Journal of Experimental Psychology: General
2014, Vol. 143, No. 3, 1259–1276

0096-3445/14/$12.00 DOI: 10.1037/a0034516

# Recalibrating Gender Perception: Face Aftereffects and the Perceptual Underpinnings of Gender-Related Biases

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Contemporary perceivers encounter highly gendered imagery in media, social networks, and the workplace. Perceivers also express strong interpersonal biases related to targets' gendered appearances after mere glimpses at their faces. In the current studies, we explored adaptation to gendered facial features as a perceptual mechanism underlying these biases. In Study 1, brief visual exposure to highly gendered exemplars shifted perceptual norms for men's and women's faces. Studies 2–4 revealed that changes in perceptual norms were accompanied by notable shifts in social evaluations. Specifically, exposure to feminine phenotypes exacerbated biases against hypermasculine faces, whereas exposure to masculine phenotypes mitigated them. These findings replicated across multiple independent samples with diverse stimulus sets and outcome measures, revealing that perceptual gender norms are calibrated on the basis of recent visual encounters, with notable implications for downstream evaluations of others. As such, visual adaptation is a useful tool for understanding and altering social biases related to gendered facial features.

*Keywords:* visual aftereffects, face perception, social vision, gender bias, gendered phenotypes



In daily life, people encounter others who vary considerably in their gendered appearance (i.e., masculinity/femininity). Although many individuals fall within the average range of gender variation, others do not. In fact, self-presentational motives and strategic editing practices ensure that the people we see in print, onscreen, or in daily life are often exceptionally gendered. One might expect that such gendered imagery would exaggerate sexually dimorphic features (i.e., exceptionally feminine women and masculine men), but that is not the case. Instead, a systematic feminization is evident across visual domains. At least in Western countries, female actresses, reporters, politicians, and models tend to embody hyperfeminine features (Carpinella & Johnson, 2013; Carter & Steiner, 2004; Collins, 2011; Heldman & Wade, 2011). Perhaps surprisingly, the same is true among Western men: Visual media rarely depict men who are hypermasculine, but increasingly depict men who are somewhat feminized (Adams, 2011; E. Anderson, 2005, 2008, 2009; Coad, 2008). Anecdotal evidence corroborates these empirical observations. For example, *People Magazine's* list of the most prominent and attractive male celebrities of 2012 included many men with visibly feminized facial features (high brow line, high cheekbones, wide eyes, small nose; e.g., Max Greenfield, Matt Bomer, Damian Lewis, Paul Rudd, Usher, Aaron Paul, Ian Somerhalder). Individuals' everyday self-presentations also favor feminized phenotypes, insofar as both men and women undergo cosmetic surgery to accentuate feminine aspects of their facial appearance, such as small noses and lifted eyelids (Davis, 2002). Taken together, these factors produce an overrepresentation of feminine phenotypes relative to more masculine phenotypes in media and social life.

Such highly gendered imagery is likely to shape our preferences for and judgments of other people. Indeed, gendered facial features predict biased impressions of men and women, with perceivers expressing distaste for exceedingly masculine features in both sexes (Frederick & Haselton, 2007; Little & Perrett, 2011; Sczensy, Spreeman, & Stahlberg, 2006). We contend that frequent visual exposure to feminine phenotypes, or infrequent exposure to more masculine phenotypes, may perpetuate these gender-related biases. Consistent with this possibility, empirical evidence suggests that visual exposure to faces helps to calibrate what is perceived as normative and that shifts in perceptual norms may influence subsequent social evaluations. For example, when perceivers adapt to caricatured faces, features of those faces begin to appear normative (Rhodes, Robbins, et al., 2005). Subsequent faces that violate this norm (i.e., anticaricatures) tend to be evaluated negatively, a shift in judgment known as an *aftereffect* (Principe & Langlois, 2012; Rhodes, Jeffery, Watson, Clifford, & Nakayama, 2003). Although compelling, evidence of this link between visual adaptation and social evaluation has been limited primarily to caricatured features and ratings of attractiveness. Whether and how visual adaptation to naturally varying phenotypes affects broader social evaluations remains less clear.

Here, we argue that visual adaptation to highly gendered phenotypes influences gender-related biases in social perception. Spe-

This article was published Online First September 30, 2013.

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This research was supported by a National Science Foundation Graduate Research Fellowship and Janet Hyde Graduate Student Research Grant (David J. Lick) as well as by National Science Foundation Grant BCS-1052896 (Kerri L. Johnson). We thank Jon Freeman for stimuli and members of the Social Communication Lab for assistance with data collection.

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cifically, we propose that people evaluate others on the basis of perceived norms for sex categories, such that targets whose gendered appearances lie far from the norm are evaluated negatively. Furthermore, we propose that these norms are malleable and that they are calibrated on the basis of the faces that observers have recently encountered in their environment. If our hypotheses are correct, then visual adaptation may be a proximal mechanism underlying gender-related biases that arise in the early stages of social perception, and it may provide a novel tool for understanding and eventually mitigating those biases.

## Gender-Related Biases in Social Perception

People readily form impressions of others on the basis of mere glimpses of their faces (Willis & Todorov, 2006), and they often exploit gendered information to do so (Freeman, Johnson, Ambady, & Rule, 2010; Keating, 1985). Indeed, social evaluations based on gendered appearance cues begin within milliseconds of visual exposure (Ito & Cacioppo, 2000; Ito, Thompson, & Cacioppo, 2004), and they carry implications for a wide range of social evaluations. For example, gendered features guide attractiveness judgments (Johnston & Franklin, 1993; Rhodes, Hickford, & Jeffery, 2000). This results in a pronounced bias favoring feminine women: Across cultures, feminine female faces (i.e., those with a rounder jaw, wider eyes, higher brow line, higher cheekbones, smaller nose) are consistently rated as more attractive than masculine female faces (Jones & Hill, 1993; Perrett et al., 1998; Perrett, May, & Yoshikawa, 1994; Rhodes et al., 2000; Valenzano, Mennucci, Tartarelli, & Cellerino, 2006). Gendered appearance cues also bias judgments of men's attractiveness, though the direction of the effect is somewhat less clear. In some studies, perceivers judge masculine male faces (i.e., those with a squarer jaw, smaller eyes, higher forehead, larger nose, and thicker eyebrows) to be most attractive (Grammer & Thornhill, 1994; Johnston, Hagel, Franklin, Fink, & Grammer, 2001; Scheib, Gangestad, & Thornhill, 1999). In other studies, perceivers judge feminine male faces to be most attractive (Little & Hancock, 2002; Perrett et al., 1998; Rhodes et al., 2000).

Researchers have obtained similar patterns of gender-related biases for social evaluations other than attractiveness. For example, gendered phenotypes have been shown to predict diverse social judgments, including a person's respectability, sincerity, prosociality, honesty, warmth, loyalty, likability, intelligence, and dependability (Lick & Johnson, 2013; Little, Jones, Penton-Voak, Burt, & Perrett, 2002; Penton-Voak et al., 2007; Principe & Langlois, 2012; Sczensy et al., 2006). The direction of these effects is common to judgments of both men and women, such that feminine targets of both sexes receive more favorable evaluations than their masculine counterparts.

Such mounting evidence of a preference for feminized features in both men and women has been surprising to many, and several research teams have begun to probe these findings in greater depth. One emergent explanation is that gendered phenotypes predict evaluative biases via stereotypic associations. For example, in women, feminine features are commonly associated with beauty, immunity, and fecundity (Symons, 1995; Thornhill & Gangestad, 1996), which may lead to more favorable evaluations of feminine women relative to masculine women. In men, masculine features are associated with negative traits such as violence, especially when those features become extreme (Rhodes, 2006; Rhodes et al., 2000). This may lead to more favorable evaluations of feminine men relative to more masculine men. In line with this reasoning, one study noted a curvilinear association between masculine appearance and ratings of male attractiveness, such that women perceived masculine body shapes to be maximally attractive to a point, after which additional musculature was perceived as unattractive, perhaps due to its association with excessive strength (Frederick & Haselton, 2007). In other work, experimental administration of oxytocin masked observers' feelings of threat when viewing hypermasculine faces. This led observers who received oxytocin to prefer more masculine faces relative to observers who did not receive oxytocin (Theodoridou, Rowe, Rogers, & Penton-Voak, 2011). Collectively, these findings suggest that social evaluations may be biased toward feminine men and women due to perceivers' stereotypically positive associations with femininity and negative associations with masculinity. Although this explanation is certainly reasonable, other factors may also be at play. In particular, we propose that perceptual experience may contribute to gender-related biases in social evaluation.

## Perceptual Experience, Gender Norms, and Evaluative Biases

Biases against hypermasculine men and women may occur in part because perceivers have limited visual exposure to such targets. Indeed, the women portrayed in popular media, politics, video games, and social networks tend to be more feminine than masculine (Carpinella & Johnson, 2013; Manago, Graham, Greenfield, & Salimkhan, 2008). A similar trend exists for men: Whereas portrayals of hypermasculine men are rare, portrayals of more feminine men are increasingly common (Adams, 2011; E. Anderson, 2005, 2008, 2009; Coad, 2008; Harris & Clayton, 2007; Swain, 2006). In fact, although it may seem counterintuitive, exposure to somewhat feminized men seems to have outpaced exposure to highly masculine men. Consider, for example, how often one sees faces similar to Rambo or Arnold Schwarzenegger—exposure to these sorts of hypermasculine faces is rare. However, many of our friends, family members, politicians, and influential celebrities exhibit less masculine, and even somewhat feminine, facial features. This is not to imply that contemporary men exhibit the same femininity as women or that they embody distinctly feminine behaviors and traits, but rather that they tend *not* to exhibit hypermasculine phenotypes. Consequently, we argue that perceivers have less perceptual exposure to hypermasculine phenotypes relative to somewhat feminized phenotypes of both sexes.

To the extent that visual exposure is skewed toward feminine phenotypes, preferences for targets with feminine facial features may emerge. Indeed, impression formation relies heavily on perceptual experience, and researchers have long known that perceivers prefer prototypical category exemplars with which they have more experience to nonprototypical exemplars with which they have less experience (Kahneman & Miller, 1986; Perry, 1994; Posner & Keele, 1968). In fact, increasing exposure to a stimulus reliably increases preferences for that stimulus (Zajonc, 1968). Such exposure effects extend to socially relevant evaluations as well: Merely observing outgroup members with whom one has had limited interpersonal contact reduces prejudice against that outgroup for up to 24 hr (Dasgupta & Greenwald, 2001; see also Mutz & Goldman, 2010; Schiappa, Gregg, & Hewes, 2005).

