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Prejudice is in the Eye of the Beholder: Harnessing Visual Adaptation to Understand and Combat Interpersonal Bias

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Prejudice is in the Eye of the Beholder:

Harnessing Visual Adaptation to Understand and Combat Interpersonal Bias

A dissertation submitted in partial satisfaction of the

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in Psychology

by

David James Lick

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ABSTRACT OF THE DISSERTATION

Prejudice is in the Eye of the Beholder:

Harnessing Visual Adaptation to Understand and Combat Interpersonal Bias

by

David James Lick

Doctor of Philosophy in Psychology

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Professor Kerri L. Johnson, Chair

People form evaluative judgments of others after mere glimpses of them. Although the consequences of these judgments have been well documented, the proximal factors that give rise to them remain less clear. Here, I integrate research from the social, cognitive, and vision sciences to argue that visual exposure guides impression formation. Specifically, I propose that perceivers visually adapt to others' appearances, forming preferences for phenotypes they encounter frequently and prejudices against phenotypes they encounter infrequently. Study Set 1 tested this theory with regard to gendered facial features. In Study 1, visual adaptation to feminine faces caused feminine features to appear increasingly normative whereas visual adaptation to masculine faces caused masculine features to appear increasingly normative. Studies 2 and 3 extended these findings to evaluative judgments: Visual adaptation to feminine faces exacerbated a baseline bias against targets with masculine relative to feminine features, whereas visual adaptation to masculine faces mitigated it. Studies 4 and 5 revealed that popular

media can act a naturalistic form of exposure that molds preferences for gendered facial features, insofar as perceivers who reported a high degree of exposure to media depicting hyper-feminine women (Study 4) and perceivers who were experimentally exposed to media images of hyper-feminine women (Study 5) espoused especially strong biases against masculine female faces relative to feminine female faces. Study Set 2 extended my initial findings to evaluative judgments related to body weight. In Study 6, exposure to thin bodies lowered the threshold for labeling others as fat whereas exposure to fat bodies heightened the threshold for labeling others as fat. Study 7 linked these threshold shifts to social evaluations, indicating that exposure to thin bodies exacerbated biases against fat targets relative to thin targets whereas exposure to fat bodies mitigated them. Using eye-tracking technology, Studies 8 and 9 revealed that perceivers unintentionally gazed at thin bodies more than fat bodies when presented with both simultaneously, which heightened evaluative preferences for thin bodies relative to fat bodies. Study 10 showed that this tendency to gaze at thin bodies can be overcome with a simple gaze manipulation in order to reduce prejudice against fat targets. Collectively, these findings offer new insights into the perceptual underpinnings of impression formation while emphasizing visual exposure as a cost-effective method for reducing prejudice against social groups that are stigmatized on the basis of their physical appearance.

The dissertation of David James Lick is approved.

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Studies 1-3 include data previously published in Lick, D. J., & Johnson, K. L. (2014). Recalibrating gender perception: Face aftereffects and the perceptual underpinnings of gender-related biases in social perception. *Journal of Experimental Psychology: General, 143,* 1259-1276. The co-author on this paper (Johnson) helped formulate the study idea and edit the manuscript, but data collection and analysis were completed by the first author. Studies 6-10 include data currently under review in Lick, D.J., Hunger, J. M., Tomiyama, A.J., & Johnson, K. L. (Submitted). Harnessing the power of visual adaptation to understand and combat weight bias. The co-authors on this paper (Hunger, Tomiyama, Johnson) helped formulate the study idea and edit the manuscript, but data collection and analysis were completed by the first author

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Chapter 1: Causes and Consequences of Interpersonal Prejudice

Interpersonal Prejudice, Past and Present

The study of interpersonal prejudice has long been a cornerstone of psychological science (Allport, 1954; Dovidio et al., 2005; Garth, 1925; Katz & Braly, 1933). According to one early definition, prejudice represents overt dislike for another person that is based on broad generalizations about the social groups to which that person belongs (Allpot, 1954; p. 9). In the intervening decades, researchers have updated this definition to reflect the fact that prejudice not only represents outward antipathy, but also subtly biased interpersonal judgments based on others' group memberships (Dovidio et al., 2005). Today, prejudice is conceptualized as the process of generalizing attitudes about a group of people to individual members of that group, often on the basis of minimal information. For example, forming a valenced impression of an individual solely on the basis of their sex, race, age, or sexual orientation would considered prejudice insofar as it reflects an evaluative bias drawn from general information about the group as opposed to individuating information about the person.[1]

With this definition in place, volumes of research have catalogued the existence of prejudice against members of diverse social groups. Early work focused on prejudice against racial and ethnic minorities, especially Black and Jewish individuals (Allport, 1954; Allport & Kramer, 1946; Horowitz, 1936; Singer, 1948; Zeligs & Hendrickson, 1933). For example, one

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[1] Prejudice, which I have defined as an evaluative bias against another person based on generalized rather than individuating information, is theoretically distinct from stereotypes, which are knowledge structures that associate certain social groups with particular traits (Hamilton, 1981). For example, prejudice might manifest as an affective feeling of dislike for a Black man relative to a White man, whereas stereotyping might manifest as the belief that a Black man is more violent than a White man. Although stereotypes can give rise to prejudice, this need not always be the case. Indeed, perceivers sometimes express prejudice against stigmatized groups without any evidence that stereotyping has occurred (Bessenoff & Sherman, 2000), and researchers have devised methods that tap into each construct separately, suggesting that they are not entirely redundant (Amodio & Devine, 2006). In fact, emerging evidence suggests that separate neural systems subserve stereotyping and prejudice (Amodio & Devine, 2006). Thus, while stereotyping and prejudice are related concepts, they remain theoretically and empirically distinct. My dissertation focuses specifically on prejudice as the evaluative outcome of impression formation, although I recognize that some forms of prejudice are derived from negative stereotypes.

study revealed that a preponderance of White Americans openly endorsed negative attitudes about Black Americans (Katz & Braly, 1933). These biases continue to operate today, as evidenced by high rates of police brutality (Correll, Judd, Park, & Wittenbrink, 2002) and discriminatory hiring practices (Dovidio & Gaertner, 2002) directed against racial minorities. Similar prejudices have been documented for other social groups. We know, for example, that many Americans openly express negative attitudes about sexual minorities (Herek, Cogan, & Gillis, 2002), women (Glick & Fiske, 1996), fat individuals (Puhl & Heuer, 2009), Islamic congregants (Strabac & Listhaug, 2008), and those suffering from mental (Corrigan, 2005) and physical illness (Crandall & Moriarty, 1995). These biases are concerning in their own right, and even more so because they have serious consequences ranging from strained interpersonal interactions (Dovidio et al., 2002) to discriminatory behavior in courtrooms (Sommers & Ellsworth, 2001), workplaces (Blommaert, Tubergen, & Coenders, 2012), political arenas (Payne et al., 2010), and healthcare settings (van Ryn, Burgess, Malat, & Griffin, 2006).

Of course, explicit dislike is not the only form of contemporary prejudice. As social norms have made outward expressions of prejudice less acceptable (Crandall, Eshleman, & O'Brien, 2002), psychologists have turned their focus toward more covert instantiations of prejudice. This work has revealed that people automatically evaluate members of some groups negatively (Amodio & Devine, 2006), even when they explicitly report positive attitudes toward the group (Blair, 2002; Dovidio, Kawakami, & Beach, 2001). Again, such implicit biases have been documented for many different groups, ranging from racial and ethnic minorities (Wittenbrink, Judd, & Park, 1997) to religious congregations (Rudman, Greenwald, Mellott, & Schwartz, 1999), sex categories (Rudman, Greenwald, & McGhee, 2001), and sexual orientations (Jellison, McConnell, & Gabriel, 2004). Moreover, implicit prejudice has links to downstream behavior (see Greenwald, Banaji, & Nosek, 2014), including physical distancing during interracial interactions (Dovidio, Kawakami, Johnson, Johnson, & Howard, 1997), decreased helping behavior (Gaertner & Dovidio, 1977), and discriminatory decisions in competitive selection processes (e.g., job interviews; Dovidio & Gaertner, 2000).

Categorical Underpinnings of Prejudice

Although this laundry list of biases is informative about the scope of the problem, it does little to advance our knowledge of its root causes. Theoretical accounts that unite individual findings by highlighting the psychological processes underlying prejudice expression would be particularly useful. Reflecting the utility of such an approach, psychologists have expended a great deal of energy searching for proximal factors that subserve the formation and perpetuation of various prejudices. A seminal contribution to this line of work was the recognition that social categorization – the act of perceiving the social groups to which others belong – is a robust predictor of prejudice (Allport, 1954). It is worth noting at the outset that categorization is not inherently problematic; it helps us navigate a complex social world by enabling us to make predictions about unknown others' goals, motivations, and behaviors simply on the basis of knowledge about their group (Gilbert & Hixon, 1991). Categorizing a man as gay, for example, may help to frame approach-oriented behavior toward another man as indicating potential romantic interest. At the same time, categorizations can and often do portend negative consequences, insofar as they color perceivers' impressions of targets belonging to stigmatized groups. For example, categorizing a man as gay may arouse prejudice against him due to a general dislike for sexual minorities.

A great deal of empirical work has substantiated early theoretical claims about the role of categorization in the formation and expression of interpersonal prejudice (see Brewer, 1988;

Fiske & Neuberg, 1990; Macrae & Bodenhausen, 2000). In particular, psychologists have highlighted three important facts about social categorization. First, social categorization occurs readily and without instruction. Indeed, after passively viewing a group of people interact, perceivers make more within-category memory errors (confusing the utterances of a woman with another woman) than between-category errors (confusing the utterances of a woman with a man; Taylor, Fiske, Etcoff, & Ruderman, 1978) when recalling "who said what." Other studies provide even clearer evidence that perceivers spontaneously categorize others according to their social groups: In the Indirect Category Accessibility Task (ICAT; Stroessner, Haines, Sherman, & Kantrowitz, 2010), participants are asked to learn a rule that distinguishes people from two different groups. Although they are never given explicit category labels, perceivers reliably learn to group targets according to basic social groupings such as sex and race. The fact that these categorizations occur readily, however, does not necessarily imply that they are automatic. Rather, categorization appears to require at least some deployment of cognitive resources, as indicated by the fact that category activation is inhibited when cognitive resources are scarce (Gilbert & Hixon, 1991; Macrae, Stangor, & Milne, 1994). Moreover, people who use categories when forming impressions of other people perform better on secondary tasks compared to those who do not, suggesting that categorization helps to conserve mental resources (Macrae, Milne, & Bodenhausen, 1994). Altogether, these findings reveal that social categorization occurs readily and unintentionally, although perhaps not automatically (see Dijksterhuis, 2010).

A second key feature of social categorization is that it occurs rapidly. Neural evidence suggests the human brain begins to distinguish members of different social groups after as little as 50 ms of visual exposure (Ito & Urland, 2003; 2005), and sometimes even on the basis of subliminal exposure (Macrae & Martin, 2006). Perhaps surprisingly, such rapid categorization does not only describe the perception of phenotypically obvious dimensions such as race and sex; perceivers can also categorize relatively concealable identities, such as political affiliation and sexual orientation, with above-chance accuracy after as little as 100 ms of visual exposure (Ballew & Todorov, 2007; Olivola & Todorov, 2010; Rule & Ambady, 2008a). Thus, social categorization happens quickly and on the basis of limited exposure to another person.

Third, and most importantly for my dissertation, these unintentional and rapid social categorizations predict the initial impressions we form of others. Targets who belong to stigmatized social groups are often evaluated negatively simply because of their group membership (Bodenhausen & Macrae, 1998; Brewer, 1988; Devine, 1989; Dovidio et al., 1986; Gilbert & Hixon, 1991; Grant & Holmes, 1981; Sinclair & Kunda, 1999). Conversely, targets who are not categorized as members of a stigmatized group are unlikely to face prejudice related to that group membership (Bodenhausen & Macrae, 2000). In fact, social categorization has long been considered the primary antecedent of prejudice, with some scholars maintaining that categorization is necessary for prejudice to occur (Wilder, 1981). While this point remains open to debate (see Park & Judd, 2005), it is safe to say that perceivers can and often do evaluate others on the basis of their social category memberships.

Altering Category Representations: Thresholds and Prototypes

Thus, a considerable amount of research has revealed that social categorizations occur readily and rapidly, giving rise to prejudice against individuals categorized as belonging to stigmatized social groups. If a man is categorized as Black on the basis of his facial appearance, then he may experience racial bias on the basis of that categorization. If the same man is not categorized as Black on the basis of his facial appearance, then he is unlikely to experience racial bias. One conclusion stemming from these observations is that eradicating social categorization would dramatically reduce the incidence of prejudice. However, that approach seems misguided, because it is inadvisable and perhaps even impossible to rid the human mind of categories. After all, categories are functional insofar as they simplify the social world by allowing perceivers to make predictions about others on the basis of minimal information (Fiske & Taylor, 1991). Without categories, perceivers would be forced to individuate every person they encounter, which would be so computationally intensive that it would quickly become paralyzing (for a similar argument, see Park & Judd, 2005). Moreover, even if we could eliminate categorization to spare some individuals from prejudice, it is unclear that doing so would yield entirely positive results: Colorblind ideologies that ignore race category memberships have ironic negative effects, such as increasing the perception that a workplace is racially biased (Apfelbaum, Norton, & Sommers, 2012). So the question becomes: Aside from eliminating categorization, what other approaches might help us to better understand and ultimately reduce prejudice?

One possibility is to begin thinking beyond *whether* a given categorization occurs to consider *how* it occurs. I am referring specifically to category representations, which are perceivers' mental images of the people belonging to a given category (Dotsch & Todorov, 2012). Theoretically, perceivers store representations of various categories in memory, and they compare novel targets to those representations when determining whether or not the targets belong to the category in question (Smith & Zarate, 1990). Two aspects of category representation are especially relevant to the study of interpersonal prejudice. First is the *category threshold*, which indicates the perceptual boundary at which a category begins. Targets with phenotypic features on one end of the boundary are seen as belonging to that category, whereas targets with phenotypic features on the other end of the boundary are not. To make this point more concrete, consider body adiposity. In the population, bodies vary considerably in their amount of adiposity; bodies with relatively high adiposity are categorized as fat while bodies with relatively low adiposity are not. The threshold for fat categorization represents the level of adiposity at which a perceiver will categorize a given target as belonging to the category “fat.”

Thresholds are critical to our knowledge of prejudice because targets whose features exceed the threshold for a stigmatized group will be categorized as members of that group, which has repeatedly been linked to prejudice expression (Brewer, 1988; Fiske & Neuberg, 1990; Macrae & Bodenhausen, 2000). Continuing with the example of body adiposity, consider a target with a body mass index (BMI) of 26. If a given perceiver’s fat category threshold reflects a BMI of 25, then the target will exceed the threshold, be categorized as fat, and potentially experience prejudice related to their weight. If, on the other hand, a perceiver’s fat category threshold reflects a BMI of 27, then the target will not exceed the threshold, will not be categorized as fat, and likely will not experience prejudice related to their weight. Thus, category thresholds are critical to understanding when and why some targets will face prejudice.

Thresholds are not the only aspect of category representations that are relevant to prejudice; *prototypes* are also important. Put simply, prototypes represent the central tendency of a given category based upon a perceiver’s previous experiences with individual members of that category. Classic research in cognitive psychology revealed that perceivers quickly and readily extract prototypes after brief exposure to several unique exemplars. For example, after viewing a series of dot patterns, perceivers were able to identify the statistical average of those patterns faster and more accurately than control patterns (Posner & Keele, 1964), even when the prototype itself was not shown during the exposure phase of the study (Bransford & Franks, 1971). Perceivers therefore extract the norm of a given category based upon their experiences with individual members of that category.

The fact that perceivers readily extract category prototypes is critical to the psychological study of impression formation because perceivers evaluate newly encountered category members relative to the prototype for that category. Specifically, there is a robust tendency for perceivers to evaluate prototypical category members more favorably than non-prototypical category members. In an early demonstration of this effect, perceivers offered more favorable affective responses to letter strings (Study 1) and dot patterns (Study 2) that approximated their category prototypes compared to letter strings and dot patterns that were less similar to their category prototypes (Gordon & Holyoak, 1983). The tendency to evaluate prototypical category members favorably extends beyond patterns to include evaluations of people belonging to various social categories. For example, perceivers in one study rated applicants who shared more central features with their prototype for a given job as more hirable than other applicants who were equally qualified but shared fewer central features with their prototype for that job (Perry, 1994). Perceivers in another study formed more favorable impressions of hypothetical targets who were similar to a prototype provided by the experimenter compared to hypothetical targets who were dissimilar to a prototype provided by the experimenter (Forgas, 1985). Perhaps the most well documented link between prototypicality and social evaluation is the "beauty in averageness" effect, in which faces with prototypical phenotypes (i.e., appearances that approximate the mathematical average of individuals in a given population) tend to be rated as more attractive than faces with less prototypical phenotypes (Rhodes, 2006). This holds true for adults (Langlois & Roggman, 1990; Little & Hancock, 2002; Rhodes, 2006; Rhodes & Tremewan, 1996; Rhodes, Sumich, & Byatt, 1999) and children (Rubenstein et al., 1999), as well as contemporary Western perceivers (Rhodes et al., 2003) and an isolated tribe of African hunter-gatherers (Apicella et al., 2007). Altogether, this evidence suggests that perceivers have a strong preference for prototypical facial features that appears constant across both development and cultural context (Vingilis-Jaremko & Maurer, 2013).[2]

Early theories invoked evolutionary arguments to explain this preference for prototypes, suggesting that average phenotypes might indicate strong genetic quality that is important for mate selection (see Rhodes, 2006). Subsequent researchers challenged this explanation in light of similar effects of prototypicality in domains that have no reproductive significance. For example, the preference for prototypical category exemplars is not exclusive to human faces; similar preferences emerge for birds, fish, automobiles, dogs, and wristwatches (Halberstadt & Rhodes, 2000, 2003). These observations cast doubt on the theory that humans' preferences for prototypes reflect a drive for high-quality mates, suggesting instead that a more general cognitive mechanism is at play. At present, the most widely accepted explanation for the preference for prototypical category exemplars is that such exemplars are "easy on the mind" (see Winkielman, Halberstadt, Fazendeiro, & Catty, 2006). Indeed, across many domains of judgment, there is a robust and generalizable tendency for perceivers to evaluate fluent stimuli (e.g., those that fall close to the category prototype) more favorably than disfluent stimuli (e.g., those that fall far from the category prototype; Alter & Oppenheimer, 2009; Lick & Johnson, 2015a).

In summary, previous theories highlighted social categorization as a primary, and perhaps even the primary, determinant of prejudice formation. The focus here was on acts of

[2] Although the tendency to evaluate prototypical category members favorably replicates across many domains of judgment, there are some instances in which prototypicality has been linked to negative evaluations. In particular, research on racial bias has shown that Black individuals with prototypically Black facial features are especially likely to be shot without cause (Ma & Correll, 2011) and sentenced to death in criminal trials (Eberhardt, Davies, Purdie-Vaughns, & Johnson, 2006). Although an empirical test is beyond the scope of this dissertation, I suspect there may be conflicting mechanisms underlying these effects. On the one hand, prototypical category members tend to be evaluated favorably. On the other hand, perceivers' prototypes of the category "Black" may include distinctly negative stereotypes, such as the belief that Black individuals are violent. In this case, the negative stereotype may be so strong that it outweighs the otherwise evaluation enhancing effects of prototypicality. This point specifically, and boundary conditions of the link between prototypicality and favorable evaluations more generally, deserve a empirical attention in the near future.

categorization: If targets were categorized as belonging to a stigmatized group, then they were susceptible to prejudice. If targets were not categorized as belonging to a stigmatized group, then they were not susceptible to prejudice. However, focusing exclusively on the act of categorization offers a limited perspective on the psychological antecedents of bias. Pushing these insights further to consider perceivers' mental representations of various categories highlights new avenues for research. In particular, understanding the threshold for a given category as well as the prototype for that category may help us predict when and why some targets face prejudice. Targets whose features do not pass the threshold for a given category will not be perceived as members of that category and therefore will not be evaluated on that basis. Targets whose features fall close to the prototype will generally be evaluated more favorably than targets whose features fall far from the prototype. These observations are especially useful to the study of prejudice because category representations may be malleable. Indeed, the fact that perceivers update their mental representations of a given category based upon their experience with individual members of that category (Bransford & Franks, 1971; Posner & Keele, 1964) suggests that we might be able to systematically change those representations, and in doing so, alter the likelihood that perceivers will express prejudice against certain social targets. In Chapter 2, I describe one means of altering category representations based upon established theories of visual adaptation.

Chapter 2: Adaptation and Aftereffects in Social Vision

Classic Findings: Low-Level Visual Adaptation

Vision scientists have long recognized that human perception is malleable, and that relatively brief exposure to a class of stimuli (*adaptation*) results in noteworthy perceptual changes (*aftereffects*; Clifford & Rhodes, 2005). In fact, observations about the malleability of human perception date back at least as far as Aristotle (ca 330 B.C.), who described the striking effects of visual adaptation to motion: “When persons turn away from looking at objects in motion, e.g., rivers, and especially those which flow very rapidly, they find that the visual stimulations still present themselves, for the things really at rest are then seen moving” (Ross, 1931, p. 459). Centuries later, Purkinje (1825, p. 60) rediscovered the motion aftereffect: “One time I observed a cavalry parade for more than an hour, and then when the parade had passed, the houses directly opposite appeared to me to move in the reversed direction to the parade.” Addams (1834, p. 373) described a similar experience at the Fall of Foyers during a tour of Scotland: “Having steadfastly looked for a few seconds at a particular part of the cascade … and then suddenly directed my eyes to the left, to observe the vertical face of the somber age-worn rocks immediately contiguous to the water-fall, I saw the rocky face as if in motion upwards, and with an apparent velocity equal to that of the descending water.” Each of these commentators described a phenomenon that subsequent researchers documented empirically: After gazing at a moving stimulus for a period of time, the visual system adapts to the motion. Perceivers who then shift their gaze to a stationary object will see that object drifting in the opposite direction of the original motion (Webster, Warner, & Field, 2005).

