presenting them for a duration that was long enough for participants to formulate their perceptions (i.e., 100ms). Participants rated masculinized faces as more physically dominant even though they were presented individually and for an extremely short duration. They followed this up with a recognition memory test. Based on the TSE (Eastwood, Smilek, & Merikle, 2001; Fox, 1996; Hansen & Hansen, 1988; Mogg & Bradley, 1999; Öhman, Flykt, & Esteves, 2001; Pizzagalli, Regard, & Lehmann, 1999), they predicted that participants would demonstrate better recognition memory for previously seen masculinized faces because they would have been more salient. However, participants did not demonstrate better recognition memory for masculinized faces. The authors reasoned that the faces were presented too briefly to be encoded into long-term memory.

In the current investigation, we sought to improve upon Albert et al. (2021) by having participants rate faces manipulated on sexual dimorphism on a dimension more in-line with the TSE, the danger/threat potential of the individual. Here we predicted that masculinized faces would be rated as belonging to men who were more dangerous if provoked and found that participants rated masculinized faces as more dangerous. Second, unlike Albert et al. (2021) we included both sexes. Differences in upper body strength make women more vulnerable to physical aggression from men (Lassek & Gaulin 2009). Therefore, we reasoned that women would assign higher dangerousness ratings to masculinized men's faces. Relative to men, women assigned higher dangerousness ratings to men's faces. However, this effect was driven by women assigning higher dangerousness ratings to feminized faces, whereas the sexes did not differ in their dangerousness ratings assigned for masculinized faces. Finally, we sought to improve upon our previous investigation by making the recognition memory phase easier.

During the rating phase Albert et al. (2021), participants were exposed to each face for 100ms, making it unlikely that the faces were encoded into long-term memory. To reduce the likelihood of producing a floor effect, we exposed participants to each face for a longer, fixed period of 5s and tested if facial sexual dimorphism affected participants recognition memory, and their confidence in their classifications. We predicted that participants would demonstrate greater recognition memory for masculinized men's faces and be more confident in their classifications. However, facial sexual dimorphism did not affect participants recognition memory, nor their confidence in their classification of faces as old or new.

Our experiment contributes to research evaluating the effects of variation in facial sexual dimorphism on social perceptions by using a paradigm that limits the effects of demand characteristics (Whitehouse et al., 2002) by testing if faces varying on facial sexual dimorphism affect observers' threat perceptions. Our finding that manipulating facial sexual dimorphism affects individuals' perceptions of the photographed men's danger contributes to this body of research by showing that it informs individuals decisions of who in their environment is dangerous and could cause them physical harm. Since more masculine faces cue upper body strength (Sell et al., 2008; Toscano et al., 2014), and perceptions of upper body strength are closely linked to observers' physical dominance (Toscano et al., 2014; Van Dongen & Sprengers 2012), observers' reliance on facial sexual dimorphism would provide additional evidence that people use this feature when formulating their overarching threat perceptions. This ability would have benefited ancestral humans because it would have allowed them to accurately determine who in their environment could cause them serious physical harm and take the necessary steps to mitigate such threat through the avoidance of these individuals.

Limitations and Future Directions

The current study is not without its limitations. These limitations can serve as starting points for future experiments. Our sample size was relatively small (25 male, 23 female) which could have affected our ability to capture individual differences in participants self-perceived dominance as well as our statistical power to find an affect. Therefore, the null findings from the analysis from the recognition memory phase of the experiment may reflect a false negative. In future investigations we will increase our sample size to increase our chances of detecting an affect if one exists.

Future investigations could benefit by testing if observers are more likely to fixate on masculinized faces using an eye tracking paradigm (e.g., Duque, & Vázquez, 2015). If masculinized faces reliably cue threat, we expect observers would be fastest to fixate on these faces during both rating and recognition phases. Such findings would imply that observers have an attentional bias to process these masculinized faces. Additionally, future investigation could benefit by presenting observers with shorter alternating blocks of rating trials and recognition memory trials to see if participants demonstrate better recognition memory for masculinized faces after a shorter time interval has passed between the rating and recognition memory phase.

Moreover, it could be that masculinized faces on their own, while sufficient to produce higher threat ratings, are not sufficient to affect participants selective attention and produce a TSE-like response. Indeed, in our daily life the traits we direct our attention to are not always relevant to our survival. Without contextual factors of a threatening situation, it could be that masculinized faces were not salient to observers. Future investigations could vary the emotional expression of facial photographs in addition to the facial sexual dimorphism. It could be that observers could demonstrate better recognition memory for masculinized faces but only if these faces were previously presented under conditions that simulate threat, such as when they are presented with a masculinized face with an angry expression. Alternatively, future investigations could prime participants with fearful eliciting images from the International Affective Picture System (Lang, Bradley, & Cuthbert 2008) before presenting faces varying on sexual dimorphism to determine if making observers sensitive to threat in their environment effects their memory for masculinized faces at follow-up.

Conclusions

The results demonstrate that both sexes perceive masculinized men's faces as more dangerous, when they are presented individually, building on the findings of Albert et al., (2021). However, participants did not demonstrate greater recognition memory for masculinized faces, nor greater confidence in their classifications. Future investigations should use alternative techniques for evaluating participants recognition memory for masculinized and feminized faces.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ETHICAL APPROVAL

This study was performed in line with the principles of the Declaration of Helsinki. All study procedures were approved by the Boston University Institutional Review Board.

INFORMED CONSENT INFORMED

Consent was obtained from all individual participants included in the study.

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TRANSPARENCY

The data set analyzed and presented in the current study are available from the corresponding author on reasonable request.

AUTHORS CONTRIBUTIONS

GA developed and implemented the study design with critical guidance from CRHS, CL and EW. GA conducted all analysis. SA provided stimuli from the Nipissing University Face Set. GA wrote the manuscript. CRHS, JKH, EW, SA and CL all provided critical revisions. All authors have consented to the draft of the manuscript.

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