Despite numerous studies linking perceptual experience to favorable evaluations, the mechanisms underlying these exposure effects remain unclear. Recent work in social vision has offered a compelling hypothesis: Visual exposure may affect social biases by shifting perceptual norms for targets' appearances. That is, stimuli may appear increasingly normative as perceivers gain additional exposure to them, leading to enhanced evaluative judgments. Studies of visual adaptation provide more direct support for these claims.

## Adaptation Aftereffects

Vision scientists have long recognized that perceptual norms are malleable and that relatively brief exposure to a class of stimuli (adaptation) can alter norms, resulting in noteworthy perceptual changes (aftereffects; Clifford & Rhodes, 2005; Webster, Werner, & Field, 2005). Early researchers documented aftereffects following adaptation to low-level visual cues such as motion (Addams, 1834; Purkinje, 1825) and color (Hering, 1878). More recent research uncovered aftereffects in higher level vision—most notably, in face perception (Leopold, Rhodes, Muller, & Jeffery, 2005). Findings revealed that prolonged visual exposure to faces with a particular feature biases perception of subsequently encountered faces in the opposite direction. For example, adaptation to large noses makes an average nose appear quite small. The dominant explanation for these aftereffects is that facial features are coded relative to a perceptual norm that shifts in response to visual exposure (Rhodes, Jeffery, Clifford, & Leopold, 2007; Rhodes, Robbins, et al., 2005). That is, perceivers possess norms that code for particular features (e.g., the average nose in the population), and these norms are dynamically calibrated to accommodate recent visual experiences. After exposure to large noses, an average nose appears quite small because the perceptual norm for noses has updated to appear bigger than it was to begin with. Thus, in general, research on face aftereffects has revealed that visual adaptation biases perception *away from* an adapting stimulus (i.e., exposure to large noses makes average noses appear small) by shifting the norm *toward* the adapting stimulus (i.e., exposure to large noses makes large noses appear normative).

Face aftereffects are well documented for adaptation to physically distorted features (e.g., caricatures and anticaricatures; N. D. Anderson & Wilson, 2005; Fang, Ijichi, & He, 2007; Yamashita, Hardy, De Valois, & Webster, 2005). In daily life, however, faces vary in more phenotypically natural ways (e.g., pigmentation, texture), and adaptation to naturally varying facial characteristics is poorly understood. The few studies in which adaptation to natural phenotypes has been examined revealed that such adaptation does occur (Little et al., 2002; Webster, Kaping, Mizokami, & Duhamel, 2004). However, the downstream consequences of such adaptations remain unclear because most of the relevant studies examined low-level face aftereffects such as perceived sex category boundaries, gaze direction, and facial viewpoint (N. D. Anderson & Wilson, 2005; Bestelmeyer et al., 2008; Fang et al., 2007).

Some evidence suggests that visual adaptation may alter higher level evaluations of faces. For example, visual adaptation results in more favorable attractiveness ratings for faces that share characteristics with the adapting stimuli (Anzures, Mondloch, & Lackner, 2009; Leopold & Bondar, 2005; Rhodes et al., 2003; Rhodes, Robbins, et al., 2005). These findings suggest that visual adaptation shifts perceptual norms and evaluative biases in the same direction, such that perceivers rate faces that are similar to adapting faces as both more normative and more attractive. Furthermore, a recent study revealed that visual adaptation leads to more favorable affective responses to human/chimpanzee facial morphs, as indicated by activity over the *zygomaticus major* muscle group (Principe & Langlois, 2012). Another study revealed that adaptation to masculine facial features enhanced the perceived trustworthiness of men's faces (Buckingham et al., 2006); however, researchers did not investigate more global evaluations or judgments related to women's gendered features. Thus, extant research suggests that adaptation to distorted facial features leads to more favorable evaluations of similar faces. However, researchers have yet to determine whether adaptation to naturally varying facial features (e.g., gender) reliably alters broad social evaluations related to those features. Such insights would help us to understand the perceptual mechanics of gender-related biases in social perception.

# The Current Research

We propose that perceivers adapt to gendered features in men's and women's faces and that these adaptations alter the perceptual norms that guide social evaluations. Specifically, we predict that brief visual exposure to gendered facial features will shift perceptual norms, such that perceivers who are exposed to masculine features will view more masculine features as normative, whereas perceivers who are exposed to feminine features will view more feminine features as normative. We also predict that social evaluations will vary concomitantly with these shifts in perceptual norms, such that perceivers who are exposed to masculine features will evaluate masculine targets more favorably, whereas perceivers who are exposed to feminine features will evaluate feminine targets more favorably. If we are correct, then perceivers may express bias against hypermasculine faces because they are exposed to them less often than feminine faces, making them appear nonnormative and therefore leading to negative evaluations. Experimental exposure to masculine faces should mitigate these biases, whereas exposure to feminine faces should exacerbate them.

We tested the evaluative implications of visual exposure to gendered facial cues in a series of related experiments. In Study 1, we tested whether perceptual norms for men's and women's facial features shifted following exposure to gendered cues in computer-generated faces. In Study 2, we explored the evaluative implications of such visual adaptation. In Study 3, we pinpointed the direction of these shifts in evaluation by including a control group. Finally, in Study 4, we tested the generality of these effects using a different set of evaluative judgments and facial photographs of real men and women that varied in their gendered appearance. Collectively, these studies support the use of visual adaptation as a tool for understanding and potentially altering gender-related biases in social perception.

# Study 1

Previous studies have demonstrated that visual adaptation alters perceived norms for faces, especially those with caricatured features (Rhodes, Robbins, et al., 2005; Webster et al., 2004). In Study 1, we sought to extend this work by testing whether adaptation to gendered facial features alters perceptual norms for men and women. On the basis of empirical and anecdotal evidence that feminine individuals are more common than more masculine individuals in media and everyday social networks, we predicted that participants would enter the study with slightly feminized norms for male and female faces. However, we expected that adaptation would alter these norms, such that exposure to masculine phenotypes would lead participants to identify more masculine faces as normative, whereas exposure to feminine phenotypes would lead participants to identify more feminine faces as normative.

## Method

**Participants.** Two hundred fifteen Internet users from the United States (85 men, 124 women, six unreported) completed an online study. Participants were diverse in terms of age ($M = 34.16$ years, $SD = 13.42$ years) and racial identity (78% White, 8% Asian, 5% Black, 6% Latino, 5% biracial), and most reported a high level of education (90% attended college).

**Stimuli.** Stimuli were 21 computer-generated male faces and 21 computer-generated female faces that varied systematically in their gendered features (400 × 477 pixels at 72 pixels/inch; see Figure 1). We created the stimuli using FaceGen Modeler, which estimates phenotypic features based on parameters observed in several hundred three-dimensional face scans of the human population (Blanz & Vetter, 1999). Specifically, we began with FaceGen's average base face and set all phenotypic features (e.g., age) at their anthropometric mean. We then used the gender-morphing tool to alter the features of the base face. For female faces, we systematically changed the apparent gender from the most feminine face possible to the point at which the face had equally male and female characteristics, yielding 21 female faces that varied incrementally in gender typicality from hyperfeminine to hypermasculine. For male faces, we systematically changed the apparent gender from the most masculine face possible to the point at which the face had equally male and female characteristics, yielding 21 male faces that varied incrementally in gender typicality from hypermasculine to hyperfeminine. Thus, our stimuli captured the full range of gendered variation for each sex, up to the point where the features were anthropometrically androgynous. We considered androgynous faces to be gender-atypical within a given sex because we explicitly informed participants of the sex category that they were judging (i.e., participants judging female faces were told that would only see female faces). Therefore, hypermasculine women and hyperfeminine men were extremely gendered relative to a sex-specific norm. To ensure that the stimuli were externally valid, we allowed all other facial features to covary with gender as they do in the population. For example, masculine faces had darker skin tone than did feminine faces, because pigmentation naturally varies along gendered lines (see Johnson, Freeman, & Pauker, 2012).

**Procedure.** Internet users from Amazon Mechanical Turk completed a study about their perceptions of other people. The study announcement made no mention of sex, gender, visual adaptation, or bias. After providing consent, participants evaluated either male or female faces in several stages.[1] First, participants identified the most average-looking man or woman from an array of all 21 male or female faces that varied in gendered appearance (*Pretest*). Next, participants were randomly assigned to one of two adaptation conditions in which they viewed either the five most feminine faces (*Feminine Adaptation*) or the five most masculine faces (*Masculine Adaptation*) from the sex category to which they were assigned. These adaptation images were selected from the images in the array, and they were repeatedly displayed for 3 s each in random order for a total of 3 min.[2] Following adaptation, participants again identified the most average-looking man or woman from an array of all 21 male or female faces (*Posttest*). The placement of faces in the array differed randomly at pretest and posttest. Finally, participants completed the Personal Attributes Questionnaire (PAQ; Spence, Helmreich, & Stapp, 1975) to assess their endorsement of masculine and feminine gender schemas, and they reported their sex, age, race, and education before being debriefed.

In total, 106 participants evaluated male faces (52 masculine adaptation, 54 feminine adaptation) and 109 participants evaluated female faces (66 masculine adaptation, 43 feminine adaptation). Participants were randomly assigned to adaptation conditions, so we suspect that differences in sample size reflect differential dropout rates across conditions. A chi-square test revealed that the number of participants did not differ significantly across these four cells, $\chi^2(1) = 2.87$, $p = .09$.

## Results and Discussion

Our primary aim in Study 1 was to explore participants' perceptual gender norms for faces and to test whether visual adaptation altered these norms. We predicted that norms would be notably feminized at pretest but that they would shift in the direction of adaptation, such that observers would find masculine faces more normative after exposure to masculine features but feminine faces more normative after exposure to feminine features.