Since these early observations about the perceptual system’s remarkable plasticity, researchers have devoted a great deal of energy to the study of visual adaptation and its related aftereffects. In fact, visual adaptation has become so important to the study of human perception that it has been termed the "psychologist's microelectrode" (Clifford & Rhodes, 2005), as it allows researchers to probe the functional organization of the perceptual system using behavioral methods. Indeed, research on visual adaptation to low-level stimulus features has revealed that aftereffects occur by altering the activity of neurons that respond to a particular stimulus feature. For example, adaptation to downward motion causes the neurons that code for downward motion to decrease their firing rate. When a novel stimulus appears in the visual field, the neurons coding for downward motion remain selectively inactive, causing stationary objects to appear as if they are drifting upward (Blakemore & Campbell, 1969; Bednar & Mukkulainen, 2000). This neural mechanism is not unique to motion perception; similar effects occur for color perception, where adaptation to a particular color (red) causes neurons coding for that color to decrease their firing rate, such that subsequently encountered stimuli are perceived as the complementary color (green; Barbur, Weiskrantz, & Harlow, 1999; McCullough, 1965). Thus, the visual system adapts to stimulus features by decreasing neuronal firing rates, recalibrating perceptual norms and biasing the perception of subsequent stimuli in the opposite direction of adaptation. This process is so powerful that it can lead to categorical shifts in the perception of a stimulus (e.g., from perceiving the color white to the color green).

It may seem surprising that the visual system can be so easily duped into perceiving illusory features in the surrounding environment. However, these illusions are byproducts of a functional process that improves processing efficiency by removing redundant information from one's visual environment (Barlow, 1990; Leopold, Bondar, & Giese, 2006). That is, visual adaptation helps to calibrate perception to the surrounding environment by reducing energy expenditure when a particular feature is constantly present. Adaptation is therefore a common and highly adaptive property of human perception that allows the visual system to rapidly tune itself to an ever-changing environment.

Contemporary Findings: Higher-Level Visual Adaptation

The vast majority of research on visual adaptation has examined adaptation to low-level stimulus features such as color and motion. Still, if visual adaptation is a general process underlying human perception, then it should also affect higher-level percepts. The past decade has welcomed robust evidence in support of this hypothesis, demonstrating that aftereffects also occur in higher-level social vision. Initial work in this area identified two distinct aftereffects that follow adaptation to human faces: (1) figural aftereffects and (2) identity aftereffects. Research on figural aftereffects revealed that relatively brief adaptation to a particular facial feature biases the perception of subsequently encountered faces in the opposite direction. For example, several minutes of adaptation to faces with features that are digitally compressed inward toward the center causes unaltered faces to appear somewhat expanded (Rhodes, Jeffery, Watson, Clifford, & Nakayama, 2003). Figural aftereffects not only alter the perception of facial distortions, but also the threshold for categorizing targets as members of real social groups. For example, adaptation to male faces shifts the boundary for sex categorization, causing observers to categorize an androgynous face as female (and vice-versa; Webster, Kaping, Mizokami, & Duhamel, 2004). Identity aftereffects function in a similar fashion: Adaptation to a face with a particular identity ("Dan") biases the perception of subsequent faces in the opposite direction ("anti-Dan;" Leopold et al., 2001; Rhodes & Jeffery, 2006). These identity aftereffects are thought to aid in the identification of others by causing the faces that one sees relatively often to appear normative and making faces that deviate from this norm easy to detect (Anderson & Wilson, 2005). Collectively, then, research on figural and identity aftereffects revealed that perceivers adapt to facial features, such that repeated exposure to a given feature alters the perceptual threshold for a given face category.

Initial evidence of higher-level visual aftereffects did not only serve as an existence proof of the phenomenon; it also provided empirical support for Valentine's (1991) influential model of facial coding. This model proposes that perceivers code faces as points within a multi-dimensional space, where each dimension represents an attribute that varies in the population (e.g., nose size). The center of the face space represents the prototypical face, which takes on average values for all of the phenotypic dimensions described by the space. Theoretically, each newly encountered face is coded in relation to this prototype, with similar faces falling close to the norm and more distinct faces falling further from it. Higher-level visual aftereffects have provided strong evidence for this norm-based model of face processing. For example, Rhodes and colleagues (2003) demonstrated that visual adaptation to figurally distorted faces shifted perceivers' prototype for facial phenotypes: Adaptation to extremely compressed faces caused a compressed face to appear increasingly normative, whereas adaptation to extremely expanded faces caused an expanded face to appear increasingly normative. Similar effects emerge for perceptions of other facial features, including eye spacing (Little, DeBruine, Jones, & Waitt, 2008), bilateral symmetry (Rhodes, Louw, & Evangelista, 2009), and gender / race typicality (Webster et al., 2004). Collectively, these studies reveal that face prototypes are calibrated toward the features perceivers encounter most often. Relatively brief experimental exposure to faces with a particular feature can shift the prototype and alter the perception of subsequent faces (for a review, see Webster & MacLeod, 2011).

One important question about higher-level visual adaptation is whether the resulting perceptual effects are truly visual aftereffects or whether they represent some other psychological phenomenon (e.g., object priming). The short answer to this question is that higher-level visual aftereffects are indeed similar to the lower-level aftereffects documented previously. Indeed, higher-level visual aftereffects follow the same temporal dynamics as lower-level visual aftereffects, including logarithmic accumulation throughout the adaptation period and a power-law relationship between the strength of the adaptation and the strength of the aftereffect (Leopold, Rhodes, Müller, & Jeffery, 2005; Rhodes et al., 2007). Moreover, neural evidence suggests that visual adaptation to human faces alters neuronal firing patterns in the same way as low-level adaptation (Ng, Ciaramitaro, Anstis, Boynton, & Fine, 2006; Rothstein, Henson, Treves, Driver, & Dolan, 2005). Aside from these similarities between low-level visual aftereffects and higher-level visual aftereffects, other evidence distinguishes higher-level visual aftereffects from cognitive processes such as object priming and contrast effects. For example, visual adaptation often results in repulsive aftereffects, such as when adaptation to male faces causes a neutral face to appear female (Webster et al., 2004). Priming, on the other hand, generally leads to attractive effects, such as when priming perceivers with a female face increases the speed of sex categorizations for subsequent female faces (Tulving & Schacter, 1990). Moreover, the strength of higher-level visual aftereffects increases logarithmically as a function of the duration of the adaptation (Leopold et al., 2005), whereas both priming and contrast effects are similar in magnitude when based on a single exposure or multiple repeated exposures (Schacter & Buckner, 1998). Finally, higher-level visual aftereffects last for considerably longer (up to a week; Strobach & Carbon, 2013) than traditional priming and contrast effects, which often decay relatively quickly (Macknik & Livingstone, 1998). Thus, visual adaptation and aftereffects appear to be distinguishable from other cognitive phenomena related to perceptual exposure.

Higher-Level Visual Adaptation and Social Evaluation

The vast majority of research on higher-level visual adaptation has examined perceptual aftereffects, such as face prototypes and thresholds for categorizing others along a given dimension. These findings broadly suggest that visual adaptation alters perceivers' mental representations for social categories, which has implications for the study of social evaluation. Indeed, as described in Chapter 1, category thresholds and category prototypes predict how a given target will be evaluated (Gordon & Holyoak, 1986; Kahneman & Miller, 1986; Perry, 1994; Posner & Keele, 1968; Rhodes, 2006; Smith & Zarate, 1990). Targets whose features exceed the threshold for categorization along a stigmatized dimension are likely to face prejudice, as are targets whose features fall far from the category prototype. If social evaluations are related to category representations, and if visual adaptation alters the representation of a given category, then it seems reasonable to expect that visual adaptation might alter evaluative preferences for social stimuli. Stated differently, visual adaptation may calibrate social preferences by altering the threshold for categorization along a given dimension as well as the features that appear prototypical for a particular group.[3]

Researchers have only recently begun to test the evaluative implications of visual adaptation, but several studies offer preliminary evidence in support of the above claims. Principe and Langlois (2012) demonstrated that visual adaptation to human/chimpanzee facial morphs made those morphs easier to categorize as faces, which resulted in more favorable affective responses to similar targets as indicated by electrical activity over the *zygomaticus major* muscle group. Winkler and Rhodes (2005) exposed perceivers to female bodies that were

[3] I use the terms *prototype* and *perceptual norm* interchangeably to reflect the fact that different literatures use different language to discuss similar concepts. Cognitive psychologists have tended to use the term prototype to describe the central tendency of a given category, whereas vision scientists have tended to use the tern perceptual norm to describe the central tendency of a given category. Employing both of these terms reflects the fact that my hypotheses are derived from two distinct literatures that describe similar phenomena in slightly different ways.

compressed or stretched to appear thin or fat, revealing that adaptation to compressed bodies exacerbated the tendency to rate thin women as more attractive than fat women. And in perhaps the most compelling demonstration of this effect, Rhodes and colleagues (2003) adapted perceivers to faces with features that were digitally compressed inward toward the center or digitally expanded outward from the center. Following adaptation, they examined perceived facial norms and attractiveness ratings of similarly distorted faces. As expected, adaptation to extremely compressed faces caused slightly compressed features to appear more normative and also to be rated more as more attractive at posttest relative to pretest (and vice-versa).

At first glance, these findings may seem reminiscent of work on the mere exposure effect, in which repeated exposure to a stimulus enhances evaluations of that stimulus (Zajonc, 1968; see also Pliner, 1982; Reber et al., 2004). Importantly, however, the mere exposure effect relies on repeated exposure to the same stimulus over time. In contrast, visual adaptation paradigms expose perceivers to a general feature (e.g., large noses) that generalizes to a whole class of stimuli (e.g., faces). Moreover, theories of visual adaptation highlight two potential mechanisms underlying these effects – shifts in category thresholds and shifts in category prototypes – that were unspecified in earlier work on the mere exposure effect. Adaptation methods therefore extend previous models by revealing the mechanisms by which visual exposure enhances liking.

In summary, recent evidence suggests that visual adaptation may guide impression formation by altering perceivers' mental representations of social categories.[4] Although extant

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[4] It is possible that the evaluative implications of adaptation extend beyond the visual domain. Indeed, several recent studies demonstrated that adaptation to auditory cues results in perceptual distortions similar to those seen in visual adaptation paradigms (Belin & Zatorre, 2003; Bestelmeyer et al., 2010; Schweinberger et al., 2008). Although there has been no work to date on the evaluative implications of auditory adaptation, these findings raise the intriguing possibility that adaptation can affect prototypes and preferences for stimuli across multiple sensory domains. This possibility has broad implications for the generalizability of adaptation's effects on social evaluation, but my dissertation focuses exclusively on adaptation in the visual domain for two reasons. First, the vast majority of research on adaptation aftereffects has been conducted in the visual domain. Second, vision is central to social perception: A greater proportion of the human brain is dedicated to visual processing than all other sensory

research on the evaluative implications of visual adaptation provides some support for this claim, however, several limitations make it difficult to confirm. First, the majority of empirical work in this area has examined adaptation to synthetic and caricatured features that do not occur naturally in the human population (e.g., facial compression). Visual adaptation's impact on social evaluations of members of real social groups remains unclear. Second, most existing studies of evaluative aftereffects have examined singular dimensions of evaluation, such as attractiveness or trustworthiness. However, interpersonal prejudice arises as a suite of related judgments in the early moments of social perception, and it is unclear whether visual adaptation alters these broad criteria on which perceivers base their evaluations of others. Third, researchers have yet to pinpoint the specific mechanisms by which visual adaptation enhance social evaluations. I have proposed two likely mechanisms. The first involves category thresholds: Adaptation is known to shift the threshold for categorization along a given dimension, and to the extent that this shift results in some targets not being categorized as members of a stigmatized group, it may spare them from prejudiced social evaluations. The second mechanism involves category prototypes: Adaptation to a given is known to make that feature appear normative, and perceivers often prefer normative stimuli to non-normative stimuli. While both of these mechanisms enjoy some indirect support from prior research, strong conclusions await studies that directly test the links between visual adaptation, category representations, and evaluative judgments.

In light of the promise that theories of visual adaptation hold for the study of impression formation, it seems surprising that researchers have yet to fully consider whether and how visual exposure impacts social evaluations of individuals belonging to real social groups. Does visual

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modalities combined (Johnson & Adams, 2013), and this visual advantage may have evolved specifically to accommodate social life (Dunbar, 1998; Humphrey, 1976). Therefore, while I recognize adaptation in other sensory modalities as an exciting avenue for future research, I restrict my studies to visual adaptation.

adaptation alter mental representations for real social categories? If so, are shifts in these representations accompanied by shifts in social evaluations? And can psychologists harness the adaptive potential of human perception in order to alter biases against some groups? My dissertation aims to address these questions by examining whether and how repeated visual exposure impacts social evaluations of individuals who face prejudice related to their physical appearance. On the basis of existing research, I propose several hypotheses:

> **Hypothesis 1a:** Visual adaptation shifts the prototype for a give category. Repeated exposure to a given feature will cause that feature to appear increasingly prototypical.
>
> **Hypothesis 1b:** Shifts in category prototypes will be accompanied by shifts in social evaluation. Specifically, as a feature appears more normative as a function of adaptation, it will also be evaluated favorably.
>
> **Hypothesis 2a:** Visual adaptation also shifts the threshold for categorization along a given dimension. Repeated exposure to targets with a particular feature will shift the threshold for categorization toward that feature. Subsequently encountered targets who lack the feature in question will categorized as belonging to a different group.
>
> **Hypothesis 2b:** Shifts in category thresholds will be accompanied by shifts in social evaluation. To the extent that adaptation shifts the threshold for categorization into a stigmatized group upward, perceivers will be less likely to categorize targets as members of that group, reducing the likelihood that they will experience prejudice.

Evidence in support of these hypotheses would provide new information about the perceptual mechanisms underlying the formation category representations that guide social evaluation.

Chapter 3: Research Overview

The above review of research in the social, cognitive, and vision sciences pinpoints exciting new directions for the study of impression formation. Whereas classic research focused primarily on acts of social categorization as antecedents to prejudice (Park & Judd, 2005), I have argued that mental representations of various categories may offer a deeper understanding of impression formation. Specifically, I highlighted two aspects of category representation that are relevant to the study of impression formation – thresholds and prototypes. To the extent that a target's features do not pass the threshold for categorization into a stigmatized group, they are unlikely to face prejudice related to that group membership. To the extent that a target's features appear prototypical for a particular group, they are unlikely to face prejudice. Critically, these two aspects of category representation may be susceptible to change on the basis of visual adaptation. Here, I aim to test the evaluative implications of these adaptation-related shifts in category representation.

Evidence in support of my hypotheses will provide theoretical and practical advances to social psychological research. Theoretically, the predicted patterns would provide new information about the perceptual underpinnings of impression formation. In contrast to existing theories that focused primarily on acts of categorization as determining social evaluation (Brewer, 1988; Fiske & Neuberg, 1990; Macrae & Bodenhausen, 2000), the proposed model would highlight how perceptual exposure alters perceivers' mental representations of various social categories, which are themselves central to impression formation. Such findings would also extend theories of visual aftereffects in important ways. Most of the existing work on this topic has examined perceptual outcomes (e.g., thresholds for categorization) following visual adaptation to digitally distorted features that do not occur in the population (e.g., facial compression). Replicating these findings with targets who vary more naturally in their appearance and extending them to social evaluative judgments would reveal whether and how visual adaptation impacts impression formation.

On a more practical level, findings about the social evaluative implications of visual adaptation could spur the development of new interventions that make use of this simple and cost-effective method to reduce prejudice. For instance, if several minutes of visual exposure increases prototypicality and decreases prejudice against individuals belonging to stigmatized social groups, then researchers might be able to harness visual adaptation to reduce prejudice on a large scale. Although my dissertation is concerned primarily with basic scientific questions about adaptation's impact on category representations and social evaluations, I highlight the applicability of the findings as exciting avenues for future work.

Of course, while I recognize visual adaptation's theoretical and applied potential, I also realize that it is unlikely to provide the sole explanation for prejudice expression or a panacea for correcting all forms of prejudice. Consider, for example, social groups associated with strong negative stereotypes (e.g., Black men). Although adaptation to Black male faces might cause those faces to appear more prototypical and subsequently improve social evaluations of them, it seems unlikely that adaptation alone could eliminate the deeply ingrained stereotype that Black men are violent. It is also worth considering the context in which adaptation occurs: If perceivers are repeatedly exposed to faces of Black men, but that exposure occurs in the context of negative stereotypes (e.g., depiction of Black men as criminals in news media), then the benefits of adaptation may be overridden by the negative valence of the stereotype. All of this is to say that some aspects of prejudice – such as those related to negative stereotypes – may be resistant to change by way of visual adaptation. Although systematic investigation of these issues is beyond the scope of my dissertation, I highlight them as potential boundary conditions worthy of empirical attention in the future. For now, my goal is to situate visual adaptation within a complex cognitive system that calibrates category representations and therefore guides social preferences and prejudices. To the extent that visual adaptation helps to explain some aspects of impression formation, it may prove a useful tool for studying and perhaps even combating interpersonal bias.

Study Set 1:

Visual Adaptation Alters Perceptual Norms and Evaluative Biases Related to Gendered Facial Features

Study Set 1 sought to test Hypotheses 1a and 1b with regard to gendered facial features, in part because gendered facial features have well-established impacts on impression formation. Indeed, perceivers begin to appreciate others' gendered appearance within mere milliseconds of visual exposure (Ito & Cacioppo, 2000; Ito, Thompson, & Cacioppo, 2004), and this process gives rise to some noteworthy evaluative biases. For example, gendered facial features guide attractiveness judgments, such that somewhat feminized features are rated as more attractive than very masculine features for both sexes (Jones & Hill, 1993; Little & Hancock, 2002; Perrett et al., 1998; Perrett, May, & Yoshikawa, 1994; Rhodes et al., 2000; Valenzano, Mennucci, Tartarelli, & Cellerino, 2006). Similar effects emerge in domains of judgment other than attractiveness, where slightly feminized features are associated with higher ratings of respectability, sincerity, prosociality, honesty, warmth, loyalty, likeability, intelligence, and dependability compared to more masculine features (Little, Jones, Penton-Voak, Burt, & Perrett, 2002; Penton-Voak et al., 2007; Principe & Langlois, 2012; Sczensy, Spreemann, & Stahlberg, 2006). Altogether, these findings suggest that perceivers prefer slightly feminized facial features in both women and men.

This preference for feminized facial features has been surprising to many, and theoretical explanations for it are lacking. I propose that perceptual experience may contribute to gender-related biases in social evaluation. This hypothesis is tenable insofar as the people portrayed in popular media and everyday life tend to appear slightly feminized (Adams, 2011; Anderson, 2005; Anderson, 2008; Coad, 2008). Intriguingly, this trend applies to both men and women.

Consider, for example, People Magazine's list of the most prominent and attractive male celebrities of 2012. Many of the men on this list have somewhat 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 may also favor feminized phenotypes, as revealed by the fact that both men and women commonly undergo cosmetic surgery to feminize aspects of their facial appearance, requesting smaller noses and lifted eyelids (Davis, 2002). Taken together, these factors may produce an overrepresentation of feminine phenotypes relative to more masculine phenotypes in media and social life. Study Set 1 tested whether repeated exposure to such visibly feminized phenotypes guides perceivers' expectations and preferences for what men and women look like.

Specifically, the studies test whether visual adaptation molds perceptual gender norms for male and female faces (Hypothesis 1a), resulting in more favorable judgments of targets who share features with the adapting images (Hypothesis 1b). If so, then deliberately exposing perceivers to masculine phenotypes should cause those phenotypes to appear increasingly normative, and in doing so, reduce the established bias against targets with hyper-masculine facial features. Although it may seem odd to think about reducing prejudice against masculine men, very masculine men do consistently receive less favorable social evaluations than more feminized men (Frederick & Haselton, 2007; Little & Perrett, 2011). Very masculine women face similarly harsh evaluations in multiple domains of social life (Little & Perrett, 2011; Sczensy, Spreeman, & Stahlberg, 2006). Thus, gendered facial features provide a theoretically and practically relevant domain in which to test my hypotheses about the impact of visual adaptation on perceptual norms and evaluative preferences.

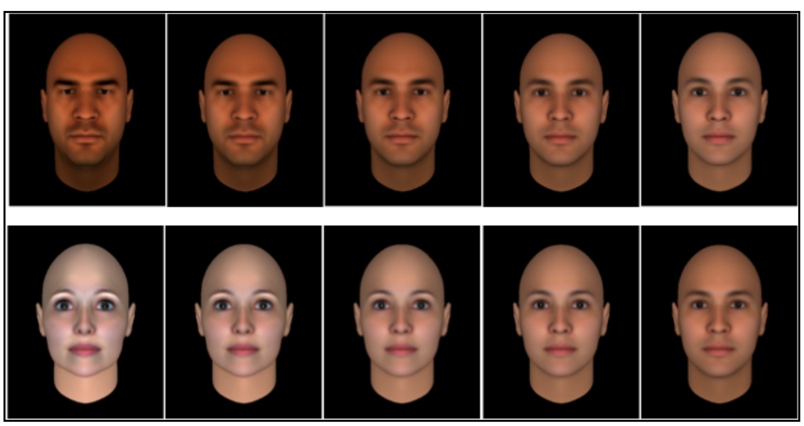
Study 1

Study 1 was designed to address Hypothesis 1a, which proposes that visual adaptation to gendered phenotypes will alter perceptual norms for male and female faces. Based on evidence that slightly feminized phenotypes are more common than more masculine phenotypes in media and everyday social networks, I expected participants to enter the study with slightly feminized norms for both male and female faces. However, I expected adaptation to alter these norms, such that exposure to masculine phenotypes would cause participants to identify more masculine faces as normative at posttest relative to pretest, whereas exposure to feminine phenotypes would cause participants to identify more feminine faces as normative at posttest relative to pretest.

Method.

Participants. Two hundred fifteen Internet users from the United States (85 men, 124 women, 6 unreported) completed the study. On average, participants were 34.16 years old (*SD* = 13.42 years), and most identified as White (78%) and 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 x 477 pixels at 72 pixels/inch; Figure 1). I created the stimuli using FaceGen Modeler, which estimates phenotypic features based upon parameters observed in several hundred three-



dimensional face scans of the human population (Blanz & Vetter, 1999). I began by creating a base face with all phenotypic features (e.g., age) set at their anthropometric mean. I then used the gender morphing tool to systematically alter the features of the base face. For female faces, I changed the apparent gender from the most feminine face possible to the point at which the face had equally male-typed and female-typed features, yielding 21 female faces that varied incrementally in gender typicality from hyper-feminine to hyper-masculine. For male faces, I changed the apparent gender from the most masculine face possible to the point at which the face had equally male-typed and female-typed characteristics, yielding 21 male faces that varied incrementally in gender typicality from hyper-masculine to hyper-feminine. Thus, the stimuli captured the full range of gendered variation for each sex, up to the point where the features were anthropometrically androgynous. I considered androgynous faces to be gender-atypical because participants received explicit information about the sex category they were judging (i.e., participants judging female faces were told that would only see female faces). Therefore, hyper-masculine women and hyper-feminine men were extremely gendered relative to a sex-specific norm. To ensure that the stimuli were externally valid, I 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 (Johnson et al., 2012).

Procedure. Internet users from Amazon Mechanical Turk completed a study about their perceptions of other people, with no mention of sex, gender, visual adaptation, or bias. After providing consent, participants evaluated either male or female faces in several stages. First, participants identified the most average-looking man or woman from a randomly sorted 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 the 5 most feminine faces (*Feminine Adaptation*) or the 5 most masculine faces (*Masculine Adaptation*) from the sex category to which they were assigned. Adaptation images were selected from the images in the array, and they were repeatedly displayed for 3 seconds each in random order for a total of 3 minutes.[5] [6] Following adaptation, participants again identified the most average-looking man or woman from a randomly sorted array of all 21 male or female faces (*Posttest*). The placement of faces in the array differed at pretest and posttest to ensure that participants did not select the same face based on its spatial location. Finally, participants reported demographics and completed the Personal Attributes Questionnaire (PAQ; Spence, Helmreich, & Stapp, 1975) to assess their endorsement of masculine and feminine gender schemas 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). A chi-square test revealed that the number of participants did not differ significantly across these four cells, $\chi^2(1) = 2.87$, $p = .090$.

Results and Discussion.

My primary aims in Study 1 were to (1) explore participants' perceptual gender norms for male and female faces, and (2) test whether visual adaptation altered these norms. I predicted that norms would be notably feminized at pretest, but that they would shift in the direction of adaptation, such that observers would rate masculine faces as more normative after exposure to masculine features but feminine faces more normative after exposure to feminine features.

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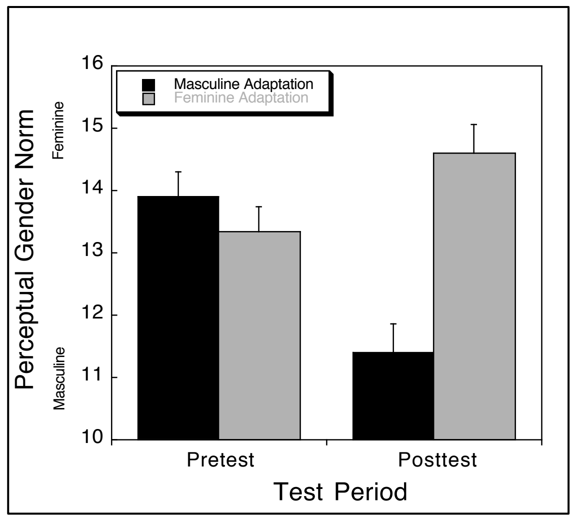
[5] Participants saw 10 faces marked with a yellow circle at random intervals throughout the adaptation period. When one of these faces appeared, participants were told to press the enter key as quickly as possible. I did not record the speed with which participants identified the marked faces; I used this task throughout Study Set 1 to ensure that participants remained visually engaged throughout the adaptation phase.

[6] Although visual aftereffects can be observed after mere seconds of adaptation, the strength of an aftereffect is directly related to the length of adaptation (Webster et al., 2004). Therefore, I used a three-minute adaptation period to remain consistent with prior work in this area (e.g., Rhodes et al., 2003) and to ensure that any resulting aftereffect would be sufficiently strong to withstand the length of the posttest period.

The stimuli varied incrementally in gender typicality, so I coded each face from 1 (*hyper-masculine*) to 21 (*hyper-feminine*) to quantify the gendered features that participants perceived as average (*Perceptual Gender Norm*). Because participants chose the most average face at two time points, I conducted analyses using multilevel regression models to account for the nested structure of the data. Specifically, I stacked Perceptual Gender Norm ratings in the dataset and differentiated them with an effect-coded variable (*Test Period*; *-0.5 = Pretest, 0.5 = Posttest*). The masculinity and femininity dimensions of the PAQ were internally consistent (Cronbach's αs = .81 and .84, respectively), so I summed the items into continuous composite scores on which higher values indicated more masculine and feminine gender schemas. I scored Participant Age (*years*) and Education (*1 = less than high school* to *8 = doctoral degree*) continuously. I effect-coded Adaptation Condition, Target Sex, and Participant Sex (*masculine adaptation = -0.5, feminine adaptation = 0.5; male = -0.5, female = 0.5*), and I dummy-coded Participant Race (White as reference category).

Descriptive statistics**.** First, I examined the extremity of the gendered features participants identified as normative at pretest. Based upon anecdotal and empirical evidence that perceivers have greater exposure to feminine relative to more masculine individuals of both sexes, I expected that perceivers would enter the study with somewhat feminized norms for both 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, ts = 6.08 and 5.50, ps < .001, respectively.

Visual adaptation influences perceptual norms for male and female faces**.** Next, I tested whether visual adaptation altered perceptual norms for men's and women's faces. To do so, I 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 effects did not vary as a function of Target Sex. I therefore collapsed across Target Sex and regressed Perceptual Gender Norm onto Adaptation Condition, Test Period, and their interaction. The expected two-way interaction emerged, $B = 3.76$, $SE = 0.60$, $t = 6.23$, $p < .001$ (Figure 2). I decomposed this interaction by examining simple slopes of Test Period within each adaptation condition. In the masculine adaptation condition, participants chose more masculine faces as normative at posttest relative to pretest, $B = -2.50$, $SE = 0.40$, $t = -6.15$, $p < .001$. The opposite trend emerged in the feminine adaptation condition, where participants chose more feminine faces as normative at posttest relative to pretest, $B = 1.26$, $SE = 0.45$, $t = 2.83$, $p = .005$.



I tested the robustness of these effects by controlling for demographic variables collected during the study. I was particularly interested in whether gender schematicity accounted for the aftereffects observed here, because the tendency to view the world in a starkly gendered manner might create especially strong gender norms that are resistant to change on the basis of visual exposure. Although I did not have a priori hypotheses about the effects of other demographic variables, I also controlled for them to test the strength of the observed aftereffects. Specifically, I recalculated the regressions described above after partialling out the effects of participant sex, age, race, education, and masculine and feminine gender schemas. After accounting for these factors, the two-way interaction between 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 was retained 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 my hypothesis that perceptual norms are calibrated on the basis of visual exposure. Perceivers entered the study with notably feminized norms for men's and women's faces, buttressing anecdotal evidence that western observers have more exposure to feminized phenotypes relative to masculine phenotypes of both sexes (Adams, 2011; Anderson, 2009; Coad, 2008; Swain, 2006). Moreover, 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.

Study 2

Study 2 aimed to test the evaluative implications of the aftereffects observed in Study 1. In line with Hypothesis 1b, I predicted that participants would harbor biases against hyper-masculine faces of both sexes because they are perceived as less normative than feminine faces at pretest. Furthermore, I predicted these biases would shift following adaptation, such that exposure to feminine faces would exacerbate the bias against masculine targets but exposure to masculine faces would attenuate it.

Method.

Participants. One hundred eighty-eight Internet users from the United States (71 men, 116 women, 1 unreported) completed the study. Participants were 34.05 years old on average (*SD* = 13.15), and most identified as White (70%) and reported a high level of education (83% attended college).

Stimuli. Stimuli included a subset of the faces described in Study 1. For the evaluation phases of the study, I used 5 faces of each sex that were evenly spaced in terms of their gendered appearance (a hyper-masculine face, a moderately masculine face, a neutral face, a moderately feminine face, a hyper-feminine face). For the adaptation phase of the study, I used the 5 most feminine faces of each sex for the feminine adaptation condition and the 5 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, with no mention of sex, gender, visual adaptation, or bias. After providing consent, participants were randomly assigned to evaluate either 5 male or 5 female faces in a random order across 12 items measured on 10-point semantic differential scales (*Pretest*). The evaluations were modeled after 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 5 most feminine faces (*Feminine Adaptation*) or the 5 most masculine faces (*Masculine Adaptation*) from the sex category to which they were assigned for 3 seconds each for a total of 3 minutes. Following adaptation, participants re-evaluated the same target faces from pretest on the scales described above (*Posttest*). Finally, participants completed a demographic questionnaire and the PAQ (Spence et al., 1975) 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.

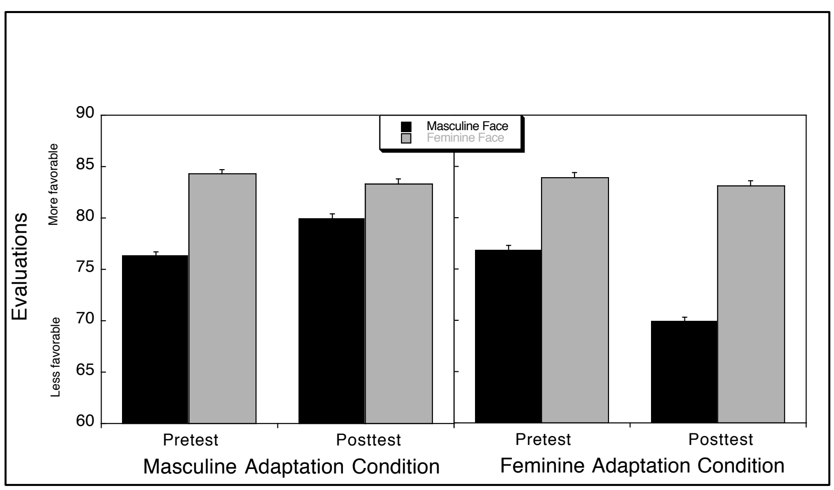
My primary aims in Study 2 were to determine whether evaluative judgments of targets were associated with perceptual gender norms, and whether visual adaptation altered these evaluative judgments. I predicted that perceivers would express notable biases against targets who deviated from perceptual gender norms. Thus, because perceptual gender norms were notably feminized in Study 1, I expected a bias against masculine relative to feminine targets at pretest. Moreover, I predicted these effects would shift following visual adaptation, such that adaptation to feminine faces would exacerbate the bias against masculine targets whereas adaptation to masculine faces would attenuate it.

Because the target faces varied incrementally in gender typicality, I coded each face from 1 (*hyper-masculine*) to 5 (*hyper-feminine*) to quantify their gendered features. I analyzed targets' gendered appearances continuously based upon this interval scale (hereafter, *Gendered Features*). I 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 I 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, I again stacked evaluative judgments in the dataset and differentiated them with an effect-coded variable (*Test Period*; *-0.5 = Pretest Evaluations, 0.5 = Posttest Evaluations*). As before, the masculinity and femininity dimensions of the PAQ were internally consistent (Cronbach's α = .81 and .86, respectively), so I created continuous composites for each subscale, and I examined demographic variables exactly as described in Study 1.

Gender-related bias at pretest. First, I tested whether perceivers expressed biases against targets who deviated from perceptual gender norms. To do so, I 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 upon the 21-point scale described in Study 1 (*1 = very masculine* to *21 = very feminine*). I then took the absolute value of this variable, such that Norm Deviation indicated deviation from the perceptual norm in either direction. 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. The Norm Deviation score for this target was 12.92, indicating a 12.92-point departure from the perceptual gender norm for men. To test whether these departures from perceptual norms predicted evaluative judgments, I regressed Pretest Evaluations onto Norm Deviation. As expected, targets who deviated from the perceptual 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 the perceived gender norm was 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 recent studies have uncovered evaluative biases against hyper-masculine targets – they deviate more from the norm than do hyper-feminine targets. I tested this bias against hyper-masculine targets 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. I decomposed the interaction by examining simple slopes for Gendered Features within each sex category. At pretest, feminine faces of both sexes were evaluated more positively than masculine faces, though this trend was more pronounced for male targets than for 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.

Visual adaptation influences gender-related biases. Next, I tested whether visual adaptation altered gender-related evaluative biases by regressing 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 effects did not vary as a function of Target Sex. I therefore collapsed across Target Sex and regressed Evaluations onto Gendered Features, Adaptation Condition, Test Period, and all interactions. The expected three-way interaction emerged, $B = 3.92$, $SE = 0.89$, $t = 4.41$, $p < .001$ (Figure 3).



I decomposed the three-way interaction by examining simple slopes of Gendered

Appearance, Test Period, and their interaction separately within the masculine and feminine adaptation conditions. 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 against masculine 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, $B = 2.22$, $SE = 0.63$, $t = 3.51$, $p < .001$. 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 they did to begin with; in fact, the magnitude of the bias nearly doubled, $B = 4.76$, $SE = 0.45$, $t = 10.61$, $p < .001$.

I again tested the strength of these effects by controlling for demographic variables collected during the study. Specifically, I recalculated the regressions described above partialling 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 significant and in the same direction as before, *B*

= 4.12, SE = 0.92, t = 4.47, p < .001.

Study 2 provided support for Hypothesis 1b by revealing that evaluative judgments related to gendered facial features shifted as a function of visual adaptation. Perceivers expressed notable biases against masculine men and women relative to more feminine men and women in part because the former departed from perceptual gender norms. Exposure to a series of feminine faces exacerbated this bias, but exposure to masculine faces mitigated it. Thus, visual adaptation calibrates not only perceptual norms for gendered facial appearances but also evaluative judgments related to those appearances.

Study 3

In Studies 1 and 2, adaptation to gendered facial features affected both perceptual norms and evaluative biases. While this pattern of results was consistent with hypotheses, my conclusions are limited by the fact that the stimuli relied on a single base face morphed with computer software. Thus, it remains possible that the aftereffects observed in these studies were due to idiosyncratic aspects of the base face or the gender morphing program. Replicating the results with real faces that vary naturally in their gendered features would improve the generalizability of the findings.

Furthermore, although Study 2 employed a measure of social evaluations that was statistically reliable and based on previously published research about evaluative biases in face perception, some of the items may have tapped into normative beliefs (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 the prior results toward favorable evaluations of feminine targets. Replicating the effects with more global measures of liking would ensure that my initial findings were not due to the specific items included in the evaluations scale.

Finally, I have argued that shifting perceptual norms may be the mechanism by which visual adaptation alters social evaluations related to gendered phenotypes, and my initial findings were consistent with this possibility. In Study 1, adaptation to hyper-masculine features made masculine faces appear more normative whereas adaptation to hyper-feminine features made feminine faces appear more normative. In Study 2, evaluative judgments followed the same pattern – masculine faces were evaluated more favorably following adaptation to hyper-masculine features whereas feminine faces were evaluated more favorably following adaptation to hyper-feminine features. Although these findings suggest that changes in perceptual norms may be functionally related to shifts in evaluative biases related to gendered phenotypes, the effects emerged in separate studies. Concurrently examining perceptual norms and evaluative biases in a single study would provide stronger evidence that shifting perceptual norms act as a mechanism by which adaptation enhances social evaluations.

With these considerations in mind, Study 3 was designed to replicate and extend my previous findings with a broader measure of social evaluation and real faces that varied naturally in their gendered phenotypes. Furthermore, I sought to test perceptual norms as a mechanism underlying these aftereffects. I predicted that exposure to hyper-masculine faces would attenuate bias against masculine targets but exposure to hyper-feminine faces would exacerbate bias against hyper-masculine targets, in part because perceptual gender norms would shift in the direction of adaptation.

Method.

Participants. Three hundred forty-seven Internet users from the United States (160 men, 193 women, 19 unreported) completed an online study. Participants were 36.30 years old on average (*SD* = 13.82 years), and most identified as White (76%) and 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 x 161 pixels at 72 pixels/inch). Research assistants gathered these faces via Internet searches for individuals who had extremely gendered appearances, who were not celebrities, and who had no visible facial hair or tattoos. This search 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*). Based upon these ratings, I selected the 7 most masculine and 7 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 the 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 (*1 = Very Masculine* to *10 = Very Feminine*). Importantly, the raters were highly consistent in their gender judgments ($ICC_{avg} = .97$), suggesting a high degree of consensus in the perception that the hyper-masculine men and women appeared more masculine than the hyper-feminine men and women.

Procedure. Internet users from Amazon Mechanical Turk completed a study about their perceptions of other people, with no mention of sex, gender, visual adaptation, or bias. After providing consent, participants were randomly assigned to rate either 6 of the male or 6 of the female faces described above (3 hyper-masculine, 3 hyper-feminine) across four items measured on 11-point sliding scales (*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. Participants repeatedly viewed either the 4 remaining hyper-feminine faces (*Feminine Adaptation*) or the 4 remaining hyper-masculine faces (*Masculine Adaptation*) from the sex category to which they were assigned for 3 seconds each for a total of 3 minutes. Thus, in contrast to my previous studies, the adaptation stimuli differed from the evaluation stimuli. Following adaptation, participants re-evaluated the same target faces from pretest on the scales described above (*Posttest*) before providing demographic information and completing the PAQ (Spence et al., 1975).

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, $\chi^2(1) = 2.67$, $p = .102$.

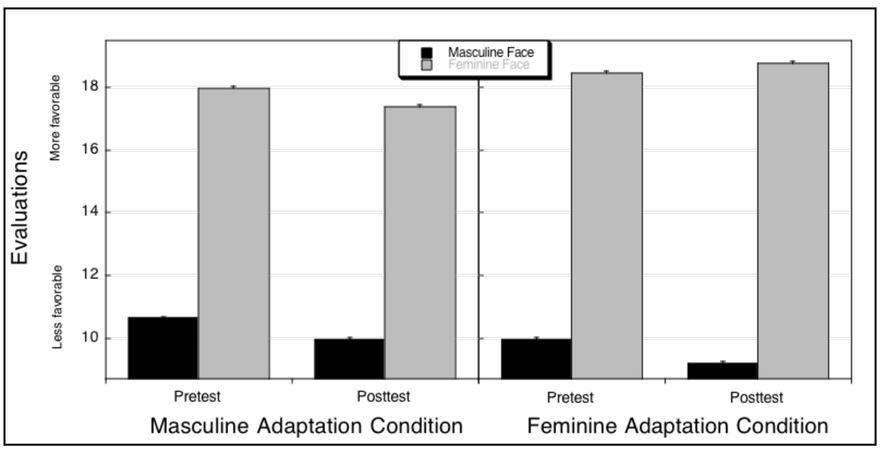
Results and Discussion.

My primary aim in Study 3 was to determine whether the adaptation effects I uncovered previously generalized to real faces and broader measures of social evaluation. Similar to Study 2, I predicted that perceivers would evaluate feminine faces more favorably than masculine faces at pretest. Moreover, I predicted that adaptation to feminine faces would exacerbate this bias against masculine targets whereas adaptation to masculine faces would attenuate it. Finally, I predicted that changes in perceptual gender norms as a function of adaptation would help to account for these evaluative shifts.

Because the target faces did not vary incrementally in gender typicality, I could not numerically code the faces as in the previous studies. Instead, I analyzed targets' gendered appearance based upon the ratings provided by independent coders (see *Stimuli* section; *1 = Very Masculine* to *10 = Very Feminine*). Specifically, I used the average gender score for each face as a continuous measure on which higher values indicated a more feminine appearance (mean-centered). The three evaluative items (attractiveness, likeability, desire for contact) showed high within-subject reliability ($R_C = 0.93$), so I 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). I 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) based upon participants' ratings of the averageness of each face for its sex category. Because participants evaluated the faces at two time points, I stacked these scores in the dataset and differentiated them with an effect-coded variable (*Test Period*; *-0.5 = Pretest, 0.5 = Posttest*). As before, the masculinity and femininity dimensions of the PAQ showed adequate reliability (Cronbach's α = .76 and .79, respectively), so I created continuous composite scores for each subscale. I examined demographic variables as described in Study 2, and again, I tested hypotheses using multilevel models to account for within-subject dependencies in the data.

Gender-related bias at pretest. First, I sought to replicate the finding that perceivers express bias against targets with hyper-masculine phenotypes. To do so, I 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. I decomposed the interaction by examining simple slopes for Gendered Features 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 than for 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, where the bias against masculine faces was stronger for men than women. The reason for this discrepancy is unclear, though it is worth reiterating that the simple effect was highly significant for both sexes, indicating a strong bias against hyper-masculine faces at pretest.

Visual adaptation influences gender-related biases. Next, I tested whether visual adaptation produced an aftereffect that reliably altered gender-related biases in social evaluation. To do so, I 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. I therefore collapsed across Target Sex and regressed Evaluations onto Gendered Appearance, Adaptation Condition, Test Period, and all interactions. The expected three-way interaction emerged, *B* = -0.24, *SE* = 0.11, *t* = -2.19, *p* = .029 (Figure 4).