Because our stimuli varied incrementally in gender typicality, we numerically coded each face from 1 (*hypermasculine*) to 21 (*hyperfeminine*) to quantify the gendered features that participants perceived as average (*Perceptual Gender Norm*). Because participants chose the most average face at two time points, we used

[1] In this and all forthcoming studies, separate samples of participants evaluated male and female targets. We conducted our studies in this way because, in our experience, it is more efficient to collect several small samples rather than one large sample on Mechanical Turk. On the advice of two anonymous reviewers, we have combined the samples and examined Target Sex as a between-subjects factor to streamline the results. This analytic decision was justified insofar as there were no notable differences between the samples: Frequencies and means of all demographic variables were not significantly different across the samples evaluating men and women. Still, it is important to note that we did not randomly allocate participants to evaluate male and female faces. Although we did not find any significant effects of Target Sex across studies, future research should confirm these findings after randomly assigning participants to judge different sex categories.

[2] To ensure that participants were engaged throughout the adaptation period, we informed them that we were interested in the speed with which they processed faces. In line with this cover story, participants saw 10 faces with a yellow circle on them at random intervals throughout the adaptation period. When one of these faces appeared, participants were told to press the *enter* key as quickly as possible. We did not record the speed with which participants identified the marked faces; we merely used this task to ensure that participants remained engaged throughout the adaptation. We used this strategy in all four studies reported here.

*Figure 1.* Example stimuli depicting the range of masculine (top left) to feminine (top right) male faces as well as feminine (bottom left) to masculine (bottom right) female faces. The most gender-atypical face in each sex category (i.e., feminine male and masculine female) was the anthropomorphic mean at which the face had equally masculine and feminine characteristics. Because we informed participants of the sex category that they were judging, we refer to these faces as hyperfeminine and hypermasculine, although they were phenotypically androgynous.

multilevel regression models to account for the nested structure of the data. Specifically, we stacked Perceptual Gender Norm scores in the data set and differentiated them with a dummy-coded variable (*Test Period*; 0 = *Pretest*, 1 = *Posttest*). The masculinity and femininity dimensions of the PAQ were internally consistent (Cronbach's $\alpha$s = .81 and .84, respectively), so we summed the items into continuous composite scores on which higher values indicated more masculine and feminine gender schemas. We scored Participant Age (*years*) and Education (1 = *less than high school* to 8 = *doctoral degree*) continuously. We effect-coded Adaptation Condition, Target Sex, and Participant Sex (*masculine adaptation* = −0.5, *feminine adaptation* = 0.5; *male* = −0.5, *female* = 0.5), and dummy-coded Participant Race (White as reference category).

As noted above, we tested our hypotheses using random coefficient multilevel models to account for within-subject dependencies in the data (i.e., multiple judgments of the same faces at multiple time points). Although we included random intercepts to account for the nested structure of the data, we were only interested in fixed effects; thus, we do not discuss random effects any further. Below, we report unstandardized regression coefficients, which indicate effect size as the expected increase in the dependent variable given a one-unit increase in the independent variable.

**Preliminary analyses.** First, we examined the extremity of the gendered features that participants identified as normative at pretest. On the basis of anecdotal evidence that perceivers have greater exposure to feminine relative to highly masculine individuals, we expected that perceivers would enter the study with somewhat feminized norms for male and female faces. As expected, participants identified an anthropometrically feminized male face ($M$ = 13.92, $SD$ = 4.96) and female face ($M$ = 13.39, $SD$ = 4.53) as normative at pretest. Both of these means were significantly above the midpoint of the gender scale (i.e., 11), indicating that participants entered the study with feminized perceptual norms for both men and women ($t$s = 6.08 and 5.50, $p$s $<$ .001, respectively).

**Visual adaptation influences perceptual norms for male and female faces.** Next, we tested whether visual adaptation produced an aftereffect that reliably altered perceptual norms for men's and women's faces. To do so, we regressed Perceptual Gender Norm onto Adaptation Condition, Test Period, Target Sex, and all interactions. The three-way interaction was not significant ($B$ = −1.04, $SE$ = 1.21, $t$ = −0.86, $p$ = .390), indicating that the predicted aftereffects did not vary as a function of Target Sex. We therefore collapsed across Target Sex and regressed Perceptual Gender Norm onto Adaptation Condition, Test Period, and their interaction. The expected two-way interaction was significant ($B$ = 3.76, $SE$ = 0.60, $t$ = 6.23, $p$ $<$ .001). We decomposed this interaction by examining simple slopes for Test Period within each adaptation condition. In the masculine adaptation condition, participants chose significantly more masculine faces as normative at posttest relative to pretest ($B$ = −2.50, $SE$ = 0.40, $t$ = −6.15, $p$ $<$ .001). In the feminine adaptation condition, the opposite trend emerged, such that participants chose significantly more feminine faces as normative at posttest relative to pretest ($B$ = 1.26, $SE$ = 0.45, $t$ = 2.83, $p$ = .005) (see Figure 2).

We tested the strength of these effects by controlling for demographic variables collected during the study. We were particularly interested in whether gender schematicity altered adaptation effects, because the tendency to view the world in a starkly gendered manner might create strong perceptual gender norms that are resistant to change. Although we did not have a priori hypotheses about the effects of other demographic variables on visual adaptation, we also controlled for them to assess the robustness of the observed aftereffects. Specifically, we recalculated the regressions described above after partialing out the effects of participant sex, age, race, education, and masculine and feminine gender schemas. After accounting for these factors, the two-way interaction be-

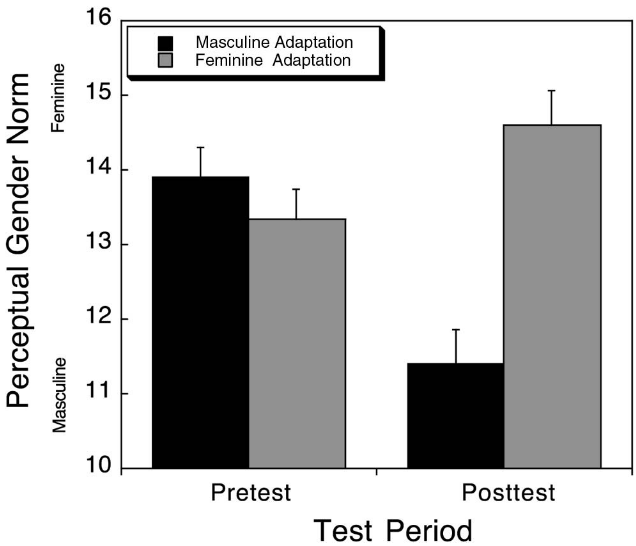


*Figure 2.* Change in perceptual gender norms as a function of visual adaptation in Study 1. Perceptual norms became more masculine following adaptation to masculine faces, but more feminine following adaptation to feminine faces. Error bars represent standard errors of the mean within each adaptation condition.

tween Adaptation Condition and Test Period remained significant and of similar magnitude as before ($B = 3.79$, $SE = 0.64$, $t = 5.95$, $p < .001$). Moreover, the simple effect of Test Period remained significant in both the masculine and feminine adaptation conditions ($B$s $= -2.52$ and 1.27, $SE$s $= 0.43$ and 0.47, $t$s $= -5.91$ and 2.69, $p$s $< .001$).

Overall, Study 1 provided support for our hypothesis that perceptual norms for men's and women's faces are calibrated on the basis of recent visual exposure. Perceivers entered the study with notably feminized norms for men's and women's faces, buttressing recent evidence that Western observers have more exposure to feminized faces than to highly masculine faces of either sex (see Adams, 2011; E. Anderson, 2009; Coad, 2008; Swain, 2006). Importantly, these norms shifted following experimental exposure to highly gendered exemplars: Perceivers who adapted to masculine phenotypes chose more masculine faces as normative at posttest relative to pretest, whereas perceivers who adapted to feminine phenotypes chose more feminine faces as normative at posttest relative to pretest. Thus, observers' perceptual norms efficiently adapted to gendered features in target faces.

## Study 2

In Study 1, adaptation to gendered features reliably altered perceptual norms for men's and women's faces. We now turn to our second hypothesis—namely, that perceptual norms are associated with social evaluations of targets. We predicted that participants would harbor preexisting biases against hypermasculine faces because they are perceived as less normative than feminine faces. Furthermore, we predicted that these biases would shift following adaptation, such that exposure to masculine faces would attenuate bias against hypermasculine targets but exposure to feminine faces would exacerbate bias against hypermasculine targets.

### Method

**Participants.** One hundred eighty-eight Internet users from the United States (71 men, 116 women, one unreported) completed an online study. Participants were diverse in terms of age ($M = 34.05$ years, $SD = 13.15$ years) and racial identity (70% White, 10% Asian, 10% Black, 7% Latino, 3% biracial), and most reported a high level of education (83% attended college).

**Stimuli.** Stimuli included a subset of the faces described in Study 1. For the evaluation portion of the study, we used five faces of each sex that were evenly spaced in terms of gender (a hypermasculine face, a moderately masculine face, a neutral face, a moderately feminine face, a hyperfeminine face). For the adaptation portion of the study, we used the five most feminine faces of each sex for the feminine adaptation condition and the five most masculine faces of each sex for the masculine adaptation condition.

**Procedure.** Internet users from Amazon Mechanical Turk completed a study about their perceptions of other people. The study announcement made no mention of sex, gender, visual adaptation, or bias. After providing consent, participants were randomly assigned to evaluate either five male or five female faces in a random order across 12 items measured on 10-point semantic differential scales (*Pretest*). The evaluations were modeled after N. H. Anderson's (1968) study of the most potent adjectives used to describe others, and they included unattractive–attractive, appropriate–inappropriate (reverse scored), improper–proper, respectable–indecent (reverse scored), acceptable–unacceptable (reverse scored), in poor taste–in good taste, sincere–insincere (reverse scored), honest–dishonest (reverse scored), loyal–disloyal (reverse scored), intelligent–unintelligent (reverse scored), dependable–not dependable (reverse scored), warm–cold (reverse scored). Previous studies have shown that these items reliably capture evaluative biases related to gendered facial features (Lick & Johnson, 2013).

After evaluating the target faces, participants were randomly assigned to adaptation conditions as described in Study 1. In particular, participants repeatedly viewed either the five most feminine faces (*Feminine Adaptation*) or the five most masculine faces (*Masculine Adaptation*) from the sex category to which they were assigned for 3 s each for a total of 3 min. Following adaptation, participants reevaluated the same target faces from pretest on the scales described above (*Posttest*). Finally, participants completed the PAQ (Spence et al., 1975) and reported their sex, age, race, and education before being debriefed.