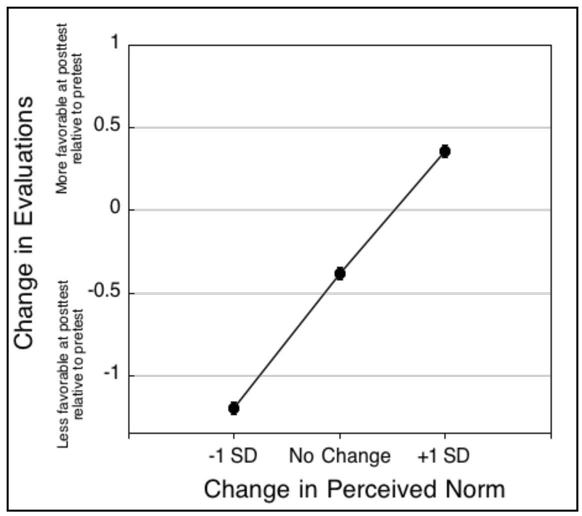


I decomposed the three-way interaction by examining simple slopes of Gendered Appearance, Test Period, and their interaction within the masculine and feminine adaptation conditions. In the masculine adaptation condition, the two-way interaction between Gendered Appearance and Test Period was not significant, *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 feminine targets more favorably than masculine targets, *B* = 1.48, *SE* = 0.06, *t* = 24.25, *p* < .001. At posttest, participants in the feminine adaptation condition were more biased, showing a stronger preference for feminine targets relative to masculine targets than they did at pretest, *B* = 1.70, *SE* = 0.06, *t* = 27.00, *p* < .001.

I tested the strength of these effects by controlling for demographic variables collected during the study. Specifically, I recalculated the regressions described above partialling 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 Gendered Appearance 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 evaluative aftereffects observed here. I first tested the association between perceived norms and evaluations by regressing Pretest Evaluations onto Pretest Perceptual Gender Norms. As expected, targets who appeared more normative were evaluated more favorably than targets who appeared less normative at pretest, *B* = 0.85, *SE* = 0.06, *t* = 15.31, *p* < .001. The same trend emerged when I regressed Posttest

Evaluations onto Posttest Perceptual Gender Norms: Targets who appeared more normative were evaluated more favorably than targets who appeared less normative at posttest, $B = 1.16$, $SE = 0.06$, $t = 19.46$, $p < .001$. In a third analysis, I restructured the dataset and created a Change in Evaluations variable (*Posttest Evaluations – Pretest Evaluations*) and a Change in Perceptual Norm variable (*Posttest Perceptual Gender Norm – Pretest Perceptual Gender Norm*). I then regressed Change in Evaluations onto Change in Perceptual Gender Norm. As faces were perceived as increasingly normative from pretest to posttest, they were also evaluated more favorably, $B = 0.39$, $SE = .04$, $t = 10.29$, $p < .001$ (Figure 5). Thus, changes in perceptual gender norms and social evaluations covaried, such that faces that appeared more normative were also evaluated more favorably following adaptation.



As a final test of whether changes in perceptual norms helped to explain the observed changes in evaluations following adaptation, I constructed series of nested regression models. First, I regressed Evaluations onto Gendered Appearance, Test Period, Adaptation Condition, and all interactions (Deviance = 27222.90). Next, I added Perceptual Gender Norms and all interactions to the model (Deviance = 26221.30). I then performed a likelihood ratio test on the deviance values from these two models, which assesses whether the inclusion of the new variable significantly improved model fit. As expected, the inclusion of Perceptual Gender Norms significantly improved the fit of the regression model linking visual adaptation to evaluations of gendered features, $X^2(7) = 1001.60$, $p < .001$. Accounting for shifts in perceptual norms therefore improved my ability to predict evaluative biases related to gendered facial features following visual adaptation.[7]

Study 3 partially replicated my previous findings by demonstrating that perceivers expressed evaluative biases against hyper-masculine men and women after mere glimpses at their faces, which worsened after adaptation to feminine faces. Unexpectedly, however, adaptation to masculine faces did not mitigate the bias against hyper-masculine targets. While it is difficult to interpret null findings, the non-significant effect in the masculine adaptation condition may have occurred for several reasons. First, the stimuli in Study 3 were less carefully controlled than the computer-generated stimuli in Studies 1 and 2. This leaves open the possibility that the masculine faces varied in ways the feminine faces did not, weakening the masculine adaptation effect. It is also possible that gendered features in the feminine faces were more extreme than gendered features in the masculine faces, improving the chances of obtaining a feminine adaptation effect in this study. 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). Thus, the feminine adaptation may have been stronger than the masculine adaptation, resulting in significant simple effects in the former condition but not the latter.

Despite the non-significant masculine adaptation effect, perceptual gender norms did help to explain changes in evaluative biases following feminine adaptation. In particular, I found that

[7] The likelihood ratio test allowed me to assess whether perceptual gender norms helped to explain links between visual adaptation and evaluative judgments while avoiding the drawbacks of a traditional mediation approach (e.g., concerns about causal directionality and distributional confusion with binary mediators). These drawbacks are compounded in cross-classified datasets, for which mediation models are not easily specified (Bauer, Preacher, & Gil, 2006). Thus, the likelihood ratio test provided a general test of mechanism that is more appropriate to the current data than a mediation model.

changes in perceptual norms predicted changes in evaluative biases related to gendered facial features. Accounting for these norm shifts reliably improved the fit of regression models predicting gender-related biases before and after visual adaptation to gendered facial features. Thus, while some caveats are in order, Study 3 provided initial evidence that adaptation effects can indeed emerge on broad measures of evaluative preference for real faces that vary naturally in their gendered phenotypes. Moreover, Study 3 highlighted shifting prototypes as a mechanism driving the evaluative aftereffect. These findings gesture toward the generalizability of visual adaptation as a method for understanding perceptual norms and evaluative biases related to gendered facial features.

Interim Summary

Thus far, Study Set 1 provided evidence in support of Hypotheses 1a and 1b. Using an established laboratory paradigm, I found that visual adaptation to highly gendered exemplars alters perceptual norms for men's and women's facial appearances and shifts evaluative biases related to gendered facial features. Although these findings were statistically robust and in line with my hypotheses, however, the paradigm itself was relatively low in ecological validity. To induce adaptation, participants were repeatedly exposed to highly gendered exemplars in rapid succession for several minutes. This method clearly demonstrated that visual adaptation calibrates perceptual norms and evaluative preferences related to gendered facial features, but how does visual adaptation function outside of the lab? Do perceivers' everyday visual experiences induce adaptation and arouse biases against people with certain phenotypes?

One aspect of social life that seems especially relevant to these questions is visual media. Indeed, contemporary western perceivers are inundated by visual media on their televisions, laptop computers, tablets, smartphones, and now watches (Featherstone, 2009; Hinckley, 2014;

Polivy & Herman, 2004). Even those who do not seek out popular media themselves are confronted with imagery on billboards along major highways, magazine covers in grocery store checkout lines, and advertisements posted around workplaces and universities. The omnipresence of visual media has led some theorists to claim that we are living in an "image economy," where patterns of preference and consumption are driven predominately by visual media (Schroeder, 2002).

The concept of image economy derives from research demonstrating that visual media are powerful stimuli impacting observers' cognitions and preferences (Zaltman, 1997). This link has been documented most extensively with regard to beauty ideals. Indeed, media representations of beauty covary with fashion trends in the population, such that men and women style themselves after the models they see in mainstream advertisements (Faludi, 1991; Freedman, 1986). Body ideals also track visual representations in popular media: 92% of women report feeling pressure to conform to the body shapes presented on mainstream television (Murray, Touyz, & Beumont, 1996), and self-reported exposure to media images of thinness predicts body dissatisfaction and eating disorder symptomatology among women (Stice et al., 1994; for a meta-analysis, see Grabe, Ward, & Hyde, 2008).

Although many theorists have implied a causal direction for these trends (i.e., media images transmit beauty ideals to viewers), this conclusion remains speculative given the correlational nature of the data. Moreover, research on the psychological impact of visual media is plagued by the absence of a testable theory for how media images alter phenotypic preferences and ideals in the population (Levine & Smolak, 1996; Thompson & Stice, 2001). The few theories that do exist offer abstract ideas about how media impacts perceptions of the self and others, but they fail to specify the proximal mechanisms by which media impacts phenotypic preferences. For example, Gerbner's (1969) Cultivation Theory proposes that media exposure accumulates over time so that perceivers eventually come to view media representations as social reality and therefore judge themselves and others on the basis of this presumed reality. Similarly, Stice and colleagues' (1996) Dual Pathway Model proposes that repeated exposure to extreme phenotypes in media causes perceivers to internalize those phenotypes as ideal, resulting in biases against those who deviate from the ideal. While certainly generative, both of these theories are concerned specifically with how media images affect self-perception, and neither of them offers a proximal explanation for how media images get "under the skull" to affect social evaluative judgments. Visual adaptation may help to fill this theoretical gap and explain how media images guide evaluative judgments of the self as well as others.

The data presented in Studies 1-3 suggest that repeated visual exposure to a specific phenotype causes that phenotype appear prototypical and ultimately arouses favorable evaluations of people who embody it. Thus, perceivers may adapt to the phenotypic features they see in popular media, ultimately viewing those features as normative and therefore evaluating them favorably. This process becomes problematic when some features are represented more than others. For example, thin bodies appear much more often than fat bodies in popular media: While 25% of women in the population are obese, only about 3% of women shown on television are obese (Greenberg et al., 2003). Conversely, about 5% of women in the population are underweight, but fully one-third of the women on television are underweight (Greenberg et al., 2003). Similar representational biases occur for gendered facial features. At least in western countries, female actresses, reporters, politicians, and models tend to embody hyper-feminine features (Carpinella & Johnson, 2013; Carter & Steiner, 2004; Collins, 2011; Heldman & Wade, 2011). The same is true among western men: Visual media rarely depict men who are hyper-masculine, but increasingly depict men who are somewhat feminized (Adams, 2011; Anderson, 2008; Anderson, 2009; Coad, 2008). Taken together, these factors produce an overrepresentation of feminine phenotypes in media, which may result in visual adaptations that favor feminized phenotypes over more masculine phenotypes in social evaluation. Put another way, the over-representation of feminine phenotypes in popular media mirrors visual adaptation paradigms at the population level. Over time, repeated exposure to such feminine phenotypes may cause perceivers to see those phenotypes as prototypical and subsequently evaluate them more favorably than masculine phenotypes. Studies 4 and 5 examined these possibilities, testing whether and how media exposure acts as a form of visual adaptation that calibrates perceptual norms and evaluative preferences for gendered facial features.

Study 4

Studies 1-3 showed that, under controlled laboratory conditions, visual adaptation reliably altered both perceptual norms and social evaluative biases related to gendered facial features. Study 4 began probing how these effects function in the real world, testing whether repeated exposure to hyper-feminized women in popular media predicts perceptual norms and evaluative biases related to women's gendered facial features. Specifically, Study 4 tested the evaluative impact of exposure to gendered imagery on magazine covers. I focused specifically on magazine covers because previous research has documented that they dramatically over-represent feminine women relative to masculine women (Berick-Aharony, 2013; Yan & Bissell, 2014), and at least one study indicated that visual representations in magazines are more strongly related to beauty ideals than are visual representations on television (Tiggemann, 2003). I predicted that perceivers reporting a great deal of exposure to magazines that depict hyper-feminine women would have more feminized facial norms and stronger biases against masculine women compared to perceivers reporting less exposure to such media.

Method.

Participants. One hundred eight undergraduates (20 men) from the University of California, Los Angeles completed the study (90% straight, 36% White, 39% Asian).

Stimuli. Stimuli included subsets of the computer-generated faces described in Studies 1 and 2. Because Target Sex did not moderate any of the effects in my initial studies, I restricted my focus to female faces for this study. Specifically, I used the randomly sorted arrays of 21 female faces that varied in their gendered appearance from Study 1, and I used five female faces that varied in their gendered appearance from hyper-masculine to hyper-feminine from Study 2.

Procedure. UCLA undergraduates were recruited for a study about their perceptions of other people, with no mention of sex, gender, media exposure, or bias. After providing consent, participants provided brief demographic information before completing three tasks in counterbalanced order. In one task, they identified the most average-looking woman from a randomly sorted array of 21 computer-generated female faces that varied in their gendered appearance, as described in Study 1. In another task, participants viewed 5 computer-generated female faces that varied systematically from hyper-masculine to hyper-feminine in random order, and they evaluated each one on four 9-point scales, indicating each woman's attractiveness, each woman's warmth, their desire for future contact with each woman, the overall positivity of their first impression of each woman. In a third task, participants responded to three questions probing their exposure to magazines depicting hyper-feminine models on the cover. In the first question, participants were provided a list of magazines geared toward their sex that tend to show hyper-feminine models on the cover, and they were asked to mark all of the title that they had read at least once in the past year. For men, the magazine titles were *Maxim, Esquire, Playboy,* *Penthouse, GQ, Mob Candy, Open Your Eyes, Smooth,* and *Sylk.* For women, the magazine titles were *InStyle, Glamour, Marie Claire, Women's Health, Women's Weekly, Cosmopolitan, Vogue, Shape, Redbook, Women's Day, Elle, Ladies' Home Journal, Good Housekeeping, Vanity Fair,* and *Prevention*. Next, participants reported the average number of hours they spend each week reading these magazines. Finally, participants reported how often they read such magazines (*1 = not at all often* to *7 = very often*). After completing all of these tasks, participants were debriefed.

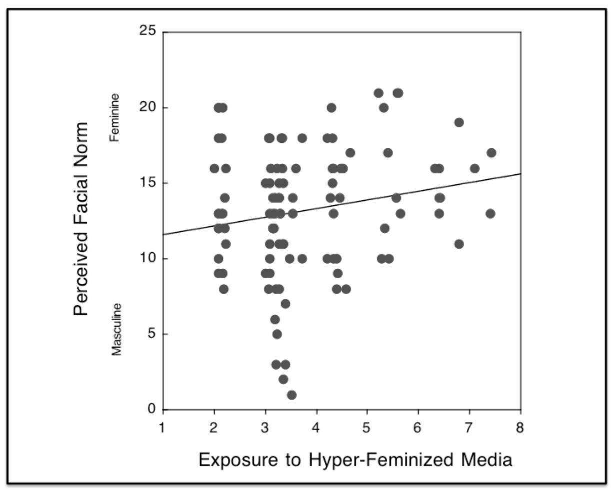
Results and Discussion.

My primary aim in Study 4 was to determine whether exposure to magazines depicting hyper-feminine women mirrored the effect of adaptation to hyper-feminine faces from laboratory studies. I predicted that perceivers who reported more exposure to magazines depicting hyper-feminine models would have more feminized perceptual norms and stronger evaluative biases against women with masculine facial features compared to those reporting relatively less exposure to magazines depicting hyper-feminine models.

Because the target faces varied incrementally in gender typicality, I numerically coded each face to indicate targets' gendered appearances (*1 = hyper-masculine* to *5 = hyper-feminine*; hereafter, *Gendered Appearance*). Similarly, I coded the faces in the array from which participants chose the average woman's phenotype from 1 (*hyper-masculine*) to 21 (*hyper-feminine*; hereafter, *Perceptual Gender Norm*). I computed within-subject reliability for the four evaluative items using the method described by Cranford et al. (2006), which revealed high reliability ($R_C = .96$). Therefore, I summed the items into a continuous composite score on which higher values indicated more favorable evaluations (*Min* = 4.00, *Max* = 36.00, *M* = 19.27, *SD* = 7.31; hereafter *Evaluations*).

The media exposure items were on different scales, so I standardized each response by transforming it to a *z*-score prior to analysis. Responses to these items were highly correlated (all *p*s < .005), and a factor analysis with varimax rotation revealed that all three items loaded onto a single factor that explained 61% of the variance in responses (factor loadings > 0.62). Therefore, I summed the items scores into a continuous composite score on which higher values indicated greater self-reported exposure to media depicting hyper-feminized women (*Min* = -2.74, *Max* = 7.88, *M* = 0.00, *SD* = 2.32; hereafter, *Exposure to Feminized Media*).[8] I used this score to predict perceptual gender norms and evaluative biases against masculine women.

Media exposure predicts perceptual gender norms for female faces. First, I tested whether perceivers who reported more exposure to magazines depicting hyper-feminine women had more feminized perceptual norms for female faces compared to perceivers who reported less exposure to such media. To do so, I calculated the bivariate Pearson correlation between Perceptual Gender Norm and Exposure to Feminized Media. As expected, perceivers who reported more exposure to magazines depicting hyper-feminine women also reported a more feminized face as appearing normative for women, $r(108) = 0.19$, $p = .022$, one-tailed (Figure 6).[9]

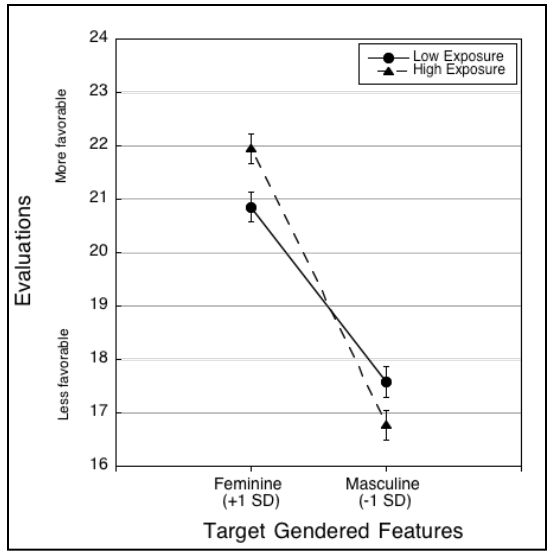


Media exposure predicts gender-related biases. Next, I tested whether perceivers who reported more exposure to magazines depicting hyper-feminine women displayed stronger biases against masculine women compared to perceivers who reported less exposure to such media.

[8] I created this composite by summing *z*-scores for each item, which explains why the mean is zero and the minimum is a negative value.

[9] Throughout this manuscript, I report one-tailed tests for analyses involving a priori directional hypotheses. All other tests are two-tailed.

Because perceivers provided multiple evaluations of multiple targets, I conducted this analysis using multilevel regression models to account for the nested data structure. Specifically, I regressed Evaluations onto Exposure to Feminized Media, Gendered Appearance, and their interaction. The expected two-way interaction emerged, $B = 0.18$, $SE = 0.08$, $z = 2.27$, $p = .024$. Participants generally evaluated feminine women more favorably than masculine women, but this bias was stronger among those who reported more compared to less consumption of media portraying hyper-feminine women, *B*s = 1.90 and 1.07, *SE*s = 0.28 and 0.28, *z*s = 6.73 and 3.84, *p*s < .001 (Figure 7).



Perceptual norms and gender-related biases. Finally, I sought to replicate previous findings linking perceptual gender norms to gender-related evaluative biases. Based upon results from Studies 2 and 3, I predicted that perceivers who chose a more feminine face as appearing normative would demonstrate stronger biases against masculine women compared to perceivers who chose a more masculine face as appearing perceptually normative. To test this possibility, I used multilevel modeling to regress Evaluations onto Gendered Appearance, Perceptual Gender Norm, and their interaction. The expected two-way interaction emerged, $B = -0.12$, $SE = 0.06$, $z = -1.97$, $p = .049$. Perceivers generally evaluated masculine women less favorably than feminine women, but this bias was notably stronger among those who indicated a more feminine perceptual norm for women's faces compared to a more masculine perceptual norm for women's faces, *B*s = 1.99 and 0.98, *SE*s = 0.32 and 0.34, *z*s = 6.14 and 2.88, *p*s < .001 and = .004.

Study 4 provided preliminary evidence for the real-world impact of visual adaptation. Compared to perceivers who reported relatively little consumption of magazines that depict hyper-feminine women on the cover, perceivers who reported more consumption of such media had more feminized perceptual norms for women's faces and stronger evaluative biases against women who departed from those norms (i.e., women with masculine facial features). These findings mirror the feminine adaptation effects from the laboratory in Studies 2 and 3. The over-representation of feminine phenotypes in popular media may therefore act as a form of visual adaptation that makes feminine phenotypes appear prototypical and arouses evaluative biases against women with more masculine phenotypes.

Study 5

Study 4 provided evidence for the emergence of evaluative aftereffects in vivo, highlighting links between perceivers' consumption of media depicting hyper-feminized women and both perceptual norms for women's facial appearance and evaluative biases against masculine women. However, the findings relied on self-reports of media exposure, which obscure the causal direction of the effects and leave open the possibility that perceivers who have feminized perceptual norms or strong biases against masculine women to begin with choose to consume media that depict hyper-feminine women (rather than vice-versa). Moreover, self-reports of media consumption do not necessarily indicate aftereffects related to visual adaptation – magazines that visually represent hyper-feminine women on the cover may also espouse gender normative ideals via written content, which could alter perceivers' evaluative biases related to gendered facial features. Study 5 sought to address these concerns by experimentally exposing perceivers to real magazine covers and testing the impact of such visual exposure on evaluative biases related to women's gendered facial appearance.

Method.

Participants**.** One hundred eighty-seven undergraduates from the University of California, Los Angeles completed the study (94% straight, 22% male, 35% White, 39% Asian).

Stimuli. Test stimuli included the same five computer-generated female faces described in Study 4, which varied systematically in their gendered appearance from hyper-masculine to hyper-feminine. Adaptation stimuli were 60 images cropped from the covers of popular magazines. Thirty of these images depicted the head and torso of hyper-feminized women (5 each from *Cosmopolitan*, *Esquire*, *Glamour*, *InStyle*, *Marie Claire*, and *Maxim*). The other thirty images depicted non-human objects featured on magazine covers (e.g., desserts, room décor; 5 each from *Better Homes and Gardens, The New Yorker, Family Circle, Reader's Digest, Real Simple,* and *Time*).

Procedure. The procedure followed a pretest / posttest design similar to Study 2. At pretest, participants saw a series of 5 female faces that varied systematically in their gendered features from hyper-masculine to hyper-feminine, and they evaluated each one on four 9-point scales, indicating each woman's attractiveness, each woman's warmth, their desire for future contact with each woman, the overall positivity of their first impression of each woman. Next, participants were randomly assigned to one of two adaptation conditions in which they either viewed the 30 hyper-feminine images or the 30 control images from magazine covers for 3 seconds each for a total of 3 minutes. Finally, participants completed the same evaluative judgments from pretest at posttest before providing demographic information and being debriefed.

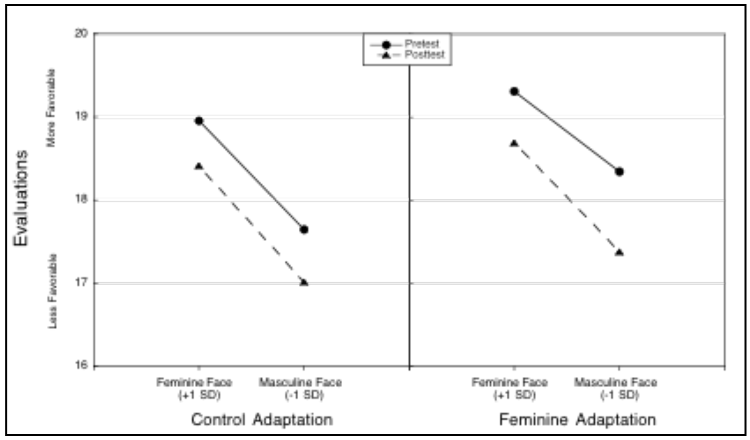
Results and Discussion.

My primary aim in Study 5 was to determine whether repeated exposure to images taken from popular magazine covers results in the evaluative aftereffects demonstrated in Studies 2 and 3. I predicted that perceivers would evaluate masculine women less favorably than feminine women at pretest, but that this bias would change as a function of visual adaptation. Specifically, I predicted that perceivers exposed to magazine covers depicting hyper-feminine women would show greater bias against masculine women at posttest relative to pretest, whereas perceivers exposed to magazine covers depicting control images would show no change in their bias against masculine women at posttest relative to pretest.

Because the target faces varied incrementally in gender typicality, I numerically coded each face from 1 (*hyper-masculine*) to 5 (*hyper-feminine*) in order to quantify their gendered features. I analyzed targets' gendered appearances continuously based upon this interval scale (hereafter, *Gendered Appearance*). I computed within-subject reliability for the four evaluative items using the method described by Cranford et al. (2006), which revealed acceptable reliability ($R_C = .89$). I therefore summed the items into continuous composite scores on which higher values indicated more favorable evaluations at pretest (*Min* = 4.00, *Max* = 36.00, *M* = 18.56, *SD* = 6.96; hereafter, *Pretest Evaluations*) and posttest (*Min* = 4.00, *Max* = 36.00, *M* = 17.87, *SD* = 7.55; hereafter, *Posttest Evaluations*). Because participants evaluated the faces at two time points, I again stacked evaluations in the dataset and differentiated them with an effect-coded variable (*Test Period*; *-0.5 = Pretest, 0.5 = Posttest*). I also effect-coded Adaptation Condition prior to analysis (*-0.5 = Control Adaptation, 0.5 = Feminine Adaptation*). I tested my hypotheses using multilevel regression models to account for within-subject dependencies in the data.

Gender-related bias at pretest. First, I tested whether perceivers expressed evaluative biases related to women's gendered facial features. To do so, I regressed Pretest Evaluations onto Gendered Appearance. As expected, feminine women were evaluated more favorably than masculine women at pretest, $B = 1.14$, $SE = 0.11$, $z = 10.15$, $p < .001$.

Visual adaptation influences gender-related biases. Next, I tested whether visual adaptation reliably altered these gender-related biases in social evaluation. To do so, I regressed Evaluations onto Gendered Appearance, Adaptation Condition, Test Period, and all interactions. The three-way interaction was not significant, $B = 0.25$, $SE = 0.20$, $z = 1.23$, $p = .217$ (Figure 8).



Importantly, however, this interaction had less power to detect an effect than those in my prior studies due to the experimental design: Rather than adapting perceivers to hyper-feminine exemplars in one condition and hyper-masculine exemplars in the other, Study 5 adapted half of the perceivers to hyper-feminine exemplars and the other half of the perceivers to control images. Thus, because the adaptation stimuli were not on opposite ends of the gender continuum (hyper-feminine and hyper-masculine), the interaction effect I observed in Study 2 was likely diluted in Study 5. Moreover, recent suggestions advise against data analyses driven entirely by *p*-values, advocating instead for exploration of predicted effects even in the face of interactions that do not reach arbitrary levels of statistical significance (Cumming, 2014). For these reasons, I decomposed the interaction to determine whether the feminine adaptation condition had the expected effect.

In the control condition, the two-way interaction between Test Period and Gendered Features was not significant, $B = 0.09$, $SE = 0.14$, $z = 0.65$, $p = .518$. As expected, the evaluative bias against masculine female faces was similar in magnitude at posttest, $B = 1.40$, $SE = 0.18$, $z =$

7.65, $p < .001$, and pretest, $B = 1.32$, $SE = 0.15$, $z = 8.68$, $p < .001$. In the feminine adaptation condition, however, the two-way interaction between Test Period and Target Gender was significant, $B = 0.34$, $SE = 0.15$, $z = 2.22$, $p = .027$. Moreover, the simple simple effect of Test Period was as predicted: The evaluative bias against masculine female faces was larger at posttest, $B = 1.31$, $SE = 0.21$, $z = 6.27$, $p < .001$, relative to pretest, $B = 0.97$, $SE = 0.17$, $z = 5.90$, $p < .001$.

Study 5 provided additional evidence for the impact of visual adaptation to gendered facial cues contained in popular media. Perceivers who adapted to images of hyper-feminine women taken from the covers of popular magazines exhibited more bias against masculine faces after exposure than before. Perceivers who adapted to control images taken from the covers of popular magazines (e.g., home décor) showed no significant change in their evaluations of masculine women from pretest to posttest. These findings augment the self-report data from Study 4 to indicate that the over-representation of feminine women in media can act as a form of visual adaptation at the societal level, giving rise to evaluative biases against masculine women.

General Discussion

Overall, Study Set 1 revealed that visual adaptation calibrates perceptual gender norms for faces as well as evaluative biases related to gendered facial features. Study 1 revealed that adaptation to hyper-masculine facial features caused masculine faces to appear increasingly normative, whereas adaptation to hyper-feminine facial features caused feminine faces to appear increasingly normative. These shifts in perceptual norms were accompanied by shifts in evaluative judgments related to gendered facial appearance: In Study 2, adaptation to hyper-masculine facial features reduced an established bias against masculine targets, but adaptation to hyper-feminine facial features exacerbated it. This pattern of effects replicated with a different set of evaluative judgments and real faces in Study 3, although the masculine adaptation effect did not reach conventional levels of statistical significance. It bears noting that all of the above effects were robust after controlling for a host of potentially confounding factors (e.g., perceivers' gender schemas). Therefore, as predicted, visual adaptation altered perceptual norms and evaluative judgments related to gendered facial features.

Study Set 1 also provided preliminary evidence for the emergence of evaluative aftereffects in vivo. Specifically, Studies 4 and 5 revealed that over-representations of certain phenotypes in popular media may act as a form of visual adaptation that guides evaluative biases related to gendered phenotypes. In Study 4, participants who reported more consumption of magazines featuring hyper-feminine women on the cover indicated more feminized perceptual norms for women's faces and stronger biases against masculine women compared to participants who reported less consumption of magazines featuring hyper-feminine women on the cover. Study 5 provided causal evidence for such media-driven visual adaptation using an experimental paradigm: Perceivers who adapted to images of hyper-feminine women taken from the covers of popular magazines demonstrated stronger biases against masculine women compared to perceivers who adapted to control images taken from other popular magazines. Thus, the aftereffects observed in Studies 1-3 are not restricted to laboratory experiments with tightly controlled stimuli; media images that perceivers encounter on a daily basis mold their norms for women's facial appearances and their judgments of women who deviate from those norms.

Altogether, the primary contribution of these studies is a new framework for understanding the perceptual underpinnings of impression formation. Specifically, the findings suggest that prototypes for a given social category change based on a perceiver's visual experiences with members of that category. In the case of gender, perceivers who encounter highly feminine phenotypes develop feminized facial norms, whereas those who encounter masculine phenotypes develop masculinized facial norms. Furthermore, because perceivers tend to prefer targets who appear prototypical, these shifts in perceptual norms predict evaluative biases against individuals with non-prototypical features. Researchers have long known that perceivers tend to prefer prototypical exemplars to more unique exemplars of a given category (Gordon & Holyoak, 1983; Perry, 1994; Posner & Keele, 1968), but the factors that influence perceptual norms themselves have remained relatively unclear. Study Set 1 augments prior knowledge by demonstrating that perceptual norms are calibrated on the basis of visual exposure, with notable implications for social evaluation.

Aside from these general contributions, Study Set 1 has more specific implications for established theories of impression formation. For example, classic studies demonstrated that repeated exposure to a stimulus increases liking for that stimulus (mere exposure; Zajonc, 1968), and more recent work extended these effects to social stimuli (Dasgupta & Greenwald, 2001; Mutz & Goldman, 2010; Schiappa et al., 2005). Despite a longstanding theoretical focus on exposure as a method of attitude change, 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.

Furthermore, proponents of contact theory have long argued that repeated encounters with members of a stigmatized group reduce prejudice against other members of that group (Pettigrew & Tropp, 2006). While classic theories proposed 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; Gómez, Tropp, & Fernández, 2011; Wright, Aron, McLaughlin-Volpe, & Ropp, 1997). The current work implicates visual adaptation as a proximal mechanism underlying the benefits of interpersonal contact. In particular, my findings suggest that perceivers visually adapt to others' facial features, making those features appear normative and subsequently leading to favorable social evaluations. Although higher-level psychological processes 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 recent why vicarious contact can effectively reduce prejudice. As such, Study Set 1 addresses recent calls for a deeper understanding of the proximal mechanisms underlying established methods of prejudice reduction (Dovidio, Eller, & Hewstone, 2011).

In terms of practical application, Study Set 1 suggests that perceptual interventions may be viable method of reducing interpersonal bias. Indeed, the above results suggest that visual exposure may act as a quick and cost-effective means of altering prejudicial attitudes against some groups. Deliberately exposing people to more diverse visual representations 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.

Although Studies 1-5 generally supported my hypotheses, several caveats deserve empirical attention in the near future. First, all of these studies relied on explicit evaluations, so it remains unclear whether visual adaptation alters more implicit forms of bias related to gendered facial features. This issue is especially important because implicit biases are more resistant to change than explicit biases (Fazio & Olson, 2003), yet they still have implications for prejudice and discrimination (Greenwald et al., 2014). In the future, studies that test the impact of visual adaptation on less controllable forms of bias will be critical to understand the breadth of adaptation's impact on social evaluation. A second point is that Studies 1-5 used adapting stimuli that were extreme in their gendered phenotypes. In everyday life, however, perceivers encounter the full range of gendered phenotypes, ranging from extreme to more moderate features. Future studies should test whether exposure to moderate exemplars dilutes the effect of adaptation to extreme exemplars, which will have implications for the strength and significance of evaluative aftereffects as they occur outside the lab. Finally, perceivers in these studies made evaluative judgments of faces that varied quite clearly in their gender typicality. Although perceivers did not make explicit ratings of each target's sex or gender, it seems likely that categories of sex and gender were made salient by the stimuli themselves. What impact does this task context have on emergence of evaluative aftereffects? If perceivers were asked to categorize these targets along some orthogonal dimension – for example, race – would adaptation to gendered features still impact evaluations? Moving forward, it will be critical to probe how task context moderates the evaluative effects of adaptation to a given phenotype, as these contexts may provide some clues about the situations in which adaptation will and will not impact social evaluations.

These points notwithstanding, Study Set 1 affords several conclusions. People form impressions of others based upon the perceived normativity of their gendered facial features, which is determined in part by their recent visual experience. Features with which perceivers have relatively limited experience (e.g., hyper-masculine faces) appear non-normative and tend to be evaluated negatively, whereas features with which perceivers have relatively more experience (e.g., hyper-feminine faces) appear normative and tend to be evaluated favorably. The process of visual adaptation therefore helps to explain why perceivers tend to prefer women whose facial appearance is similar to the models featured in popular media. Moreover, this process can be harnessed in order to alter those preferences. As such, the current studies offer the optimistic conclusion that manipulating the composition of one's visual environment may be a reliable method of combating social biases related to gendered facial appearance.

Study Set 2

Visual Adaptation Alters Weight Bias by Shifting the Threshold for Fat Categorization

Study Set 1 revealed that visual adaptation shifts perceptual norms and evaluative biases related to men's and women's gendered facial appearances. While the findings were largely in line with my hypotheses, however, gendered facial cues are not the only phenotypic features that inform social evaluations; body cues sometimes rival facial cues in their importance for impression formation (Aviezer, Trope, & Todorov, 2012). Indeed, weight bias – defined here as the negative evaluation of individuals perceived to have high body mass and the idealization of individuals perceived to have low body mass – pervades employment settings (Roehling, Roehling, & Pichler, 2007), healthcare institutions (Foster et al., 2003), schools (Puhl & Latner, 2007), and intimate relationships (Puhl & Brownell, 2006).[10] Such widespread bias is concerning because it portends negative outcomes for millions of people. For example, experiences with weight bias are associated with healthcare underutilization (Meisinger, Heier, & Loewel, 2004), poor mental and physical health (Hunger & Major, 2014), and maladaptive cardiovascular functioning (Matthews, Solomon, Kenyon, & Zhou, 2005) among fat individuals.

In spite of its consequences, theoretical accounts of the formation of weight bias trail behind work with other stigmatized identities, such as sex, race, and sexual orientation (Puhl & Brownell, 2001). Early research suggested that evolutionary pressures for high-quality mates shape preferences for women with small waist-to-hip ratios (Singh, 1993), but a re-examination of those data reveals that the effect of waist-to-hip ratio on attractiveness judgments was eclipsed by the effect of body mass. Indeed, although attractiveness judgments varied as a function of

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[10] I use the term fat not as a pejorative, but as a neutral descriptor that reflects natural variation in body weight, akin to the terms "tall" and "short" (Crandall, 1994). I deliberately avoid the terms overweight and obese because they have specific medical definitions based upon body mass index (BMI) categories outlined by the World Health Organization, and also because many people find them more stigmatizing than the term "fat" (Vartanian, 2010a).

waist-to-hip ratio, slender female figures were consistently rated as more attractive, healthier, and more desirable than heavy female figures (Singh & Young, 1995). In fact, the effect of body mass was so strong that the evaluative benefit of a small waist-to-hip ratio disappeared entirely for heavy women: When perceivers were asked to rank female bodies in terms of their attractiveness, heavier figures were never selected as maximally attractive, even when they had small waist-to-hip ratios (Singh, 1993, Study 1). All of this is to say that body mass strongly guides social evaluations, and researchers have only recently begun to consider how and why this is true. Still, existing work on this topic has made several important points. For example, weight bias stems in part from blaming fat individuals for their stigma, with perceivers believing that fat individuals can or should change their body weight with behavioral modification (e.g., diet/exercise; Crandall, 1994; Puhl & Brownell, 2003; Weiner, Perry, & Magnusson, 1988). Other research has documented robust links between weight bias and disgust sensitivity (Neel, Neufeld, & Neuberg, 2013), revealing that people who express high levels of weight bias also report feeling disgusted by the appearance of fat individuals (Lieberman, Tybur, & Latner, 2012; Park, Schaller, & Crandall, 2007; Vartanian, 2010b).

Although these contributions shed light on some of the psychological correlates of weight bias, other pathways are sure to exist. I propose that visual adaptation represents one such pathway. To the extent that perceivers are visually exposed to thin bodies, they may come to prefer those bodies and express biases against people with higher body mass. Specifically, this process may occur due to shifting category thresholds: As perceivers gain exposure to fat bodies, their threshold for categorizing others as fat may be heightened, making it less likely that subsequently encountered targets will experience prejudice related to the perception they are fat. Study Set 2 tested this idea directly, applying the findings from my initial studies to augment scientific understanding of the psychological antecedents of evaluative biases related to body weight. I predicted that visual adaptation would shift perceivers' category threshold for fatness (Hypothesis 2a), which would result in more favorable evaluative judgments of targets whose bodies appear similar to the adapting images (Hypothesis 2b).

Study 6

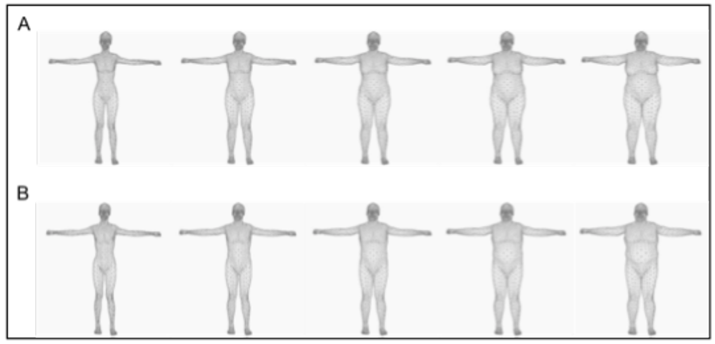
In Study Set 1, visual adaptation altered the prototypicality of gendered facial features and therefore enhanced evaluative judgments of targets who shared features with the adapting stimuli. But prototypicality may not be the only mechanism by which visual adaptation enhances social evaluations; previous work indicated that visual adaptation can also alter the threshold for categorization along a given dimension. For example, adaptation to male faces causes perceivers to categorize androgynous faces as female (and vice-versa; Webster et al., 2004). To the extent that visual adaptation alters category representations in such a way that stops some targets from being included in a stigmatized group, then it may alter patterns of prejudice expression. Study 6 began exploring this possibility by testing whether and how visual adaptation affects a form of body categorization known to have social consequences – labeling others as fat. A recent longitudinal study found that adolescent girls who reported being labeled as fat during childhood had higher odds of becoming obese 9 years later after controlling for initial BMI (Hunger & Tomiyama, 2014). Study 6 therefore tested whether visual adaptation alters perceivers' mental representation of the category fat. I predicted that perceivers would have a lower threshold for fat categorization following adaptation to thin bodies but a higher threshold following adaptation to fat bodies.

Method.

Participants. One hundred eighty-nine Internet users (86 men) completed the study (M_{Age}

= 38.47 years, M_{BMI} = 26.89, 90% straight, 78% White).

Stimuli. Stimuli were 34 mesh frame bodies facing forward with arms outstretched (17 men, 17 women; PerceivingSystems, 2011; Figure 9). The stimuli were standardized for height but varied systematically in BMI based upon three-dimensional scans of human bodies (*$Minimum_{BMI}$ = 14, $Maximum_{BMI}$ = 46*).



Procedure. Internet users from Amazon Mechanical Turk completed a study about their perceptions of other people, with no mention of weight, visual adaptation, or bias. After providing consent, participants were randomly assigned to evaluate either male or female bodies.[11] Participants first identified the threshold at which they would categorize a person as fat ("the point at which a person goes from belonging to the category 'thin' to the category 'fat'") from an array of all 17 male or female bodies arranged in order of increasing BMI (*Pretest*). After indicating their fat category threshold, participants were randomly assigned to one of two adaptation conditions in which they viewed the three thinnest bodies (*Thin Adaptation*) or the three fattest bodies (*Fat Adaptation*) from the sex category to which they were assigned. Adaptation images were repeatedly displayed for three seconds each for three minutes total.[12] Following adaptation, participants again identified the threshold at which they would categorize a person as fat (*Posttest*). Finally, participants completed individual difference measures of anti-

[11] Target Sex did not moderate any effects reported here (see below), so I collapse across male and female bodies for all analyses.

[12] As before, the adaptation stimuli included ten bodies marked with a yellow circle presented at random intervals throughout the adaptation period. Participants were instructed to press enter as quickly as possible when one of these marked bodies appeared on the screen. I did not record the speed with which participants identified the marked bodies; I used this task to ensure that participants remained visually engaged throughout the adaptation period.

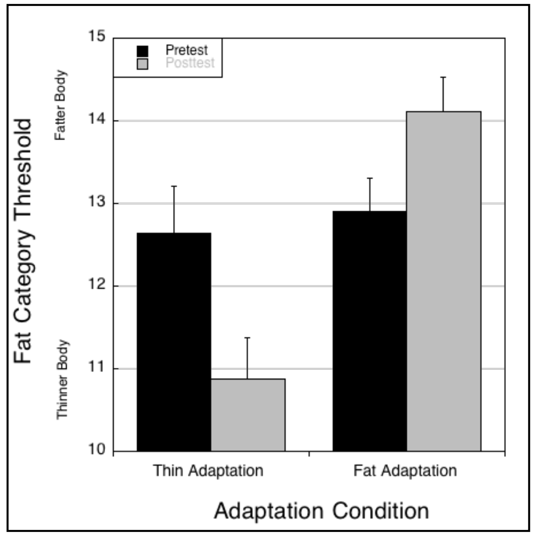
fat attitudes (dislike subscale of the Anti-Fat Attitudes Scale; Crandall, 1994), implicit theories about the controllability of body weight (Burnette, 2010), appearance-related self-esteem (Appearance Subscale of State Self-Esteem Scale; Heatherton & Polivy, 1991), and demographics including sex, age, race, education, sexual orientation, height, weight, and perceived weight status (*1=very underweight* to *7=very overweight*) before being debriefed.

In total, 86 participants evaluated male bodies (39 thin adaptation, 47 fat adaptation) and 103 participants evaluated female bodies (46 thin adaptation, 57 fat adaptation). A chi-square test revealed that the number of participants did not differ across these four cells, $\chi^2(1) = 0.01$, $p = .924$.

Results and Discussion.