In total, 93 participants evaluated male faces (46 masculine adaptation, 47 feminine adaptation) and 95 participants evaluated female faces (49 masculine adaptation, 46 feminine adaptation). A chi-square test revealed that the number of participants did not differ significantly across these four cells, $\chi^2(1) = 0.84$, $p = .772$.

### Results and Discussion

Our primary aims in Study 2 were to determine whether evaluative judgments of targets were associated with perceptual gender norms and to test whether visual adaptation altered these judgments. We predicted that perceivers would express notable biases against targets who deviated from perceptual gender norms. Thus, because norms were notably feminized in Study 1, we expected a stronger bias against masculine relative to feminine targets at pretest. More importantly, we predicted that these biases would shift following adaptation, such that visual exposure to masculine faces would lead to more favorable evaluations of masculine targets but less favorable evaluations of feminine targets, whereas visual exposure to feminine faces would lead to more favorable evaluations of feminine targets but less favorable evaluations of masculine targets.

Because the target faces varied incrementally in gender typicality, we numerically coded each face from 1 (*hypermasculine*) to 5 (*hyperfeminine*) in order to quantify their gendered features. We analyzed targets' gendered appearances continuously based on this interval scale (hereafter, *Gendered Features*). We computed within-subject reliability for the evaluative items using the method described by Cranford et al. (2006), which indicates a scale's ability to capture changes in judgments across a range of stimuli. The items showed acceptable reliability ($R_C$ = .82), so we summed them into continuous composite scores on which higher values indicated more favorable evaluations at pretest (Min = 12.00, Max = 120.00; $M$ = 80.43, $SD$ = 19.28) and posttest (Min = 12.00, Max = 120.00; $M$ = 79.21, $SD$ = 20.76). Because participants evaluated the faces at two time points, we again stacked evaluations in the data set and differentiated them with a dummy-coded variable (*Test Period*; 0 = *Pretest Evaluations*, 1 = *Posttest Evaluations*). As before, the masculinity and femininity dimensions of the PAQ were internally consistent (Cronbach's $\alpha$ = .81 and .86, respectively), so we created continuous composites for each subscale. We examined demographic variables exactly as described in Study 1, and we again tested our hypotheses using random coefficient multilevel models to account for within-subject dependencies in the data.

**Gender-related bias at pretest.** First, we tested whether perceivers expressed biases against targets who deviated from perceptual norms. To do so, we created a Norm Deviation variable by subtracting the average Perceptual Gender Norm for men and women from Study 1 from each target's objective gender score, based on the 21-point scale described in Study 1 (from 1 = *very masculine* to 21 = *very feminine*). We then took the absolute value of this variable, such that norm deviation indicated absolute deviation from the perceptual norm in either direction (hereafter, Norm Deviation). For example, the average Perceived Gender Norm for men in Study 1 was 13.92, and the most masculine male face had a gender score of 1. So, the norm deviation score for this target was 12.92, indicating a 12.92-point departure from observers' perceptual gender norms for men. Then we regressed Pretest Evaluations onto Norm Deviation. As expected, targets who deviated from the perceived gender norm in either direction (i.e., more feminine or more masculine) were evaluated more negatively than targets who fell closer to the norm ($B$ = −1.59, $SE$ = 0.15, $t$ = −10.49, $p$ < .001).

Because perceived norms were notably feminized in Study 1, there was more room for targets to deviate in the masculine direction than in the feminine direction. This may help to explain why several recent studies have uncovered evaluative biases against hypermasculine targets—they simply deviate more from the norm than do feminine targets. We tested whether perceivers expressed biases against hypermasculine targets in our study by regressing Pretest Evaluations onto Gendered Features, Target Sex, and their interaction. The two-way interaction was significant ($B$ = −2.28, $SE$ = 0.60, $t$ = −3.80, $p$ < .001), indicating that preferences for gendered features differed across sex categories. We decomposed the interaction by examining simple slopes for Gendered Features within each sex category. Feminine faces of both sexes were evaluated more positively than masculine faces at pretest, though this trend was more pronounced for male targets relative to female targets ($B$s = 3.85 and 1.58, $SE$s = 0.43 and 0.42, $t$s = 8.98 and 3.78, $p$s < .001, respectively). Thus, as in previous research, participants expressed notable biases against masculine faces of both sexes at pretest.

**Visual adaptation influences gender-related biases.** Next, we tested whether visual adaptation produced an aftereffect that reliably altered gender-related biases in social evaluation. To do so, we regressed Evaluations onto Gendered Features, Target Sex, Adaptation Condition, Test Period, and all interactions. The four-way interaction was not significant ($B$ = −0.55, $SE$ = 1.75, $t$ = −0.32, $p$ = .750), indicating that the predicted aftereffects did not vary as a function of Target Sex. We therefore collapsed across Target Sex and regressed Evaluations onto Gendered Features, Adaptation Condition, Test Period, and all interactions. The expected three-way interaction was significant ($B$ = 3.92, $SE$ = 0.89, $t$ = 4.41, $p$ < .001).

We decomposed the three-way interaction by examining simple slopes of Gendered Appearance, Test Period, and their interaction within the masculine and feminine adaptation conditions (see Figure 3). In the masculine adaptation condition, the two-way interaction between Gendered Appearance and Test Period was significant ($B$ = −1.70, $SE$ = 0.62, $t$ = −2.72, $p$ = .007), indicating that the effect of Gendered Appearance on Evaluations differed significantly at pretest and posttest. At pretest, participants in the masculine adaptation condition evaluated feminine targets more favorably than masculine targets ($B$ = 2.90, $SE$ = 0.44, $t$ = 6.60, $p$ < .001). At posttest, participants in the masculine adaptation condition showed less bias toward feminine targets; in fact, the magnitude of the bias was reduced by more than half ($B$ = 1.20, $SE$ = 0.44, $t$ = 2.71, $p$ = .007).

In the feminine adaptation condition, the two-way interaction between Test Period and Gendered Appearance was also significant ($B$ = 2.22, $SE$ = 0.63, $t$ = 3.51, $p$ < .001), indicating that the effect of Gendered Appearance on Evaluations differed reliably at pretest and posttest. At pretest, participants in the feminine adaptation condition evaluated feminine targets more favorably than masculine targets ($B$ = 2.54, $SE$ = 0.45, $t$ = 5.68, $p$ < .001). At posttest, participants in the feminine adaptation condition were more biased, evaluating feminine targets even more favorably than masculine targets; in fact, the magnitude of the bias nearly doubled ($B$ = 4.76, $SE$ = 0.45, $t$ = 10.61, $p$ < .001).

We tested the strength of these effects by controlling for demographic variables collected during the study. Specifically, we recalculated the regressions described above, partialing out the effects of participant sex, age, race, education, and masculine and feminine gender schemas. After accounting for these factors, feminine male and female targets were still evaluated more favorably than masculine male and female targets at pretest ($B$s = 3.91 and 1.62, $SE$s = 0.45 and 0.43, $z$s = 8.69 and 3.76, $p$s < .001, respectively). Moreover, the three-way interaction indicating change in evaluations from pretest to posttest as a function of Adaptation Condition and Gendered Appearance remained highly significant and in the same direction as before ($B$ = 4.12, $SE$ = 0.92, $t$ = 4.47, $p$ < .001).

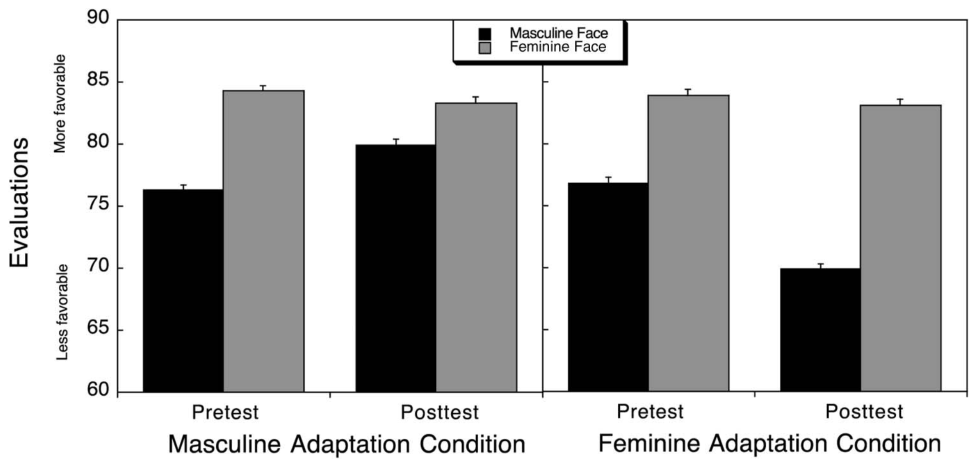


*Figure 3.* Change in evaluative judgments from pretest to posttest as a function of gendered features and adaptation condition in Study 2. The magnitude of the preference for feminine faces was smaller following adaptation to masculine features (left panel), but larger following adaptation to feminine features (right panel). Error bars depict standard errors for the effect of gendered features within each adaptation condition.

Overall, Study 2 provided support for our hypothesis that visual adaptation alters gender-related biases in social perception. Perceivers expressed notable biases against hypermasculine men and women after mere glimpses at their faces, in part because they departed from perceptual gender norms. Exposure to a series of feminine faces exacerbated this bias, but exposure to masculine faces reduced it. These changes in evaluative judgments mirrored the changes in perceptual gender norms that we observed in Study 1, suggesting that adaptation to gendered facial features altered evaluative preferences by making certain features appear more or less normative. In summary, visual exposure to gendered phenotypes reliably altered gender-related biases in social evaluation.

## Study 3

In Studies 1 and 2, adaptation to gendered facial features altered perceived phenotypic norms and subsequent social biases toward men and women. Although compelling, the lack of a control condition did not allow us to specify whether visual adaptation shifted evaluations over and above any changes that may have occurred due to repeated evaluations of the same stimuli (see Zajonc, 1968). Study 3 addressed this issue.

### Method

**Participants.** Three hundred forty-seven Internet users from the United States (151 men, 173 women, 23 unreported) completed an online study. Participants were diverse in terms of age ($M$ = 33.12 years, $SD$ = 11.92 years) and racial identity (70% White, 7% Asian, 8% Black, 9% Latino, 6% biracial), and most reported a high level of education (82% attended college).

**Stimuli and procedure.** Stimuli and procedure were identical to Study 2, with the addition of a control condition. Participants in the control condition evaluated target faces exactly as described in Study 2, but during the adaptation phase, they viewed a series of images from the Psychological Image Collection at Stirling database of manmade objects (www.pics.stir.ac.uk; trashcan, stapler, lamp, park bench, and chair). As in the other conditions, these images were repeatedly presented in random order for 3 s each for a total of 3 min.

In total, 192 participants evaluated male faces (63 masculine adaptation, 63 feminine adaptation, 66 control) and 155 participants evaluated female faces (58 masculine adaptation, 47 feminine adaptation, 50 control). We collected data for male and female targets for equal and prespecified amounts of time (2 weeks), but still obtained a larger sample for female targets. One reason for this difference in sample size may be that our studies were quite demanding relative to other Mechanical Turk studies, resulting in a limited pool of interested participants. Because we collected data for male targets during the 2 weeks immediately preceding data collection for female targets, we suspect that we tapped the participant pool, resulting in a somewhat smaller sample for female faces than for male faces. Importantly, however, a chi-square test revealed that the number of participants did not differ significantly across the six cells, $\chi^2(2) = 0.81$, $p = .669$.

### Results and Discussion

Our primary aim in Study 3 was to replicate our previous findings with the addition of a control group. As before, we expected to uncover a bias against masculine relative to feminine targets at pretest. Moreover, we predicted that these biases would shift following adaptation, such that visual exposure to masculine faces would lead to more favorable evaluations of masculine targets but less favorable evaluations of feminine targets, whereas visual exposure to feminine faces would lead to more favorable evaluations of feminine targets but less favorable evaluations of masculine targets. We did not expect the control condition to reliably alter gender-related biases in social perception.

We examined our hypotheses in the same steps described in Study 2. As before, we numerically coded each face from 1 (*hypermasculine*) to 5 (*hyperfeminine*) in order to quantify their gendered appearance (hereafter, *Gendered Features*). Again, the Evaluative Judgments items showed adequate within-subject reliability ($R_C$ = .83), so we summed the items into continuous composite scores on which higher values indicated more favorable evaluations at pretest (Min = 0.00, Max = 120.00; $M$ = 82.74, $SD$ = 19.99) and posttest (Min = 0.00, Max = 120.00; $M$ = 81.58, $SD$ = 21.43). Because participants evaluated the faces at two time points, we stacked evaluation scores in the data set and differentiated them with a dummy-coded variable (*Test Period*; 0 = *Pretest Evaluations*, 1 = *Posttest Evaluations*). The masculinity and femininity dimensions of the PAQ were internally consistent (Cronbach's $\alpha$ = .78 and .84, respectively), so we created continuous composite scores for each. All other numeric coding was identical to Study 2 with the exception of Adaptation Condition, which was dummy coded (control as the reference category). As before, we tested our hypotheses using random coefficient multilevel models to account for within-subject dependencies in the data.

**Gender-related bias at pretest.** First, we tested whether perceivers expressed biases against targets who deviated from perceptual norms. As in Study 2, we created a norm deviation variable by subtracting the average Perceptual Gender Norm for men and women from Study 1 from each target's gender score, based on the 21-point scale described in Study 1 (from 1 = *very masculine* to 21 = *very feminine*). We then took the absolute value of this variable, such that norm deviation indicated absolute deviation from the perceptual norm in either direction. Then, we regressed Pretest Evaluations onto Norm Deviation. As expected, targets who deviated from the perceptual norm in either direction (i.e., more masculine or more feminine) were evaluated more negatively than targets who fell closer to the norm ($B = -1.60$, $SE = 0.09$, $t = -17.04$, $p < .001$).

Because perceptual norms were notably feminized in Study 1, there was more room for targets to deviate in the masculine direction than in the feminine direction. This may help to explain why previous studies have uncovered biases against hypermasculine targets—they simply differ more from the norm than do feminine targets. We tested whether perceivers expressed biases against hypermasculine targets in our study by regressing Pretest Evaluations onto Gendered Features, Target Sex, and their interaction. The two-way interaction was significant ($B = -2.84$, $SE = 0.45$, $t = -6.34$, $p < .001$), indicating that preferences for gendered features differed across sex categories. We decomposed this interaction by examining simple slopes for Gendered Features within each sex category. Feminine faces of both sexes were evaluated more positively than masculine faces at pretest, though this trend was more pronounced for male targets relative to female targets ($B$s = 4.07 and 1.23, $SE$s = 0.31 and 0.33, $z$s = 13.32 and 3.77, $p$s < .001, respectively). Thus, replicating our effects from Study 2, participants expressed notable biases against masculine faces of both sexes at pretest.

**Visual adaptation influences gender-related biases.** Next, we tested whether visual adaptation produced an aftereffect that reliably altered gender-related biases in social evaluation. Because Adaptation Condition was a multicategorical variable, we examined Type 3 tests of fixed effects to determine the significance of interactions. First, we regressed Evaluations onto Gendered Features, Target Sex, Adaptation Condition, Test Period, and all interactions. The four-way interaction was not statistically significant, $\chi^2(2) = 1.25$, $p = .287$, indicating that the predicted aftereffects did not vary as a function of Target Sex. We therefore collapsed across Target Sex and regressed Evaluations onto Gendered Features, Adaptation Condition, Test Period, and all interactions. The expected three-way interaction was significant, $\chi^2(2) = 4.83$, $p = .008$.

We decomposed the three-way interaction by examining simple slopes of Gendered Features, Test Period, and their interaction within each adaptation condition (see Figure 4). In the masculine adaptation condition, the two-way interaction between Test Period and Gendered Features was marginally significant ($B = -1.06$, $SE = 0.56$, $t = -1.88$, $p = .060$). At pretest, participants in the masculine adaptation condition evaluated feminine targets more favorably than masculine targets ($B = 2.78$, $SE = 0.39$, $t = 7.07$, $p < .001$). At posttest, participants in the masculine adaptation

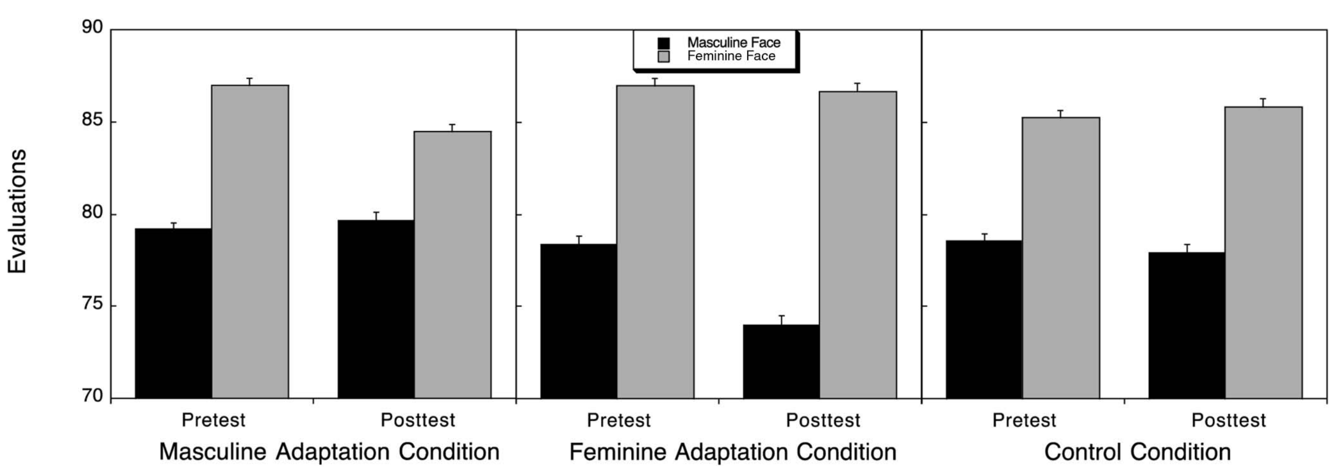


*Figure 4.* Change in evaluative judgments from pretest to posttest as a function of gendered features and adaptation condition in Study 3. The magnitude of the preference for feminine faces was smaller following adaptation to masculine faces (left panel), larger following adaptation to feminine faces (middle panel), and the same following a control adaptation (right panel). Error bars depict standard errors for the effect of gendered features within each adaptation condition.

condition showed less bias toward feminine targets; in fact, the magnitude of the bias was reduced by a full scale point ($B = 1.72$, $SE = 0.40$, $t = 4.29$, $p < .001$).

In the feminine adaptation condition, the two-way interaction between Test Period and Gendered Features was significant ($B = 1.46$, $SE = 0.60$, $t = 2.45$, $p = .014$). At pretest, participants in the feminine adaptation condition evaluated feminine targets more favorably than masculine targets ($B = 3.04$, $SE = 0.42$, $t = 7.27$, $p < .001$). At posttest, participants in the feminine adaptation condition were more biased, evaluating feminine targets even more favorably than masculine targets; in fact, the magnitude of the bias was more than a full scale point larger than it was to begin with ($B = 4.50$, $SE = 0.42$, $t = 10.61$, $p < .001$).

In the control condition, the two-way interaction between Test Period and Gendered Features was not significant ($B = 0.44$, $SE = 0.60$, $t = 0.74$, $p = .459$). At pretest, participants in the control condition evaluated feminine targets more favorably than masculine targets ($B = 2.40$, $SE = 0.42$, $t = 5.68$, $p < .001$). At posttest, participants in the control condition continued to evaluate feminine targets more favorably than masculine targets, and this effect was similar in magnitude to the effect at pretest ($B = 2.84$, $SE = 0.42$, $t = 6.70$, $p < .001$). Thus, the bias toward feminine targets did not differ significantly following the control adaptation.

We tested the strength of these effects by controlling for demographic variables collected during the study. Specifically, we recalculated the regressions described above, partialing out the effects of participant sex, age, race, education, and masculine and feminine gender schemas. After accounting for these factors, feminine male and female targets were still evaluated more favorably than masculine male and female targets at pretest ($B$s $= 3.94$ and $1.51$, $SE$s $= 0.31$ and $0.34$, $z$s $= 12.74$ and $4.44$, $p$s $< .001$, respectively). Furthermore, the three-way interaction indicating change in evaluations from pretest to posttest as a function of Adaptation Condition and Target Gender remained highly significant and in the same direction as before, $\chi^2(2) = 4.19$, $p = .015$.