I tested my hypotheses using multilevel regression models to account for within-subject dependencies in the data. Specifically, I stacked threshold ratings and differentiated them with an effect-coded variable (*Test Period*; *-0.5 = Pretest, 0.5 = Posttest*). I numerically coded the stimuli from 1 (*lowest BMI*) to 17 (*highest BMI*) to quantify their body mass (hereafter, *Fat Category Threshold*), and I effect-coded Adaptation Condition (*thin adaptation = -0.5, fat adaptation = 0.5*). Scores on measures of anti-fat attitudes, state self-esteem, and implicit weight theories were internally consistent (Cronbach's αs = .91, .92, and .91), so I summed the items into continuous composite scores on which higher values indicated stronger anti-fat bias, appearance-related self-esteem, and beliefs in the fixed nature of body weight, respectively. I computed each participant's BMI (weight (kg) / $[\text{height (m)}]^2$) and coded their perceived weight status continuously based upon self-report. Below, I report unstandardized coefficients for all regression models, which indicate effect size in terms of the expected increase in the dependent variable given a one-unit increase in the independent variable.

Visual adaptation and fat category thresholds. To test whether visual adaptation altered perceptual thresholds for fat categorization, I regressed Fat Category Threshold onto Adaptation Condition, Test Period, and their interaction. The expected two-way interaction emerged, B = 2.98, SE = 0.45, z = 6.61, p < .001. In the thin adaptation condition, participants chose a lower threshold for fat categorization at posttest (M_{BMI} = 35) relative to pretest (M_{BMI} = 37), B = -1.76, SE = 0.33, z = -5.41, p < .001. In the fat adaptation condition, participants chose a higher threshold for fat categorization at posttest (M_{BMI} = 38) relative to pretest (M_{BMI} = 37), B = 1.22, SE = 0.31, z = 3.91, p < .001 (Figure 10).



Moderating effects of perceiver characteristics. Visual adaptation effects represent relatively low-level perceptual phenomena, so I did not expect perceiver-level factors to moderate the findings described above. Still, in all of the studies reported in Study Set 2, I probed the effects of individual differences that have been linked to weight bias in prior research. For example, most of the studies test the impact of measures of participants' global anti-fat attitudes (Crandall, 1994) and perceived weight status (e.g., BMI). In addition to these measures, I also included measures tapping perceivers' lay theories about the controllability of weight (Burnette, 2010) in Study 6, as previous research has shown that perceivers who believe weight is malleable are especially likely to express weight bias. Although I did not have strong a priori hypotheses about the effects of these individual differences on the aftereffects of primary interest, I tested for moderation in an exploratory fashion and present the results to inform future research endeavors.

To test whether the perceptual shifts that occurred as a function of visual adaptation were moderated by perceiver-level factors in Study 6, I regressed Fat Category Thresholds onto Adaptation Condition, Test Period, each of the potential moderators (separately), and all interactions. The three-way interactions that would indicate moderation were not statistically reliable for target sex, $B = 0.02$, $SE = 0.90$, $z = 0.03$, $p = .997$, anti-fat attitudes, $B = -0.02$, $SE = 0.05$, $z = -0.39$, $p = .694$, implicit weight theories, $B = 0.05$, $SE = 0.09$, $z = 0.61$, $p = .542$, or perceived weight status, $B = -0.48$, $SE = 0.38$, $z = -1.25$, $p = .212$.

The three-way interaction was reliable for perceiver BMI, $B = -0.17$, $SE = 0.06$, $z = -2.65$, $p = .008$, 95% CI [-0.29, -0.04]. The focal two-way interaction between Adaptation Condition and Test Period was significant and in the same direction for participants with both low and high BMIs (± 1 SD), but the effect was more than twice as large among perceivers with low BMIs, *B*s = 4.01 and 1.92, *SE*s = 0.64 and 0.54, *z*s = 6.31 and 3.53, *p*s < .001, respectively.

The three-way interaction was also reliable for appearance-based self-esteem, $B = 0.19$, $SE = 0.07$, $z = 2.70$, $p = .007$. Again, the focal two-way interaction between Adaptation Condition and Test Period was significant and in the same direction for participants with both high and low appearance-based self-esteem (± 1 SD), but the effect was more than twice as large among those with high appearance-based self-esteem, *B*s = 4.00 and 1.89, *SE*s = 0.67 and 0.52, *z*s = 6.01 and 3.68, *p*s < .001, respectively.

As an additional test of the robustness of the adaptation effect, I included all of the potential moderators and demographic variables collected during the study as control variables in a regression equation linking Fat Category Threshold to Adaptation Condition, Test Period, and their interaction. That is, I recalculated the regressions described above after partialling out the effects of participant sex, age, race, sexual orientation, education, anti-fat attitudes, state self-esteem, implicit weight theories, perceived weight status, and BMI. After accounting for these factors, the two-way interaction between Adaptation Condition and Test Period remained significant and of similar magnitude as before, $B = 2.90$, $SE = 0.46$, $z = 6.33$, $p < .001$. Moreover, the simple effect of Test Period remained significant in both the thin and fat adaptation conditions, *B*s = -1.72 and 1.19, *SE*s = 0.32 and 0.32, *z*s = -5.32 and 3.67, *p*s < .001, respectively.

In summary, perceivers' thresholds for categorizing others as fat varied as a function of visual exposure: Adaptation to thin bodies led participants to identify a lower threshold for fat categorization whereas adaptation to fat bodies led participants to identify a higher threshold for fat categorization. These effects were relatively impervious to perceiver-level factors. Although adaptation had especially pronounced effects among perceivers with low BMI and high appearance-related self-esteem, these effects were not hypothesized a priori, so I hesitate to interpret them without replication. Moreover, simple effects remained directionally consistent and statistically robust in all subgroups of participants. In fact, the adaptation effects of primary theoretical interest were robust even after controlling for all demographic and individual difference measures collected during the study. Perceivers' thresholds for fat categorization were therefore calibrated based upon recent visual exposure to thin and fat bodies.

Study 7

In Study 6, visual adaptation shifted perceivers' thresholds for fat categorization. These thresholds are presumably related to weight bias, insofar as perceivers are unlikely to express prejudice against someone they do not categorize as fat. Study 7 tested this notion by assessing whether visual adaptation alters social evaluations related to body weight. I predicted that exposure to thin bodies would exacerbate weight bias due to a downward shift in the fat categorization threshold but that exposure to fat bodies would mitigate weight bias due to an upward shift in the fat categorization threshold. That is, visual adaptation should affect weight bias by altering perceivers' threshold for categorizing others as fat.

Method.

Participants. Two hundred forty-six Internet users (88 men) completed the study (M_{Age} = 37.89 years, M_{BMI} = 27.26, 93% straight, 80% White).

Stimuli. Stimuli were identical to Study 6 with one exception: The bodies were shown in profile to test the generalizability of the above findings across visual vantages.

Procedure. Internet users from Amazon Mechanical Turk completed a study about their perceptions of other people, with no mention of weight, visual adaptation, or bias. At pretest, participants completed two tasks in counterbalanced order. In one task, participants identified the threshold at which they considered a body fat, as described in Study 6. In the other task, participants evaluated 5 bodies in random order that varied systematically in BMI (*14, 22, 30, 38, 46*) across six dimensions anchored at 1 (*not at all*) and 9 (*extremely*): attractive, warm, desire to have a conversation, lazy (reverse-scored), clean, and healthy.[13] I chose these items to remain consistent with previous research on both visual adaptation and anti-fat attitudes. Indeed, the first three items have been used in previous studies demonstrating the impact of visual adaptation on evaluative biases (Study Set 1), and the latter three items tap common negative beliefs about fat individuals (Lewis, Cash, Jacobi, & Bubb-Lewis, 1997). I reasoned that, collectively, these six items would indicate weight bias to the extent that perceivers evaluated fat targets more negatively than thin targets.

After evaluating the target bodies, participants were randomly assigned to adaptation conditions as described in Study 6. Following adaptation, participants again indicated their fat

[13] It may seem somewhat artificial to ascribe these characteristics to mesh-frame bodies. If anything, this approach serves as a conservative test of my hypothesis. If perceivers show notable biases when ascribing these traits to synthetic bodies that lack individuating features, they would probably be even more likely to do so with real targets.

category threshold and re-evaluated the target bodies according to the six characteristics described above in counterbalanced order (*Posttest*). Finally, participants responded to individual difference measures of anti-fat attitudes (Crandall, 1994), implicit theories about the controllability of body weight (Burnette, 2010), appearance-related self-esteem (Heatherton & Polivy, 1991), and personal demographics before being debriefed.

In total, 124 participants evaluated male bodies (62 thin adaptation, 62 fat adaptation) and 122 participants evaluated female bodies (63 thin adaptation, 59 fat adaptation). A chi-square test revealed that the number of participants did not differ across these four cells, $\chi^2(1) = 0.07$, $p = .797$.

Results and Discussion

I coded the target bodies perceivers evaluated from 1 (*extremely thin*) to 5 (*extremely fat; Target Body Mass*). The evaluative items were highly correlated (*r*s > .50), except for the laziness item, which was weakly correlated with all other items (*r*s = .20 – .30).[14] Therefore, I dropped the laziness item and computed within-subject reliability for the remaining items (see Cranford et al., 2006). These items showed high within-subject reliability ($R_C = .85$), so I summed them into a composite score on which higher values indicated more favorable evaluations at pretest and posttest (*Evaluations*). All other coding was identical to Study 6.

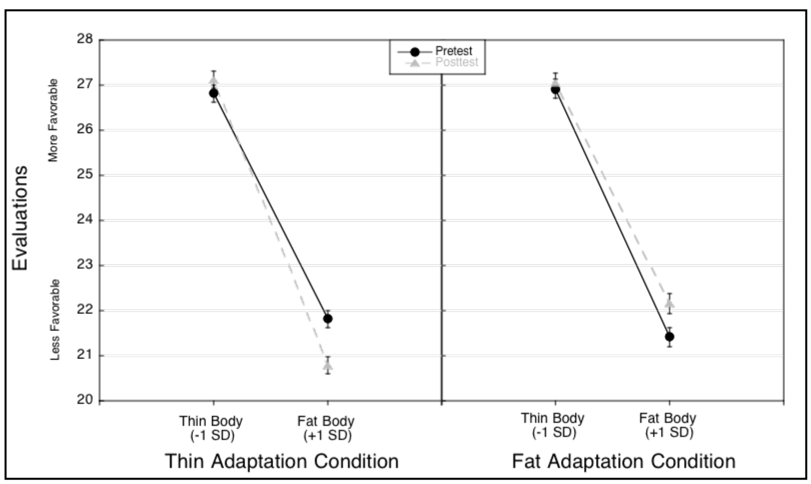
Visual adaptation shifts fat category thresholds. I first sought to replicate findings from Study 6 by regressing Fat Category Threshold onto Adaptation Condition, Test Period, and

[14] I also examined the misfit of the laziness item using factor analysis. Specifically, I aggregated the dataset so that each participant had an average score for each evaluative item at pretest and posttest, collapsed across the five test bodies. I then conducted separate factor analyses with varimax rotation on the six pretest items and the six posttest items. For pretest evaluations, the items loaded strongly onto a single factor (factor loadings ranged from 0.79 – 0.90), with the exception of the laziness item, which had a factor loading of 0.37. Excluding the laziness item increased the total variance explained by the factor from 60.80% to 70.92%. Similar effects emerged for posttest evaluations: The items loaded strongly onto a single factor (factor loadings ranged from 0.78 – 0.90), with the exception of the laziness item, which again had a factor loading of 0.37. Excluding the laziness item increased the total variance explained by the factor from 60.70% to 70.76%. These findings indicate that the laziness item did not tap into the same evaluative construct as the other five items, so I excluded it from the evaluation composite.

their interaction. The expected two-way interaction emerged, $B = 1.82$, $SE = 0.34$, $t = 5.27$, $p < .001$. In the thin adaptation condition, participants chose a lower threshold for fat categorization at posttest ($M_{BMI} = 35$) relative to pretest ($M_{BMI} = 36$), $B = -0.82$, $SE = 0.22$, $t = -3.68$, $p < .001$. In the fat adaptation condition, participants chose a higher threshold for fat categorization at posttest ($M_{BMI} = 36$) relative to pretest ($M_{BMI} = 35$), $B = 0.99$, $SE = 0.26$, $t = 3.79$, $p < .001$.

Visual adaptation influences anti-fat biases. Next, I tested whether visual adaptation altered weight-related evaluations. I first examined weight bias at pretest by regressing Pretest Evaluations onto Target Body Mass. As expected, participants evaluated thin bodies more favorably than fat bodies at pretest, $B = -1.86$, $SE = 0.14$, $z = -12.93$, $p < .001$.

Having established the presence of weight bias at pretest, I tested whether and how this bias changed as a function of visual adaptation by regressing Evaluations onto Target Body Mass, Adaptation Condition, Test Period, and all interactions. The expected three-way interaction emerged, $B = 0.70$, $SE = 0.17$, $z = 4.16$, $p < .001$ (Figure 11). In the thin adaptation condition, the two-way interaction between Target Body Mass and Test Period was significant, $B = -0.48$, $SE = 0.13$, $z = -3.61$, $p < .001$. Specifically, the evaluative bias against fat targets relative to thin targets was larger at posttest, $B = -2.25$, $SE = 0.19$, $z = -11.53$, $p < .001$, than it was at pretest, $B = -1.77$, $SE = 0.19$, $z = -9.10$, $p < .001$. In the fat adaptation condition, the two-way interaction between Target Body Mass and Test Period was also significant, $B =$



0.22, *SE* = 0.10, *z* = 2.13, *p* = .033. Specifically, the evaluative bias against fat targets relative to thin targets was smaller at posttest, *B* = -1.73, *SE* = 0.22, *z* = -7.95, *p* < .001, than it was at pretest, *B* = -1.95, *SE* = 0.21, *z* = -9.21, *p* < .001.

Shifting fat category thresholds as a mechanism driving anti-fat biases. Finally, I tested whether changes in the threshold for fat categorization helped to explain the evaluative shifts described above. First, I regressed Evaluations onto Adaptation Condition, Target Body Mass, Test Period, and all interactions. The expected three-way interaction emerged, *B* = 0.70, *SE* = 0.17, *z* = 4.16, *p* < .001. Next, I added Fat Category Threshold to the model. After accounting for shifts in fat category thresholds, the three-way interaction between Adaptation Condition, Target Body Mass, and Test Period was no longer significant, *B* = 0.62, *SE* = 0.70, *z* = 0.88, *p* = .381. This suggests the evaluative aftereffects described above were statistically accounted for by the fact that fat category thresholds shifted from pretest to posttest as a function of visual adaptation.

To obtain corroborating evidence for the role of fat category thresholds in evaluative shifts related to body weight, I conducted a likelihood ratio test on the deviance values from the two models described above, which indicates whether accounting for shifting fat category thresholds improved the statistical fit of the regression equation linking changes in weight bias to visual adaptation (see Snijders & Bosker, 2011). As expected, including Fat Category Threshold in the model enhanced the predictive power of the regression equation linking expressions of weight bias to visual adaptation, $X^2(8) = 15.70$, *p* = .047. In combination, these analyses reveal that changes in fat category thresholds help to explain the evaluative shifts that occurred as a function of visual adaptation.

Moderating effects of perceiver characteristics. As before, scores on measures of anti-fat attitudes, state self-esteem, and implicit weight bias were internally consistent (Cronbach's αs = .90, .91, and .91), so I summed the items into continuous composite scores on which higher values indicated more anti-fat bias, greater appearance-related self-esteem, and stronger beliefs in the fixed nature of body weight, respectively. I coded both participant BMI and perceived weight status continuously based upon participants' self-reports. I then tested the potential moderating effects of these variables in a series of exploratory analyses to determine whether the moderation effects that emerged in Study 6 replicated in a new sample.

Moderating effects involving fat category threshold. I began by testing whether the effect of visual adaptation on fat category threshold was moderated by target sex or by perceivers' anti-fat attitudes, state self-esteem, implicit weight theories, perceived weight status, or BMI. To do so, I regressed Fat Category Thresholds onto Adaptation Condition, Test Period, each of the potential moderators (separately), and all interactions. The three-way interactions that would indicate moderation were not statistically reliable for target sex, $B = 0.29$, $SE = 0.69$, $z = 0.42$, $p = .674$, anti-fat attitudes, $B = -0.05$, $SE = 0.04$, $z = -1.12$, $p = .264$, state self-esteem, $B = 0.07$, $SE = 0.06$, $z = 1.12$, $p = .265$, implicit weight theories, $B = 0.05$, $SE = 0.07$, $z = 0.71$, $p = .478$, perceived weight status, $B = -0.02$, $SE = 0.28$, $z = -0.06$, $p = .951$, or perceiver BMI, $B = 0.06$, $SE = 0.06$, $z = 1.05$, $p = .292$. Thus, although the effect of visual adaptation on fat category thresholds was consistent across studies, the moderators that emerged in Study 6 (perceiver BMI and appearance-related self-esteem) were not statistically reliable in Study 7.

As an additional test of the robustness of the fat category threshold effect, I included all potential moderators and demographic variables collected during the study as control variables in the regression equation linking Adaptation Condition, Test Period, and their interaction to Fat Category Threshold. That is, I recalculated the regressions described above after partialling out the effects of participant sex, age, race, sexual orientation, education, anti-fat attitudes, state self-esteem, implicit weight theories, perceived weight status, and BMI. After accounting for these factors, the two-way interaction between Adaptation Condition and Test Period remained significant and of similar magnitude as before, $B = 1.82$, $SE = 0.35$, $z = 5.27$, $p < .001$. Moreover, the simple effect of Test Period remained significant in both the thin and fat adaptation conditions, *B*s = -0.83 and 0.99, *SE*s = 0.23 and 0.26, *z*s = -3.68 and 3.79, *p*s < .001, respectively.

Moderating effects involving weight bias. I also tested whether the effect of visual adaptation on social evaluations related to body weight was moderated by target sex or by perceivers' anti-fat attitudes, state self-esteem, implicit weight theories, perceived weight status, or BMI. To do so, I regressed Evaluations onto Target Body Mass, Adaptation Condition, Test Period, each of the potential moderators (separately), and all interactions. The four-way interactions that would indicate moderation were not statistically reliable for target sex, $B = 0.08$, $SE = 0.34$, $z = 0.24$, $p = .812$, anti-fat attitudes, $B = 0.02$, $SE = 0.02$, $z = 0.87$, $p = .386$, state self-esteem, $B = 0.02$, $SE = 0.03$, $z = 0.65$, $p = .515$, implicit weight theories, $B = 0.04$, $SE = 0.03$, $z = 1.18$, $p = .239$, perceived weight status, $B = -0.12$, $SE = 0.14$, $z = -0.85$, $p = .393$, or BMI, $B < 0.01$, $SE = 0.02$, $z = 0.20$, $p = .845$.

As an additional test of the robustness of the evaluative aftereffect, I included all of the potential moderators and demographic variables collected during the study as control variables in the regression equation linking Target Body Mass, Adaptation Condition, Test Period, and their interactions to Evaluations. That is, I recalculated the regressions described above after partialling out the effects of participant sex, age, race, sexual orientation, education, anti-fat attitudes, state self-esteem, implicit weight theories, perceived weight status, and BMI. After accounting for these factors, the three-way interaction between Target Body Mass, Adaptation

Condition, and Test Period remained significant and of similar magnitude as before, $B = 0.70$, $SE = 0.17$, $z = 4.16$, $p < .001$. Moreover, the simple two-way interactions between Target Body Mass and Test Period remained significant in both the thin and fat adaptation conditions, *B*s = -0.48 and 0.22, *SE*s = 0.13 and 0.10, *z*s = -3.61 and 2.13, *p*s < .001 and =.033, respectively.

Study 7 extended insights from Study 6 in three important ways. First, I replicated the finding that fat category thresholds are calibrated based upon recent visual exposure: Perceivers adapted to thin bodies chose a lower threshold whereas perceivers adapted to fat bodies chose a higher threshold for fat categorization at posttest relative to pretest. Second, I found that visual adaptation alters evaluative biases related to body weight. Specifically, adaptation to thin bodies exacerbated weight bias against discrete targets, whereas adaptation to fat bodies mitigated such bias. Third, I demonstrated that these two observations were functionally related, insofar as shifting fat category thresholds statistically accounted for changes in weight bias following visual adaptation. Perceivers exposed to thin bodies evaluated fat targets more negatively in part because the threshold for fat categorization was shifted downward. On the other hand, perceivers exposed to fat bodies evaluated fat targets more favorably in part because the threshold for fat categorization was shifted upward.

These results were consistent across perceivers with varying levels of anti-fat bias, implicit weight theories, self-esteem, body mass, and personal demographics. Thus, the aftereffects observed in Study 7 were not moderated by any of the perceiver-level factors measured during the study. This outcome differs slightly from that observed in Study 6, where perceiver BMI and appearance-related self-esteem moderated the effect of visual adaptation on fat category thresholds. I hesitate to over-interpret null results, but should note that the primary methodological difference between Studies 6 and 7 is the fact that Study 6 utilized front-facing stimuli whereas Study 7 utilized profile-facing stimuli. It is possible that the change in visual vantage point eradicated the moderating effects I observed in Study 6, although I see no theoretical reason why this would be the case. Another possibility is that the moderating effects observed in Study 6 were statistical artifacts, a possibility heightened by the fact that the moderator analyses were exploratory and not guided by a priori hypotheses. Although the exact reason for the inconsistent moderating effects remains unclear, I reiterate that the focal analyses linking visual adaptation to fat category thresholds and weight-related evaluations were in line with my hypotheses and statistically reliable across all participant subgroups. Visual adaptation resulted in a perceptual aftereffect that altered the threshold for fat categorization as well as expressions of weight bias against discrete targets.

Interim Summary

Studies 6 and 7 demonstrated that visual adaptation alters both category representations and evaluative biases related to body mass. However, there is an inconsistency in my argument about the evaluative impacts of adaptation to human bodies that remains unaddressed. Specifically, if adaptation to fat bodies improves evaluations of fat individuals (Robinson & Christiansen 2014; Robinson & Kirkham, 2014), then the persistence of weight bias is perplexing given that a majority of the U.S. population is overweight or obese (Hedley et al., 2004; Flegal, Carroll, Kit, & Ogden, 2012). Shouldn't natural exposure to fat bodies eradicate weight bias, or perhaps even result in a preference for fat bodies over thin bodies?