Thus, Study 3 provided additional evidence for our hypothesis that visual adaptation helps to explain evaluative biases stemming from gendered phenotypes. In particular, perceivers expressed notable biases against hypermasculine men and women after mere glimpses at their faces, in part because masculine faces appeared less normative than feminine faces. The addition of a control condition allowed us to explore the directional nature of changes in these biases following adaptation to highly gendered exemplars. For both male and female faces, adaptation to feminine features exacerbated the bias, whereas adaptation to masculine features reduced it. Importantly, the control condition had no significant impact on evaluative biases against hypermasculine faces.

We should note that the mechanism driving shifts in evaluative biases after visual adaptation remains somewhat unclear. As shown in Figure 4, following masculine adaptation, preferences for masculine faces improved slightly, whereas preferences for feminine faces decreased. Following feminine adaptation, preferences for feminine faces did not change appreciably, but preferences for masculine faces decreased. Thus, adaptation may affect social biases by increasing preferences for targets similar to the adapting stimuli or by reducing preferences for targets dissimilar to the adapting stimuli. Our study provides some indication of both trends, though the latter was especially strong. Future studies that also include control conditions will be critical to tease apart the precise mechanism by which evaluative biases change following visual adaptation to phenotypically natural facial cues. For now, we conclude that adaptation to both masculine and feminine faces alters gender-related biases in social perception over and above any effects of repeated evaluation.

## Study 4

In Studies 1–3, adaptation to gendered facial features affected both perceptual norms and social biases. Although this pattern of results is consistent with existing theory, our conclusions are limited by the fact that our stimuli relied on a single base face that we morphed using computer software. Thus, it remains possible that the adaptation effects observed in our initial studies were due to idiosyncratic aspects of the base face (e.g., luminance, expression) or the gender-morphing program. Furthermore, it is worth noting that the stimuli in Studies 1–3 were bald, which may have biased gendered perceptions of the faces toward masculinity because baldness is relatively rare among women. If anything, we suspect that this weakened the feminization of the perceptual norms in Study 1 and the feminine adaptation effects in Studies 2 and 3, both of which were highly significant. Nevertheless, replicating our results with real faces of multiple individuals that vary naturally in gendered features and are cropped to remove hair cues would improve the generalizability and applicability of our findings.

Furthermore, although our measure of social evaluations was statistically reliable and based on previously published research about interpersonal biases in face perception (Lick & Johnson, 2013), some of the items may have tapped into participants' beliefs about norms (e.g., appropriate–inappropriate) rather than evaluative preferences per se. Moreover, the items may have described traits that are more stereotypically desirable in women than in men (e.g., proper, sincere, honest, warm), biasing our results toward favorable evaluations of feminine targets. Replicating our effects with more global measures of liking would ensure that our initial findings were not due to the specific items included in the evaluations scale.

Finally, we have argued that shifting perceptual norms are the mechanism by which visual adaptation alters social evaluations related to gendered phenotypes. Our initial findings were consistent with this possibility. Indeed, in Study 1, visual adaptation shifted perceptual norms for men's and women's faces, such that adaptation to hypermasculine features made masculine faces appear more normative, whereas adaptation to hyperfeminine features made feminine faces appear more normative. Studies 2 and 3 showed that evaluative judgments shift in the same direction as perceptual norms—masculine faces were evaluated more favorably following adaptation to hypermasculine features, whereas feminine faces were evaluated more favorably following adaptation to hyperfeminine features. Although these findings suggest that changes in perceptual norms may be functionally related to shifts in evaluative biases related to gendered phenotypes, we documented the effects in separate studies. Concurrently examining perceptual norms and evaluative biases in a single study would provide stronger evidence that shifting perceptual norms is the mechanism underlying the aftereffects we observed.

With these considerations in mind, we designed Study 4 to replicate and extend our previous findings with a broader measure of social evaluation and real faces that varied naturally in their gendered phenotypes. Furthermore, we sought to systematically test shifting perceptual norms as a mechanism underlying these aftereffects. We predicted that biases against hypermasculine faces would shift following adaptation, such that exposure to masculine faces would attenuate bias against hypermasculine targets but exposure to feminine faces would exacerbate bias against hypermasculine targets, and that these changes would be associated with changes in perceived gender norms.

## Method

**Participants.** Three hundred seventy-two Internet users from the United States (160 men, 193 women, 19 unreported) completed an online study. Participants were diverse in terms of age ($M$ = 36.30 years, $SD$ = 13.82 years) and racial identity (76% White, 7% Asian, 8% Black, 6% Latino, 2% biracial), and most reported a high level of education (87% attended college).

**Stimuli.** Stimuli were 14 faces of real men and 14 faces of real women that varied in their gendered features (100 × 161 pixels at 72 pixels/inch). Research assistants gathered these faces via Internet searches for individuals who had extremely gendered appearances (i.e., hypermasculine and hyperfeminine), were not celebrities, and had no visible facial hair or tattoos. This resulted in a sample of 88 images. Nineteen raters then evaluated the gendered appearance of each image on a 10-point scale (1 = *Very Masculine* to 10 = *Very Feminine*). On the basis of these ratings, we selected the seven most masculine and seven most feminine faces in each sex category and then transformed the images to grayscale, standardized their size, and oval-cropped them to remove hair. A separate sample of 12 raters evaluated the gendered appearance of these standardized stimuli, rating the masculine male and female faces ($M$s = 1.94 and 4.69, respectively) as notably more masculine than the feminine male and female faces ($M$s = 6.33 and 9.47, respectively) on a 10-point scale (from 1 = *Very Masculine* to 10 = *Very Feminine*). Importantly, the raters were highly consistent in their judgments of the stimuli's gendered appearances ($ICC_{avg}$ = .97).

**Procedure.** Internet users from Amazon Mechanical Turk completed a study about their perceptions of other people. The study announcement made no mention of sex, gender, visual adaptation, or bias. After providing consent, participants were randomly assigned to rate either six of the male or six of the female faces described above (three hypermasculine, three hyperfeminine) across four items measured on 11-point sliding scales, with higher values indicating more favorable ratings (*Pretest*). Three of these items assessed interpersonal judgments: (1) How attractive is this man(woman)? (2) How much do you like this man(woman)? (3) How much would you like to be friends with this man(woman)? A fourth item assessed perceptual gender norms: How much does this man(woman) look like the average man(woman)?

After evaluating the target faces, participants were randomly assigned to adaptation conditions as described in Studies 1 and 2. In particular, participants repeatedly viewed either the four remaining hyperfeminine faces (*Feminine Adaptation*) or the four remaining hypermasculine faces (*Masculine Adaptation*) from the sex category to which they were assigned for 3 s each for a total of 3 min. Thus, in contrast to our previous studies, the adaptation stimuli differed from the evaluation stimuli. Following adaptation, participants reevaluated the same target faces from pretest on the scales described above (*Posttest*). Finally, participants completed the PAQ (Spence et al., 1975) and reported their sex, age, race, and education before being debriefed.

In total, 175 participants evaluated male faces (81 masculine adaptation, 94 feminine adaptation) and 197 participants evaluated female faces (98 masculine adaptation, 99 feminine adaptation). A chi-square test revealed that the number of participants did not differ across these four cells, $\chi^2(1) = 2.67$, $p = .10$.

## Results and Discussion

Our primary aim in Study 4 was to determine whether the adaptation effects we uncovered in Studies 1–3 generalized to real faces and to broader measures of social evaluation. We predicted that perceivers would express notable biases against masculine targets at pretest and that these biases would shift following adaptation. Specifically, we expected that visual exposure to masculine faces would lead to more favorable evaluations of masculine targets but less favorable evaluations of feminine targets, whereas visual exposure to feminine faces would lead to more favorable evaluations of feminine targets but less favorable evaluations of masculine targets.

Because the target faces did not vary incrementally in gender typicality, we could not numerically code the faces as we did in our previous studies. Instead, we analyzed targets' gendered features on the basis of the ratings provided by independent coders (see the Stimuli section; 1 = *Very Masculine* to 10 = *Very Feminine*). Specifically, we used the average gender score for each face as a continuous measure of gendered appearance, on which higher values indicated a more feminine appearance (mean centered). The three interpersonal evaluations (attractiveness, likability, desire for contact) showed high within-subject reliability ($R_C = 0.93$), so we summed them into continuous composite scores on which higher values indicated more favorable evaluations at pretest (Min = 0.00, Max = 30.00; $M$ = 14.25, $SD$ = 7.23) and posttest (Min = 0.00, Max = 30.00; $M$ = 13.84, $SD$ = 7.73). We analyzed perceptual norms at pretest (Min = 0, Max = 10; $M$ = 4.65, $SD$ = 2.52) and posttest (Min = 0, Max = 10; $M$ = 4.54, $SD$ = 2.52) on the basis of participants' ratings of the averageness of each face for its sex category. Because participants evaluated the faces at two time points, we stacked these scores in the data set and differentiated them with a dummy-coded variable (*Test Period*; 0 = *Pretest*, 1 = *Posttest*). As before, the masculinity and femininity dimensions of the PAQ showed adequate reliability (Cronbach's $\alpha$ = .76 and .79, respectively), so we created continuous composite scores for each subscale. We examined demographic variables as described in Study 2, and again, we tested our hypotheses using random coefficient multilevel models to account for within-subject dependencies in the data.

**Gender-related bias at pretest.** First, we sought to replicate our finding that perceivers express notable biases against targets with highly masculine phenotypes. To do so, we regressed Pretest Evaluations onto Gendered Appearance, Target Sex, and their interaction. The two-way interaction was significant ($B$ = 1.61, $SE$ = 0.09, $t$ = 17.29, $p$ < .001), indicating that preferences for gendered features differed across sex categories. We decomposed the interaction by examining simple slopes for Gendered Appearance within each sex category. As before, feminine faces of both sexes were evaluated more favorably than masculine faces at pretest, though this trend was more pronounced for female targets relative to male targets ($B$s = 0.41 and 2.02, $SE$s = 0.07 and 0.06, $t$s = 5.57 and 36.16, $p$s $<$ .001, respectively). These findings differ slightly from Study 2, in which the bias against masculine faces was stronger for men than women. Despite this discrepancy, the effect was highly significant for both sexes, indicating a strong bias against hypermasculine faces at pretest.

**Visual adaptation influences gender-related biases.** Next, we tested whether visual adaptation produced an aftereffect that reliably altered gender-related biases in social evaluation. To do so, we regressed Evaluations onto Gendered Appearance, Target Sex, Adaptation Condition, Test Period, and all interactions. The four-way interaction was not statistically significant ($B = -0.10$, $SE = 0.27$, $t = -0.37$, $p = .714$), indicating that the predicted aftereffects did not vary as a function of Target Sex. We therefore collapsed across Target Sex and regressed Evaluations onto Gendered Appearance, Adaptation Condition, Test Period, and all interactions. The expected three-way interaction was significant ($B = -0.24$, $SE = 0.11$, $t = -2.19$, $p = .029$) (see Figure 5).

We decomposed the three-way interaction by examining simple slopes of Gendered Appearance, Test Period, and their interaction within the masculine and feminine adaptation conditions. In the masculine adaptation condition, the two-way interaction between Gendered Appearance and Test Period was not significant ($B = -0.02$, $SE = 0.08$, $t = -0.22$, $p = .828$). In the feminine adaptation condition, however, the two-way interaction between Test Period and Gendered Appearance was significant ($B = 0.22$, $SE = 0.08$, $t = 2.81$, $p = .005$), indicating that the effect of Gendered Appearance on Evaluations differed reliably at pretest and posttest. At pretest, participants in the feminine adaptation condition evaluated masculine targets less favorably than feminine targets ($B = 1.48$, $SE = 0.06$, $t = 24.25$, $p < .001$). At posttest, participants in the feminine adaptation condition were even more biased, evaluating masculine targets less favorably than they did at pretest ($B = 1.70$, $SE = 0.06$, $t = 27.00$, $p < .001$).

We tested the strength of these effects by controlling for demographic variables collected during the study. Specifically, we recalculated the regressions described above, partialing out the effects of participant age, sex, race, education, and masculine and feminine gender schemas. After accounting for these factors, feminine male and female targets were still evaluated more favorably than masculine male and female targets at pretest ($B$s = 0.41 and 1.99, $SE$s = 0.08 and 0.06, $t$s = 5.23 and 33.20, $p$s $<$ .001, respectively). Moreover, the three-way interaction indicating change in evaluations from pretest to posttest as a function of Adaptation Condition and Target Gender remained marginally significant and in the same direction as before ($B = -0.22$, $SE = 0.11$, $t = -1.92$, $p = .056$).

**Perceptual norms drive observed shifts in evaluative biases.** A final goal of Study 3 was to test whether changes in perceptual norms drove the observed changes in evaluation following adaptation. We first tested the association between perceived norms and evaluations by regressing Pretest Evaluations onto Pretest Perceptual Norms. As expected, targets who appeared more normative at pretest were evaluated more favorably than were targets who appeared less normative ($B = 0.85$, $SE = 0.06$, $t = 15.31$, $p < .001$). The same trend emerged when we regressed Posttest Evaluations onto Posttest Perceptual Norms: Targets who appeared more normative at posttest were evaluated more favorably than were targets who appeared less normative ($B = 1.16$, $SE = 0.06$, $t = 19.46$, $p < .001$). Next, we restructured the data set and created a change in evaluations variable (*Posttest Evaluations – Pretest Evaluations*) and a change in perceptual corm variable (*Posttest Norm – Pretest Norm*). Then, we regressed Change in Evaluations onto Change in Perceptual Norm. As faces were perceived as increasingly normative from pretest to posttest, they were also evaluated more favorably ($B = 0.39$, $SE = .04$, $t = 10.29$, $p < .001$) (see Figure 6). Thus, perceptual norms and social evaluations changed concurrently, such that faces that appeared more normative were also evaluated more favorably following adaptation.

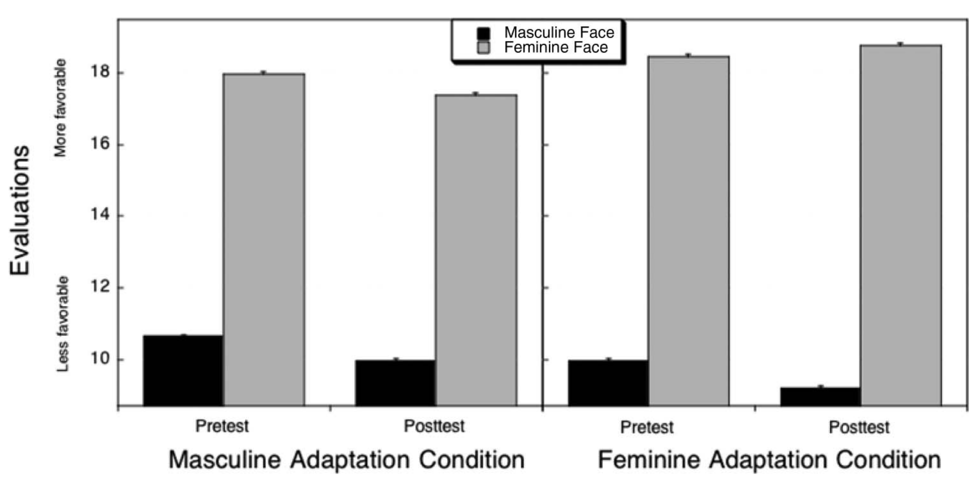


*Figure 5.* Change in evaluative judgments from pretest to posttest as a function of gendered features and adaptation condition in Study 4. The magnitude of the preference for feminine faces did not change following adaptation to masculine features (left panel), but was larger following adaptation to feminine features (right panel). Error bars depict standard errors for the effect of gendered features within each adaptation condition.

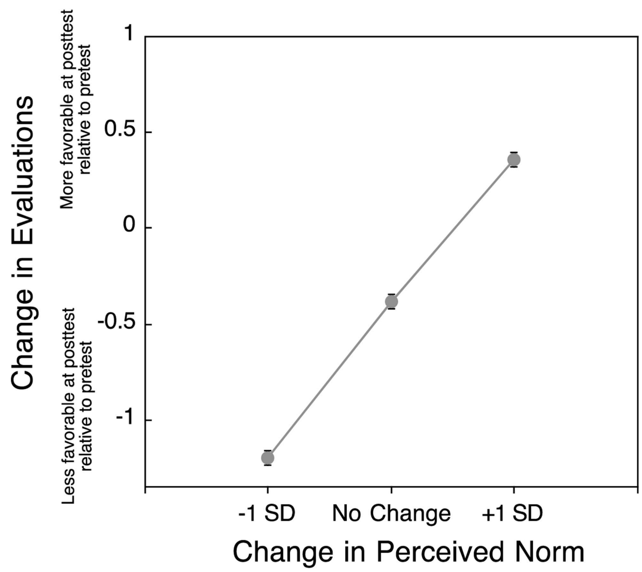


*Figure 6.* Change in evaluative judgments from pretest to posttest as a function of change in perceived gender norms in Study 4. Targets were evaluated more favorably as they were perceived to be increasingly normative. Error bars depict standard errors for the effect of perceived gender norms.

As a final test of whether changes in perceptual norms helped to explain the observed changes in evaluations following adaptation, we constructed a series of nested regression models. First, we regressed Evaluations onto Gendered Appearance, Test Period, Adaptation Condition, and all interactions (Deviance = 27222.90). Next, we added Perceptual Norms and all interactions to the model (Deviance = 26221.30). We then performed a likelihood ratio test on the deviance values from these two models, which assesses whether the inclusion of the new variable improved model fit. As expected, the inclusion of Perceptual Norms significantly improved the fit of the regression model, $\chi^2(7) = 1001.60$, $p < .001$. Thus, accounting for shifts in perceptual norms greatly improved our ability to predict evaluations on the basis of gendered phenotypes following visual adaptation.

In summary, Study 4 partially replicated our previous findings by demonstrating that perceivers expressed notable biases against hypermasculine men and women after mere glimpses at their faces and that perceivers who were experimentally exposed to feminine faces developed even stronger biases against masculine faces. Unexpectedly, adaptation to masculine faces did not reliably alter social evaluations related to gendered facial features. Although it is always difficult to interpret null findings, the nonsignificant masculine adaptation effect may have emerged for several reasons. First, the stimuli in Study 4 were less carefully controlled than the computer-generated stimuli in Studies 1–3. Thus, the masculine faces may have varied in unexpected ways (e.g., viewpoint) that the feminine faces did not. Although adaptation effects can transfer across changes in viewpoint and other low-level features (see Jeffery, Rhodes, & Busey, 2006), they may be substantially weakened, reducing our chances of obtaining a significant effect for masculine adaptation in Study 4. It is also possible that features in the feminine faces were more extreme than features in the masculine faces, improving the chances of obtaining a feminine adaptation effect. Indeed, at least for the female stimuli, feminine faces were rated as being extremely feminine (9.47 on a 10-point scale ranging from masculine to feminine), whereas the masculine faces were only slightly below the midpoint of the scale (4.69 on a 10-point scale ranging from masculine to feminine). If feminine features were indeed more extreme than masculine features in our stimuli, then the feminine adaptation effect may have been stronger than the masculine adaptation effect, as we saw here.

Despite the nonsignificant masculine adaptation effect, perceptual gender norms did help to explain changes in evaluative biases following feminine adaptation. In particular, we found that changes in perceptual norms predicted changes in evaluative biases related to gendered facial features. Accounting for these norm shifts greatly improved the fit of regression models predicting gender-related biases before and after visual adaptation to gendered facial features.

It is also important to note that the magnitude of the feminine adaptation effect was smaller than in our previous studies. This smaller effect size offers an important caveat to our findings, suggesting that real-world visual aftereffects may be somewhat limited when they occur after such brief exposure. In general, however, Study 4 provided evidence that adaptation effects can indeed emerge on broad measures of evaluative preference for real faces that vary naturally in their gendered phenotypes, gesturing toward the generalizability and applicability of our findings.