To address these questions, it is important to consider how visual adaptation functions in vivo, and previous research offers several intriguing possibilities. The first is that media constrains the bodies to which Western perceivers are exposed. Although a majority of the U.S. population is overweight or obese, fat bodies are severely underrepresented in the media to which perceivers devote a great deal of visual attention (Klein & Shiffman, 2005). In stark contrast to population averages, about one-third of all female characters depicted on television are underweight, whereas only 13% are overweight and 3% are obese (Greenberg, Eastin, Hofschire, Lachlan, & Brownell, 2003). Moreover, thin actors are more likely than fat actors to assume recurring roles and to appear in 60-minute television shows rather than 30-minute television shows (Greenberg et al., 2003). Similar findings emerge for other forms of media. In a study of periodicals, researchers found that 94% of magazines geared toward women and 50% of magazines geared toward men featured a thin model on the cover (Malkin, Wornian, & Chrisler, 1999). And in video games geared toward both children and adults, thin characters are featured more prominently than fat characters (Martins, Williams, Harrison, & Ratan, 2009). Thus, one explanation for the persistence of weight bias despite relatively large body masses in the population is the fact that fat bodies are statistically rare in perceptually salient media. This argument is bolstered by the data from Studies 4 and 5 (Study Set 1), which demonstrated that both self-reported and experimental exposure to media depicting hyper-feminine women altered norms and evaluative judgments related to gendered facial features. Although these effects were specific to gendered facial features, the fact that the aftereffects observed in Study Set 2 are nearly identical to those observed in Study Set 1 suggests that similar media effects are likely to occur for bodies.

Alongside established media effects, I offer an additional explanation for the mismatch between adiposity in the population and attitudes regarding body weight that engages with recent advances in the field of social vision. Specifically, I propose that even when perceivers are confronted with fat bodies, they may not visually engage with them. This argument is supported by several recent studies demonstrating that perceivers do not process all social targets equally.

Rather, in both early and later stages of visual processing, White perceivers gaze longer at same-race relative to other-race faces (Bean et al., 2012; Donders, Correll, & Wittenbrink, 2008; Trawalter, Todd, Baird, & Richeson, 2008; Van Bavel & Cunningham, 2012). These tendencies have implications for outcomes relevant to social psychologists, such that preferential gazing toward ingroup members relative to outgroup members helps explain a well-documented memory advantage for the former (Goldinger, He, & Papesh, 2009; Kawakami et al., 2014). That is, perceivers remember ingroup members in part because they visually process them more deeply than outgroup members.

Although recent work suggests that visual attention is biased toward some social targets over others, the existing evidence is restricted to race categories and minimal groups. Moreover, the evaluative implications of these preferential gaze tendencies remain untested. That said, there is at least some reason to believe that gaze preferences are related to perceivers' intergroup attitudes. Dovidio and colleagues (1997) reported that White participants with high levels of implicit racial bias tended to avert their gaze from a Black interaction partner. On the other hand, White perceivers with implicitly egalitarian goals tended to direct attention toward Black male faces; once their egalitarian goals were satisfied, however, this selective attention toward Black male faces disappeared (Moskowitz, Li, Ignarri, & Stone, 2011). Similar effects have emerged in other domains. In real-world interactions, for example, able-bodied confederates engaged in less eye contact with a wheelchair-bound interviewer relative to an interviewer who was not in a wheelchair (Comer & Piliavin, 1972). It is therefore possible that perceivers direct visual attention toward objects/people they consider hedonically pleasing and away from objects/people that are less pleasing. It is also possible that perceivers consider it rude to stare at stigmatized people, and therefore direct attention away from them. Both explanations likely hold some truth, yet both result in preferential visual engagement with some social stimuli over others (Riccio, Cole, & Balcetis, 2013).

On the basis of this evidence, I propose that preferential gaze patterns may act as a form of visual adaptation that alters body preferences. If perceivers preferentially gaze at targets with low body mass, then they may become adapted to thin bodies and ultimately come to prefer those bodies over fat bodies. Data consistent with this possibility would highlight visual adaptation's effects in vivo, helping to explain why contemporary perceivers prefer exceedingly thin bodies to fatter bodies that are more prevalent in the social environment.

Study 8

I propose that perceivers preferentially gaze at thin bodies, and that this tendency sets up a form of visual adaptation that arouses preferences for thin bodies and biases against fat bodies. Study 8 began exploring this hypothesis by testing whether perceivers indeed gaze at thin bodies more than fat bodies when presented with both simultaneously.

Method.

Participants. Thirty undergraduates (5 men) from the University of California, Los Angeles completed the study (90% straight, 37% White, 37% Asian).[15]

Stimuli. Stimuli were 40 slides, each depicting two images on opposite sides of a computer screen. Most of the slides (n = 32) were fillers intended to mask the true purpose of the study. These filler slides looked identical to the focal slides described below, but they did not depict bodies; instead, they depicted facial images that varied along social category dimensions other than weight. The 8 focal slides depicted two sex-matched bodies – one thin (*BMI = 14*) and one fat (*BMI = 46*) – on opposite sides of a white background. Four of the focal slides depicted

[15] Samples for our final three studies were predominately female. Although this is worth noting, I doubt it strongly influenced the results, as there is little evidence to suggest that perceiver-level factors moderate the outcomes of visual adaptation. In fact, controlling for perceiver sex had no notable impact on the results described in Studies 1-2.

female bodies (two profile, two front-facing), and four of the focal slides depicted male bodies (two profile, two front-facing). The location of the thin and fat bodies was fully counterbalanced, such that each participant saw each body presented once on the left-hand side of the screen and once on the right-hand side of the screen.

Procedure. Undergraduate students completed a study about the perceptions of other people for course credit, with no mention of body mass or weight bias. Upon arriving at the lab, participants were seated approximately 120 cm behind a Tobii T60 eye-tracker, which provides an unobtrusive method of tracking eye movements as materials are shown on a computer screen. Tobii software presented the stimuli on a 17-inch monitor at a resolution of 1024 x 768, and it recorded binocular eye movements using corneal reflection tracking at 60 Hz.

Before the study began, participants were asked to put on glasses if they normally wore them when working at a computer. Next, a trained research assistant calibrated the eye-tracker by directing participants' attention to 5 spatial locations on the screen. After successful calibration, participants were told that they would take part in a simple viewing study. Participants were never explicitly told that the computer was tracking their eye movements; rather, they were asked to view the slideshow freely, as if they were watching television at home.

The 40 slides appeared individually on the screen in random order for 5 seconds each. I recorded eye movement data throughout the entire presentation of each slide. After viewing all 40 slides, participants responded to individual difference measures of anti-fat attitudes (Crandall, 1994) and implicit and explicit motivations to respond without prejudice (Plant & Devine, 1998) before reporting demographics and being debriefed. I included motivational measures here because prior research demonstrated that participants who are intrinsically motivated to respond without prejudice tend to have relatively low scores on measures of intergroup bias (Plant &

Devine, 1998). To the extent that preferential gaze patterns are associated with weight bias, perceivers who are motivated to respond without prejudice might show a reduced gaze preference for thin bodies.

Results and Discussion.

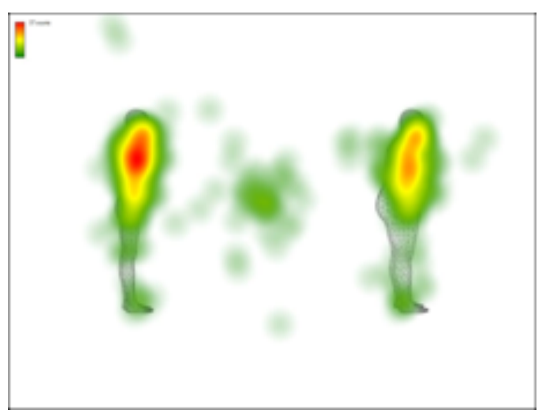
Before analyzing data, I defined equally sized non-overlapping areas of interest around the thin and fat body on each slide. I then aggregated the eye-movement data within each area of interest to test whether perceivers preferentially gazed at thin bodies relative to fat bodies. I was specifically interested in *gaze fixations*, which Tobii software recorded as moments when perceivers' gaze was stationary for longer than 100 ms. I tested my hypotheses using two related but non-redundant aspects of gaze fixation: The total amount of time that participants fixated within each area of interest (*Fixation Duration*) and the total number of fixations within each area of interest (*Fixation Count*). Both of these outcomes are relevant to visual adaptation because they indicate the amount of visual attention allocated to a given stimulus, and I had the same hypothesis for each measure – namely, that participants would gaze more (in terms of duration and number of fixations) at thin bodies relative to fat bodies. That said, these measures do not necessarily provide redundant information. It might be the case, for example, that perceivers gaze at fat bodies for less time but more frequently than thin bodies, effectively "peeking" at the fat targets without visually engaging with them for sustained periods of time. I therefore include analyses for both measures of gaze fixation in the results that follow.

I tested my hypotheses using several different analytic techniques. First, I analyzed the data on a trial-by-trial basis using multilevel regression models, which account for the fact that participants' viewing tendencies were likely correlated across slides. For these analyses, I effect-coded Target Body Mass (*-0.5 = Thin, 0.5 = Fat*), Target Sex (*-0.5 = Male, 0.5 = Female*), and

Target Orientation (*-0.5 = Frontal, 0.5 = Profile*), and I centered continuous predictors at their mean. Individual difference measures of anti-fat attitudes, internal motivations to respond without prejudice, and external to respond without prejudice showed high internal consistency (αs = 0.84, 0.85, 0.82, respectively), so I summed them into continuous composite scores. As in the previous studies, I did not have a priori hypotheses about the effect of these perceiver-level factors on preferential gazing, but I tested for moderation in an exploratory fashion.

In a second set of analyses, I aggregated data across all 8 focal slides to get a better indication of participants' tendency to gaze at thin bodies. To do so, I recorded the total fixation duration and total number of fixations within each area of interest and then averaged these values across the eight focal slides. Next, I calculated proportions indicating the average duration and average number of times that participants fixated on thin bodies relative to total gazing time within the areas of interest on each slide. Proportions exceeding 0.50 would indicate preferential gazing toward thin bodies. I present both sets of analyses in turn below.

Preferential gazing on a trial-by-trial basis. I first used multilevel regression models to test whether participants preferentially gazed at thin bodies on a trial-by-trial basis. To begin, I regressed Fixation Duration onto Target Body Mass. As expected, participants gazed longer at the thin body relative to the fat body on a trial-by-trial basis, B = -0.21, SE = 0.12, z = -1.75, p = .080 (see Figure 12 for sample heat map). This effect was not qualified by two-way interactions with Target Sex (*male, female*), B = 0.03, SE = 0.12, z = 0.25, p = .803, or Target Orientation (*frontal, profile*), B = 0.08, SE = 0.17, z = 0.47, p = .638. I also tested whether this preferential



gazing effect was moderated by higher-level perceiver characteristics measured during the study. The tendency to gaze longer at the thin body relative to the fat body on a trial-by-trial basis was not qualified by two-way interactions with internal motivations to control prejudice, $B = 0.03$, $SE = 0.02$, $z = 1.12$, $p = .262$, external motivations to control prejudice, $B = -0.02$, $SE = 0.04$, $z = -0.54$, $p = .592$, or self-perceived weight status, $B = -0.02$, $SE = 0.20$, $z = -0.12$, $p = .904$. There was, however, a marginally significant interaction between Target Body Mass and Anti-Fat Attitudes, $B = -0.03$, $SE = 0.01$, $z = -1.87$, $p = .062$. The tendency to gaze at thin bodies longer than fat bodies was more pronounced among participants high in anti-fat attitudes compared to participants low in anti-fat attitudes, *B*s = -0.41 and -0.01, *SE*s = 0.18 and 0.13, *z*s = -2.24 and -0.08, *p*s = .025 and .934, respectively.

I replicated these analyses using the total number of fixations within each area of interest. Again, I began by regressing Fixation Count onto Target Body Mass (*thin, fat*). As expected, participants fixated more often on the thin body relative to the fat body on a trial-by-trial basis, $B = -0.53$, $SE = 0.32$, $z = -1.66$, $p = .097$. This effect was not qualified by two-way interactions with Target Sex (*male, female*), $B = 0.13$, $SE = 0.31$, $z = 0.40$, $p = .690$, or Target Orientation (*frontal, profile*), $B = 0.01$, $SE = 0.41$, $z = 0.02$, $p = .984$. I also tested whether this preferential gazing effect was moderated by higher-level perceiver characteristics measured during the study. The tendency to fixate more often on thin bodies relative to fat bodies on a trial-by-trial basis was not qualified by two-way interactions with internal motivations to control prejudice, $B = 0.10$, $SE = 0.06$, $z = 0.65$, $p = .091$, external motivations to control prejudice, $B = 0.02$, $SE = 0.11$, $z = 0.23$, $p = .821$, or self-perceived weight status, $B = -0.03$, $SE = 0.56$, $z = -0.05$, $p = .963$. Again, however, I uncovered a marginally significant interaction between Target Body Mass and Anti-Fat Attitudes, $B = -0.06$, $SE = 0.03$, $z = -1.91$, $p = .057$. The tendency to fixate on thin bodies more often than fat bodies was especially pronounced among participants relatively high in anti-fat attitudes, *B*s = -1.02 and -0.03, *SE*s = 0.42 and 0.38, *z*s = -2.41 and -0.09, *p*s = .016 and .929, respectively.

Preferential gazing overall. In a second set of analyses, I aggregated the data to get a more general sense of participants' preferential looking tendencies. To do so, I averaged fixation duration and fixation count for thin bodies and fat bodies across all 8 focal slides. I then calculated proportions by dividing average fixation duration and average fixation count for thin bodies by the average fixation duration and average fixation count for both bodies (i.e., thin gazing / total gazing). Finally, I subjected these proportions to one-sample *t*-tests against a null value of 0.50. If my hypothesis is correct, then the proportions for duration and number of fixations should exceed 50%, indicating preferential gazing toward thin bodies. This is indeed what I found. With regard to fixation duration, participants gazed at thin targets (*M* = 2.33 sec, *SD* = 0.40 sec) longer than fat targets (*M* = 2.11 sec, *SD* = 0.34 sec) on average. In fact, of the time that participants spent fixating on bodies, they spent more than half the time gazing at thin bodies, *t*(29) = 1.68, *p* = .053, *d* = 0.31, one-tailed. This tendency to preferentially gaze at thin bodies was not significantly correlated with internal motivations to control prejudice, *r*(30) = -.15, *p* = .440, external motivations to control prejudice, *r*(30) = .08, *p* = .683, self-perceived weight status, *r*(30) = .03, *p* = .863, or anti-fat attitudes, *r*(30) = .31, *p* = .098.

The same pattern of effects emerged for total number of fixations. On average, participants fixated on thin targets (*M* = 6.57 fixations, *SD* = 1.28 fixations) more than on fat targets (*M* = 6.04 fixations, *SD* = 1.20 fixations). In fact, out of the total number of fixations participants made, significantly more than half were directed toward thin bodies, *t*(29) = 1.60, *p* = .060, *d* = 0.30, one-tailed. This tendency to preferentially fixate on thin bodies was not significantly associated with anti-fat attitudes, $r(30) = .28$, $p = .138$, internal motivations to control prejudice, $r(30) = -.19$, $p = .328$, external motivations to control prejudice, $r(30) = -.04$, $p = .819$, or self-perceived weight status, $r(30) = .04$, $p = .850$.

Study 8 provided preliminary evidence for how evaluative aftereffects related to body adiposity function in vivo. Drawing upon recent theories of motivated visual processing, I used corneal reflection eye-tracking to test whether and how perceivers differ in their level of visual engagement with thin and fat bodies when both are presented simultaneously. As expected, participants gazed longer and more frequently at thin bodies relative to fat bodies. In general, this effect was not moderated by perceiver-level characteristics, such as motivations to control prejudice. Although there was some indication that perceivers high in anti-fat attitudes were especially likely to preferentially gaze at thin bodies, this moderating effect was not especially robust and did not emerge consistently across analyses. Thus, in general, perceivers preferentially gazed at thin bodies relative to fat bodies. Next, I turn to the evaluative implications of these viewing patterns.

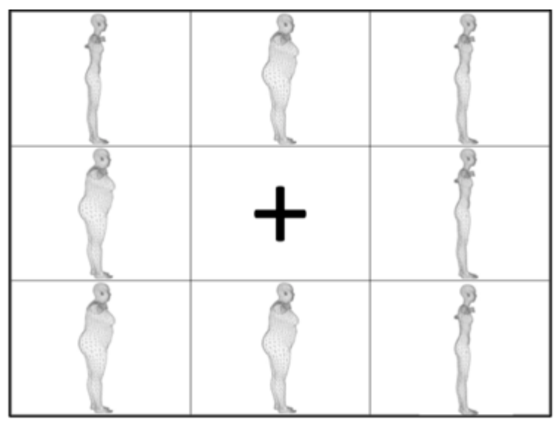
Study 9

In Study 8, perceivers gazed at thin bodies longer and more frequently than fat bodies when freely viewing social scenes. Although these findings provided some indication about how visual adaptation emerges under natural viewing conditions, the results were limited in several respects. First, the preferential gazing effects, although consistent across various dependent measures, were fairly subtle (*p*s = .05 – .09). Replicating the findings with a different sample would ensure their robustness. Second, these preferential gazing effects emerged when participants viewed slides that contained only two bodies – one thin and one fat. In everyday life, however, perceivers are confronted with many bodies at once, and it remains unclear whether and how preferential gaze might emerge in busier social scenes. Third, Study 9 did not test whether preferential gaze patterns were associated with evaluative preferences for discrete targets. If my argument that visual adaptation molds weight bias is correct, then preferentially gazing toward thin bodies should predict especially strong preferences for thin bodies and against fat bodies after viewing. Study 9 addressed each of these points by replicating the previous findings with scenes depicting more than two targets and linking preferential gaze tendencies to evaluative body weight preferences.

Method.

Participants. Forty-three undergraduates (6 men) from the University of California, Los Angeles completed the study (91% straight, 40% Asian, 35% White).

Stimuli. Stimuli were 12 3x3 arrays that depicted 8 female bodies in profile view with a fixation cross at the center (Figure 13).[16] The fixation cross was meant to reset visual attention at the beginning of each trial to avoid carryover gaze effects from the previous slide. Within each array, four bodies depicted thin women (*BMI = 14*) and four bodies depicted fat women (*BMI = 46*), with the placement of thin and fat bodies varying randomly across arrays.



Procedure. Eye-tracking procedures were nearly identical to Study 8. As before, participants were asked to wear glasses if they normally wore them when working at a computer before being seated approximately 120 cm behind a Tobii T60 eye-tracker. After successful calibration, participants were told that they would take part in a simple viewing study; as before, they were not told that the computer would be tracking their eye movements, and they were

[16] I only included female bodies because Target Sex did not moderate any of the effects described in Studies 6-8.

asked to view the stimuli freely as if they were watching television at home. Next, the 12 body arrays appeared on the screen individually in random order for 10 seconds each. I increased the presentation time from 5 seconds in Study 8 to 10 seconds in Study 9 to accommodate the presence of additional bodies. Increasing the viewing time also allowed me to test whether the preferential gaze tendency observed in Study 8 replicates under more sustained viewing conditions.

After participants viewed all 12 arrays, I measured weight bias in terms of body ideals. Specifically, participants viewed a randomly sorted lineup of six female bodies that varied in BMI and identified the most attractive female body shape. I opted to include a single measure of attractiveness here for two reasons. First, early research on body evaluations (Singh, 1995) used similar ranking procedures to assess body preferences. Second, attractiveness ratings are known to shape broader social evaluations (Dion, Berscheid, & Walster, 1972; Eagly, Ashmore, Makhijani, & Longo, 1991), and attractiveness ratings were very highly correlated with the other evaluative items in Study 7, suggesting that this dimension captures a large amount of the variance in body-related evaluations. I reasoned that this attractiveness item would indicate weight bias to the extent that perceivers chose a relatively thin body as being maximally attractive. After making this judgment, participants responded to a measure of anti-fat attitudes (Crandall, 1994) and a brief demographic questionnaire before being debriefed.

Results and Discussion.

I defined equally sized non-overlapping areas of interest around the 4 thin bodies and the 4 fat bodies within each array. I then aggregated the eye-movement data within these areas of interest to test whether perceivers preferentially gazed at thin bodies relative to fat bodies. As in Study 8, I tested this possibility using two related but non-redundant aspects of gaze: The total amount of time that participants fixated within each area of interest (*Fixation Duration*) and the total number of fixations that participants demonstrated within each area of interest (*Fixation Count*). Also as in Study 8, I tested my hypotheses about these outcome measures using several different analytic techniques. First, I analyzed the data on a trial-by-trial basis using multilevel regression models to account for the fact that participants' viewing tendencies were likely correlated across 12 slides. For these analyses, I effect-coded Target Body Mass (*-0.5 = Thin, 0.5 = Fat*) and I centered continuous predictors at their mean. The measure of anti-fat attitudes showed high internal consistency ($\alpha = 0.87$), so I summed it into a continuous composite score prior to analysis and tested for its potential moderating effect in an exploratory fashion.

In a second set of analyses, I aggregated data across all 12 slides to get a better indication of participants' overall tendency to gaze at thin bodies. To do so, I recorded the total fixation duration and total number of fixations within each area of interest and then averaged these values across the 12 slides. Next, I calculated a proportion indicating the average duration and average number of times that participants fixated on thin bodies relative to total gazing toward thin and fat bodies on each slide. Proportions exceeding 0.50 would indicate preferential gazing toward thin bodies over fat bodies. I present both sets of analyses in turn below.