## General Discussion

Perceivers express strong biases against hypermasculine individuals of both sexes after mere glimpses at their faces (Jones & Hill, 1993; Little & Hancock, 2002; Perrett et al., 1998; Rhodes et al., 2000). Across four studies, we found that these biases were associated with recent visual exposure to gendered facial features. Study 1 revealed that perceptual norms for men's and women's faces shift depending on visual experience. In particular, exposure to hypermasculine phenotypes made masculine faces of both sexes appear more normative, whereas exposure to hyperfeminine phenotypes made feminine faces of both sexes appear more normative. These shifts in perceptual norms were mirrored by shifts in evaluative judgments related to facial appearance: In Studies 2–4, brief adaptation to hypermasculine phenotypes reduced biases against masculine targets, but exposure to hyperfeminine phenotypes exacerbated them. With one exception (i.e., a nonsignificant effect of masculine adaptation in Study 4), this pattern of effects replicated across both male and female targets, multiple outcome measures, and real and computer-generated faces. Moreover, the findings were robust after controlling for a host of potentially confounding factors (e.g., gender schemas). Therefore, visual adaptation affects perceptual norms and social evaluations related to gendered phenotypes. These results provide novel information about the perceptual mechanics of gender-related biases in particular, and they pinpoint important new directions for research on impression formation and bias reduction more generally.

### Perceptual Underpinnings of Prejudice

The primary contribution of our work is a new framework for understanding the perceptual underpinnings of prejudice. Interpersonal prejudice is an enduring psychological problem with insidious consequences for target groups (Dovidio & Gaertner, 2010; Dovidio, Glick, & Rudman, 2005; Lick, Durso, & Johnson, in press). One reason that prejudice may persist is its foundation in basic processes that guide human perception. Indeed, a growing body of research suggests that people form impressions of others on the basis of brief glimpses of their faces (Freeman et al., 2010; Ito et al., 2004; Lick & Johnson, 2013) and that these impressions have important implications for downstream behaviors (Snyder & Stukas, 1999). Although researchers have begun to document these early footprints of prejudice, the perceptual processes that give rise to them remain less clear.

Perceptual norms have emerged as one important mechanism underlying interpersonal bias. Researchers have long known that perceivers tend to prefer prototypical exemplars to more unique exemplars of a given category (Posner & Keele, 1968). More recent work has extended this concept to social domains. For example, one study revealed that targets whose facial features were normative for their sex category were likely to be categorized as heterosexual and evaluated favorably, whereas those whose phenotypes were less normative for their sex category were likely to be categorized as gay and evaluated negatively (Lick & Johnson, 2013). These findings generally suggest that perceptual norms help to explain biases that originate in the early stages of person perception. Still, the factors that influence perceptual norms themselves have remained unclear. The current research begins to reveal how perceptual norms are calibrated, and how these calibrations affect social evaluations.

Specifically, our findings suggest that perceptual norms for a given social category change on the basis of a perceiver's recent visual experiences with members of that category. In the case of gender, perceivers who encounter highly feminine phenotypes tend to form feminized facial norms, whereas those who encounter masculine phenotypes tend to form masculinized facial norms. Furthermore, because perceivers tend to prefer targets who appear prototypical, these shifts in perceptual norms help to explain evaluative biases against individuals who embody nonprototypical features. Indeed, the current studies revealed that visual adaptation to highly gendered phenotypes reliably shifted perceptual norms, which in turn shifted evaluative judgments.

The current research therefore augments our knowledge of how visual exposure molds perceptual norms, with implications for downstream social evaluations. As such, our work uniquely contributes to psychologists' understanding of the perceptual roots of interpersonal prejudice. Although our findings cannot speak to the factors underlying development of perceptual norms in the first place, they suggest that visual exposure reliably alters these norms, with concomitant effects on evaluative preferences. Our findings also inform literatures related to visual aftereffects and prejudice reduction, which we discuss below.

## Visual Aftereffects and Social Evaluations

The current work contributes to the burgeoning literature on visual aftereffects. To date, most evidence of higher level face aftereffects has been limited to grossly distorted features (e.g., caricatures). Our studies are among a small handful demonstrating that humans also adapt to gendered phenotypes that vary naturally in the population. As such, the current work helps to extend the ecological validity of research on face aftereffects.

Furthermore, most previous studies of face aftereffects have examined how habituation to facial features affects ratings of subsequent targets' normality and attractiveness, often with single-item measures. Our studies are among the first to demonstrate that aftereffects alter a broader constellation of social judgments that arise together early in person perception. In particular, we found that adaptation to gendered facial features affects perceivers' judgments of many characteristics, including a person's warmth, respectability, sincerity, honesty, intelligence, and overall likability. Thus, our studies extend face aftereffects to a decidedly interpersonal domain, revealing that visual adaptation alters a broad set of social evaluations that have implications for impression formation and downstream social interactions.

## Prejudice and Gendered Appearances

Our findings also engage with long-standing discussions about the effects of gendered portrayals in everyday life. Feminist scholars have argued that people strategically exaggerate gendered aspects of their facial appearance (Davis, 2002; Gill, Henwood, & McLean, 2005; Schilt & Westbrook, 2009) and that exposure to such highly gendered portrayals is damaging to both women and men (Prentice & Carranza, 2002). However, the specific mechanisms linking gendered imagery to downstream social biases have remained largely unexplored. The current work reveals that exposure to highly gendered imagery alters low-level social cognitive processes. In particular, we found that even relatively brief exposure to gendered facial features can shift perceptual norms for men and women and subsequently alter social judgments. Thus, our studies provide empirical evidence for previous claims that the overrepresentation of highly gendered phenotypes perpetuates interpersonal biases.

Our findings also supplement previous research that has noted the frequency and consistency of gender-related biases in social perception (Little & Perrett, 2011; Perrett et al., 1998; Rhodes et al., 2000; Rudman & Glick, 2001; Rudman, Greenwald, & McGhee, 2001). Indeed, we found that perceivers judge hypermasculine men and women negatively across a wide range of social domains. Furthermore, we pinpointed deviation from perceptual gender norms as a factor contributing to these biases. Because the norms for men's and women's faces were initially feminized, faces could deviate more in the masculine direction than in the feminine direction. This may account for perceivers' negative evaluations of masculine targets relative to feminine targets—they simply deviate further from perceptual norms. In this way, our findings help to explain the somewhat surprising results of recent studies that have indicated preferences for feminized facial features in both sexes.

## Prejudice Reduction

Finally, and perhaps most importantly, the current work has important implications for theory and applied efforts aimed at prejudice reduction. Classic studies demonstrated that repeated exposure to a stimulus increases liking for that stimulus (mere exposure; Zajonc, 1968, 2001), and more recent work extended these effects to social stimuli (Dasgupta & Greenwald, 2001;

Mutz & Goldman, 2010; Schiappa et al., 2005). Despite a long-standing theoretical focus on mere exposure as a method of prejudice reduction, the perceptual mechanisms underlying mere exposure have remained elusive. The current studies indicate that shifts in perceptual norms may underlie these well-documented effects—because repeated exposure to a particular type of stimulus renders it normative, repeated exposure enhances liking.

Moreover, mere exposure effects have generally shown that exposure to a stimulus increases liking for that same stimulus. Although some scholars have argued that exposure might also improve liking for similar but nonidentical targets, evidence of a generalized mere exposure effect is scant (Rhodes, Halberstadt, Jeffery, & Palermo, 2005). Here, we found that visual exposure may indeed operate at the level of features. Viewing a series of highly gendered facial features enhanced perceivers' evaluations of individuals who share similar features, even when those individuals were not included among the adaptation stimuli (e.g., Study 4). These findings pave the way for continued research on generalized mere exposure effects, and they suggest that visual adaptation may be an important process driving such effects.

Proponents of contact theory have argued that repeated interpersonal encounters reduce prejudice against a stigmatized group (Dovidio, Eller, & Hewstone, 2011; Pettigrew & Tropp, 2006). Whereas classical theorizing suggested that face-to-face interactions between individuals of equal status working to achieve a common goal were necessary to achieve the social benefits of contact (Allport, 1954), newer studies have demonstrated that merely observing or imagining outgroup members can effectively reduce prejudice (Birtel & Crisp, 2012; Dasgupta & Greenwald, 200l; Gómez, Tropp, & Fernández, 2011; Schiappa et al., 2005; Wright, Aron, McLaughlin-Volpe, & Ropp, 1997). The current studies implicate visual adaptation as a proximal mechanism underlying the benefits of observed contact. In particular, our findings suggest that perceivers visually adapt following repeated exposure to members of different social groups, which makes them appear more normative and subsequently leads to more favorable social evaluations. Although higher level psychological processes may also contribute to contact effects (e.g., reduced intergroup anxiety; Pettigrew, 1998), visual adaptation may act as a low-level perceptual mechanism, which helps to explain why recent vicarious and extended contact can effectively reduce prejudice. In all, our findings address recent calls for a deeper understanding of the proximal mechanisms underlying several common methods of prejudice reduction (Dovidio et al., 2011).

Finally, in terms of practical application, our results offer some preliminary evidence that media interventions may reduce interpersonal biases that originate in the early moments of face perception. Indeed, some social groups are underrepresented in national media (Williams, 2000), and individuals from these underrepresented groups also face consistent prejudice and discrimination (Dovidio, Gaertner, Kawakami, & Hodson, 2002). Our results suggest that deliberately exposing people to more visual representations of these underrepresented groups in film, television, and print might help to mitigate biases that develop in the early stages of person perception and form the basis of downstream prejudice. Still, it is important to note that the masculine adaptation effect was not significant and that the feminine adaptation effect was relatively modest in Study 4, where we used real faces. Before planning large-scale interventions, it will be important for researchers to determine the efficacy of relatively brief visual exposure for reducing prejudice.

## Conclusion

In summary, people form impressions of others based on the perceived normativity of their gendered facial features; recent visual exposure helps to determine these perceptual norms. Thus, features with which perceivers have relatively limited exposure (e.g., hypermasculine features) appear nonnormative and tend to be evaluated negatively. Although the current findings demonstrate the existence and perceptual underpinnings of gender-related biases in social evaluation, they also offer the optimistic conclusion that manipulating the composition of one's visual environment can change biases. This information may aid in eradicating the unequal treatment of men and women on the basis of their gendered phenotypes, and may eventually lead us toward a better understanding of the formation and reduction of other biases related to physical appearance.

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Received December 2, 2012
Revision received August 19, 2013
Accepted August 26, 2013 ■