Preferential gazing on a trial-by-trial basis. I used multilevel regression models to test whether participants preferentially gazed at thin bodies on a trial-by-trial basis. I began by regressing Fixation Duration onto Target Body Mass (*thin, fat*). As expected, participants gazed longer at the thin bodies relative to the fat bodies on a trial-by-trial basis, $B = -0.54$, $SE = 0.14$, $z = -3.72$, $p < .001$. This tendency to gaze longer at thin bodies relative to fat bodies on a trial-by-trial basis was not qualified by two-way interactions with anti-fat attitudes, $B < 0.01$, $SE = 0.01$, $z = -0.17$, $p = .861$, or self-perceived weight status, $B = -0.02$, $SE = 0.14$, $z = -0.15$, $p = .881$.

I replicated these analyses with the total number of fixations within each area of interest. I began by regressing Fixation Count onto Target Body Mass (*thin, fat*). As expected, participants gazed more often at thin bodies relative to fat bodies on a trial-by-trial basis, B = -1.43, SE = 0.41, z = -3.46, p = .001. This tendency was not qualified by two-way interactions with anti-fat attitudes, B = -0.02, SE = 0.04, z = -0.44, p = .400, or self-perceived weight status, B = 0.28, SE = 0.40, z = 0.71, p = .479.

Preferential gazing overall. In a conceptually related set of analyses, I aggregated the eye-movement data to get a general sense of participants' preferential looking tendencies across all 12 slides. To do so, I averaged fixation duration and fixation count for thin bodies and fat bodies across the 12 slides. I then calculated proportions by dividing average fixation duration and average fixation count for thin bodies by the average fixation duration and average fixation count for both bodies (i.e., thin gazing / total gazing). Finally, I subjected these proportions to one-sample *t*-tests against a null value of 0.50. If my hypothesis is correct, then the proportions for duration and number of fixations should exceed 50%, indicating preferential gazing toward thin bodies. This is indeed what I found. With regard to total fixation duration, participants gazed at the thin targets (M = 3.92 sec, SD = 1.00 sec) longer than the fat targets (M = 3.38 sec, SD = 0.94 sec). In fact, of the time that participants spent fixating on bodies, they spent more than half the time gazing at thin bodies, $t(42)$ = 3.78, p < .001, d = 0.56, one-tailed. This tendency to gaze longer at thin bodies relative to fat bodies was not significantly correlated with anti-fat attitudes, $r(43)$ = -.03, p = .852, or self-perceived weight, $r(43)$ = .01, p = .969.

The same pattern of effects emerged for total number of fixations. On average, participants fixated on thin targets (M = 12.42 fixations, SD = 3.80 fixations) more often than fat targets (M = 10.99 fixations, SD = 3.27 fixations). In fact, of the total number of fixations, significantly more than half were direct toward thin bodies, $t(42) = 3.51$, $p < .001$, $d = 0.58$, one-tailed. This tendency to gaze at thin bodies more often than fat bodies was not significantly correlated with anti-fat attitudes, $r(43) = .05$, $p = .769$, or self-perceived weight, $r(43) = -.11$, $p = .492$.

Preferential gazing and weight bias. Finally, I tested whether the preferential gaze tendencies described above predicted body preferences after viewing. I examined this effect using the aggregated data described above, because the dependent variable indicating female body ideal was constant within participant (i.e., each participant provided only one ideal body rating), so the data were not appropriate for multilevel analysis. Specifically, I scored the attractiveness rating such that lower values indicated a thinner body ideal whereas higher values indicated a fatter body ideal. I then regressed these body ideal ratings onto each measure of preferential gaze. I first regressed ratings of the female body ideal onto the proportion of time participants spent gazing at thin bodies (i.e., fixation duration). As expected, participants who spent relatively more time gazing at thin bodies chose a thinner body as maximally attractive after viewing, $B = -3.96$, $SE = 1.56$, $t = -2.54$, $p = .015$. This effect was not qualified by a two-way interaction with anti-fat attitudes, $B = 0.35$, $SE = 0.30$, $t = 1.15$, $p = .256$, or self-perceived weight status, $B = 1.00$, $SE = 2.08$, $t = 0.48$, $p = .633$.

I also regressed ratings of the female body ideal onto the proportion of fixations directed toward thin bodies (i.e., fixation count). As expected, participants who fixated more often on thin bodies indicated a thinner body as maximally attractive after viewing, $B = -3.59$, $SE = 2.02$, $t = -1.78$, $p = .083$. Again, this effect was not qualified by a two-way interaction with anti-fat attitudes, $B = 0.28$, $SE = 0.32$, $t = 0.86$, $p = .398$, or self-perceived weight status, $B = 0.70$, $SE = 2.40$, $t = 0.29$, $p = .773$.

Study 9 extended the findings from Study 8 in several ways. First, I showed that the tendency to preferentially gaze at thin bodies extends beyond dyads to include social scenes depicting multiple targets. This suggests that preferential gazing toward thin bodies is robust to changes in the particulars of stimulus presentation. More importantly, Study 9 linked these preferential gaze tendencies to evaluative judgments. Compared to participants who showed a weaker tendency to preferentially gaze at thin bodies, those who showed a stronger tendency to preferentially gaze at thin bodies reported a thinner body ideal after the viewing task. This finding replicated across two distinct measures of preferential gaze (i.e., fixation duration and fixation count), indicating a robust association between preferential gazing toward thin bodies and evaluative biases related to body weight. Further, and similar to my previous findings, none of these effects were moderated by higher-level perceiver characteristics measured during the study (anti-fat attitudes and self-perceived weight status). As such, Study 9 provides additional support for my hypothesis that natural viewing patterns act as a form of visual adaptation: Perceivers preferentially gaze at thin bodies relative to fat bodies when viewing social scenes, and this gaze pattern is associated with a preference for thin bodies downstream.

Study 10

Studies 8 and 9 revealed a problematic and previously unrecognized fact about social vision: Perceivers preferentially and spontaneously gaze at thin bodies more than fat bodies when viewing social scenes, which predicts a thin body ideal after viewing. Overall, these findings suggest that perceivers' natural viewing tendencies may result in visual adaptations that give rise to preferences for thin bodies. However, at least two concerns remain. One is that Study 9 did not include pretest evaluations, so I cannot be sure whether preferential gazing toward thin bodies caused a change in the body ideal or whether having a thinner body ideal to begin with caused preferential gazing toward thin bodies. Study 7 clearly showed that visual exposure alters weight-related biases even after accounting for biases existing at pretest, but replicating those findings using the current paradigm would provide stronger support for causal claims. Another concern is that although the preferential gaze patterns described above are consistent with the adaptation effects documented earlier, I have yet to map preferential gazing onto visual adaptation directly. Specifically, it remains unclear whether psychologists can harness visual adaptation to alter gaze tendencies when perceivers are exposed to multiple bodies at once. If preferential gazing sets up a natural form of visual adaptation that carries evaluative implications, then experimentally directing visual attention should reduce this tendency and therefore reduce weight bias. Study 10 tested this possibility using a pretest / posttest design. I predicted that experimentally drawing perceivers' attention to certain bodies within an array – that is, manipulating gaze in the presence of distractors – would alter body preferences from pretest to posttest. More specifically, I predicted that participants whose gaze was directed toward thin bodies would prefer thinner bodies at posttest relative to pretest whereas participants whose gaze was directed toward fat bodies would prefer fatter bodies at posttest relative to pretest.

Method.

Participants. Fifty undergraduates (7 men) from the University of California, Los Angeles completed the study (94% straight, 32% Asian, 44% White).

Stimuli. Stimuli were the same 12 arrays described in Study 9.

Procedure. Eye-tracking procedures were identical to Study 9 with two exceptions. The first exception is that participants were randomly assigned to have their attention directed toward either thin bodies (n = 25 participants) or fat bodies (n = 25 participants) throughout the viewing period. Thus, rather than viewing freely, participants were told that the study was designed to test how well they could pay attention to a single target surrounded by many other distracting targets. In line with this cover story, I directed participants' gaze toward either one thin body or one fat body within each array by circling it with a red oval. The placement of the focal body changed randomly from slide to slide, but participants always had their attention drawn to either a single thin body or a single fat body per slide, depending upon condition. The second departure from Study 9 is that preferences were measured for a series of discrete bodies rather than a single array to map more closely onto the methods described in Study 7. Specifically, participants viewed four female bodies that varied systematically in BMI in random order and rated each one's attractiveness on a 9-point rating scale (*1=not at all attractive* to *9=extremely attractive*). After completing these procedures, participants responded to individual difference measures of anti-fat attitudes (Crandall, 1994) and disgust sensitivity (3 subscales tapping sensitivity moral, pathogen, and sexual disgust; Tybur et al., 2009) before reporting demographics and being debriefed. I measured disgust sensitivity here because prior research linked feelings of disgust to negative evaluations of fat individuals (Lieberman et al., 2012; Neel et al., 2013; Park et al., 2007; Vartanian, 2010b). Thus, perceivers with different levels of disgust sensitivity might be differentially sensitive to the gaze manipulation, which could impact evaluative biases at pretest and posttest.

Results and Discussion.

Before analyzing the data, I defined equally sized non-overlapping areas of interest within each array. Specifically, I coded the focal body that was meant to draw participants' attention as the primary area of interest, and all remaining areas of the array as a second area of interest. As in the prior studies, I examined two indices of gaze fixation within these areas of interest: The total amount of time that participants fixated within each area (*Fixation Duration*) and the total number of fixations within each area (*Fixation Count*). I then tested my hypotheses using two different analytic techniques. First, I analyzed the data on a trial-by-trial basis using multilevel regression models to account for the fact that participants' viewing tendencies were likely correlated across slides. For these analyses, I effect-coded the areas of interest defining the focal body and all other bodies (*-0.5 = gaze directed away from of focal body, 0.5 = gaze directed toward focal body*) as well as adaptation condition (*-0.5 = thin adaptation, 0.5 = fat adaptation*), and I centered continuous predictors at their mean. The items tapping anti-fat attitudes and moral disgust, sexual disgust, and pathogen disgust showed acceptable internal consistency (αs = .87, .77, .81, .83, respectively), so I summed them into continuous composite scores prior to analysis and tested for their potential moderating effects in an exploratory fashion.

In a second set of analyses, I aggregated data across all slides to get a better sense of participants' gaze tendencies overall. To do so, I recorded the total fixation duration and total number of fixations within each area of interest and then averaged these values across all slides. Next, I formed a proportion indicating the amount of time and number of fixations that participant spent gazing at the focal body relative to all other areas of interest on each slide. Because there were 9 areas of interest on each slide (1 focal body, 7 other bodies, 1 fixation cross), proportions exceeding 0.11 (1/9) would indicate preferential gazing toward the single body to which participants' attention was directed. I present both sets of analyses in turn below.

Manipulation check on a trial-by-trial basis. As a check of the directed gaze manipulation, I used multilevel regression models to test whether participants preferentially gazed at the focal body on a trial-by-trial basis. To do so, I calculated the total amount of time and the total number of fixations within an area of interest that included the specified body and within areas of interest that included all of the other bodies for each slide. I then regressed Fixation Duration onto Area of Interest (*-0.5 = gaze directed away from of focal body, 0.5 = gaze directed toward focal body*). As expected, participants gazed longer at the focal body than all other bodies combined, B = 8.24, SE = 0.39, z = 21.01, p < .001. I also tested whether this effect was moderated by higher-level perceiver characteristics. The tendency for participants to gaze longer at the focal body on a trial-by-trial basis was not qualified by two-way interactions with self-perceived weight status, B = 0.74, SE = 0.47, z = 1.58, p = .114, anti-fat attitudes, B = -0.02, SE = 0.04, z = -0.53, p = .596, sexual disgust sensitivity, B = 0.02, SE = 0.06, z = 0.38, p = .706, moral disgust sensitivity, B = -0.04, SE = 0.05, z = -0.74, p = .459, or pathogen disgust sensitivity, B = -0.01, SE = 0.03, z = -0.44, p = .661.

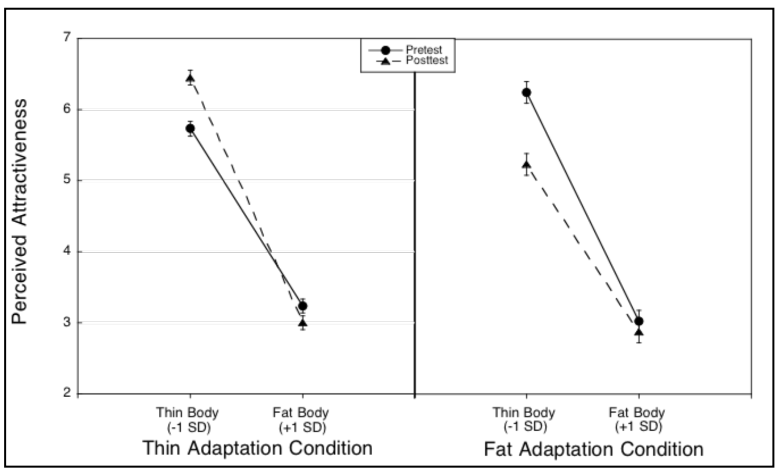
I sought to replicate these findings with the total number of fixations within each area of interest. To do so, I regressed Fixation Count onto Area of Interest (*-0.5 = gaze directed away from of focal body, 0.5 = gaze directed toward focal body*). As expected, participants gazed more often at the focal body relative to all other bodies on a trial-by-trial basis, B = 7.40, SE = 0.59, z = 12.52, p < .001. Again, this tendency for participants to gaze more often at the focal body was not qualified by two-way interactions with perceived weight status, B = 0.18, SE = 0.61, z = 0.30, p = .766, anti-fat attitudes, B = -0.11, SE = 0.07, z = -1.63, p = .103, sexual disgust sensitivity, B = 0.02, SE = 0.07, z = 0.30, p = .767, moral disgust sensitivity, B = 0.01, SE = 0.09, z = 0.15, p = .880, or pathogen disgust sensitivity, B < 0.01, SE = 0.08, z = -0.02, p = .986.

Manipulation check overall. Next, I aggregated the data across slides to get a general sense of participants' gaze tendencies. Specifically, I averaged the amount of time and the number of times participants gazed at the focal body as well as the amount of time and the number of times participants gazed at all other bodies across the slides. I then calculated proportions by dividing the average amount of time and number of times that participants gazed at the focal body by the average amount of time and number of times that participants gazed at all other bodies (i.e., gazing at directed body / gazing at other bodies). I subjected these proportions to one-sample *t*-tests against a null value of 0.11 (1 focal area / 9 total areas in 3x3 array). If the directed gaze manipulation was successful, then the proportion of time and fixations that participants spent gazing at the focal body should be significantly greater than 11%, indicating successful manipulation of eye gaze. This is indeed what I found. With regard to fixation duration, on average, participants gazed at the focal body (M = 4.12 sec, SD = 1.03 sec) longer than all other bodies combined (M = 1.37 sec, SD = 0.61 sec). In fact, participants spent more than 1/9 of their gazing time viewing the focal body, $t(49) = 47.12$, $p < .001$, $d = 6.36$, one-tailed. This tendency to gaze at the focal body was not significantly correlated with anti-fat attitudes, $r(50) = -.16$, $p = .254$, self-perceived weight, $r(50) = .17$, $p = .230$, moral disgust sensitivity, $r(50) = -.20$, $p = .157$, sexual disgust sensitivity, $r(50) = .07$, $p = .611$, or pathogen disgust sensitivity, $r(50) = .03$, $p = .863$.

The same pattern emerged for number of fixations. On average, participants fixated on the focal body (M = 4.23 fixations, SD = 1.52 fixations) more often than all other bodies combined (M = 1.76 fixations, SD = 0.99 fixations). In fact, participants spent more than 1/9 of their fixations on the focal body, $t(49) = 46.50$, $p < .001$, $d = 6.67$, one-tailed. Again, this tendency was not significantly correlated with anti-fat attitudes, $r(50) = -.16$, $p = .274$, self-perceived weight, $r(50) = .16$, $p = .258$, moral disgust sensitivity, $r(50) = -.05$, $p = .727$, sexual disgust sensitivity, $r(50) = .05$, $p = .710$, or pathogen disgust sensitivity, $r(50) = -.16$, $p = .259$.

Directed looking influences anti-fat biases. The above analyses served as a statistical check of the directed gaze manipulation, revealing that perceivers indeed gazed at the focal body to which their gaze was directed on each slide. Next, I tested whether this directed viewing manipulation changed body preferences from pretest to posttest. Because participants provided multiple attractiveness ratings of multiple bodies, I conducted this analysis using multilevel regression models to account for the nested structure of the dependent variable. To begin, I examined weight bias at pretest by regressing Pretest Attractiveness Ratings onto Target Body Mass. As expected, participants rated thin bodies as more attractive than fat bodies at pretest, $B = -1.13$, $SE = 0.08$, $z = -14.07$, $p < .001$.

Next, I tested whether weight bias changed as a function of the gaze manipulation by regressing Attractiveness Ratings onto Target Body Mass (*1=thinnest body to 4=fattest body;* mean-centered), Adaptation Condition (*-0.5 = thin adaptation, 0.5 = fat adaptation*), Test Period (*-0.5 = pretest, 0.5 = posttest*), and all interactions. The expected three-way interaction emerged, $B = 0.73$, $SE = 0.15$, $z = 5.00$, $p < .001$ (Figure 14). In the thin adaptation condition, the two-way interaction between Target Body Mass and Test Period was statistically significant, $B = -0.42$, $SE = 0.08$, $z = -5.46$, $p < .001$.



Specifically, the tendency to rate thin bodies as more attractive than fat bodies was stronger at posttest, B=-1.54, SE=0.11, z=-14.02, p<.001, relative to pretest, B=-1.12, SE=0.10, z=-11.53, p<.001. In the fat adaptation condition, the two-way interaction between Target Body Mass and Test Period was also statistically significant, $B = 0.30$, $SE = 0.12$, $z = 2.46$, $p = .014$. The tendency to rate thin bodies as more attractive than fat bodies was weaker at posttest, $B = -0.84$,

$SE = 0.12$, $z = -7.18$, $p < .001$, relative to pretest, $B = -1.15$, $SE = 0.13$, $z = -8.93$, $p < .001$.

Finally, I tested whether the impact of directed gaze on body preferences was moderated by higher-level perceiver characteristics. To do so, I regressed Attractiveness Ratings onto Target Body Mass, Adaptation Condition, Test Period, each of the potential moderators (separately), and all interactions. The four-way interactions were not reliable for perceived weight status, $B < 0.01$, $SE = 0.14$, $z = -0.02$, $p = .981$, anti-fat attitudes, $B = -0.02$, $SE = 0.02$, $z = -1.14$, $p = .255$, sexual disgust sensitivity, $B = -0.01$, $SE = 0.02$, $z = -0.42$, $p = .671$, or pathogen disgust sensitivity, $B = 0.01$, $SE = 0.02$, $z = 0.85$, $p = .393$. The four-way interaction was significant for moral disgust sensitivity, $B = -0.07$, $SE = 0.02$, $z = -3.51$, $p < .001$. Specifically, the focal three-way interaction between Adaptation Condition, Target Body Mass, and Test Period was marginally significant for participants high in moral disgust sensitivity, $B = 0.29$, $SE = 0.17$, $z = 1.76$, $p = .079$, but was highly significant for participants low in moral disgust sensitivity, $B = 1.24$, $SE = 0.20$, $z = 6.19$, $p < .001$. This suggests that the gaze manipulation had an especially strong impact on body preferences among participants who were low in moral disgust sensitivity.

As a final test of the robustness of these effects, I included all of the potential moderators and demographic variables collected during the study as control variables in the regression equation linking Adaptation Condition, Test Period, Target Body Mass, and their interactions to Attractiveness Ratings. Specifically, I recalculated the regressions described above after partialling out the effects of participant sex, age, race, sexual orientation, anti-fat attitudes, perceived weight status, moral disgust sensitivity, pathogen disgust sensitivity, and sexual disgust sensitivity. After accounting for these factors, the three-way interaction between Adaptation Condition, Test Period, and Target Body Mass remained identical to the original effect after rounding, $B = 0.73$, $SE = 0.15$, $z = 5.00$, $p < .001$. Moreover, the simple two-way interactions between Target Body Mass and Test Period remained significant in both the thin and fat adaptation conditions, Bs = -0.42 and 0.30, SEs = 0.08 and 0.12, zs = -5.46 and 2.46, ps < .001 and =.014, respectively.

Study 10 combined insights from Studies 8 and 9 about perceivers' visual preference for thin bodies with insights from Study 7 about the evaluative implications of visual adaptation to bodies of varying size. A simple gaze manipulation altered participants' baseline tendency to preferentially gaze at thin bodies within social scenes. Moreover, this gaze manipulation impacted social evaluations related to body weight: Perceivers whose gaze was directed toward thin bodies showed a stronger bias against fat targets at posttest relative to pretest, whereas perceivers whose gaze was directed toward fat bodies showed a smaller bias against fat targets at posttest relative to pretest. Thus, aftereffects caused by preferential gazing can be altered with directed viewing techniques based upon established methods of visual adaptation.

The directed gaze manipulation had the strongest effects for perceivers low in moral disgust sensitivity. This is perhaps not surprising, given prior research showing that disgust sensitivity is positively associated with weight bias (Vartanian, 2010b). I suspect that perceivers who feel disgusted when looking at fat bodies may not be as susceptible to perceptual manipulations that attempt to draw their attention to fat bodies, whereas those with lower levels of disgust may be more apt to visually engage with fat bodies when directed to do so. This moderator notwithstanding, the overall effect of directed gaze on weight bias was similar among perceivers who were both high and low in moral disgust sensitivity. Study 10 therefore demonstrates that the tendency to preferentially gaze at thin bodies can be overcome, with implications for social evaluations related to body weight.

General Discussion

Study Set 2 demonstrated that visual exposure plays a critical role in the etiology of weight bias, and that psychologists can harness visual exposure to alter such biases as they are directed against individual targets. In Study 6, visual adaptation altered perceivers' thresholds for fat categorization: Adaptation to thin bodies lowered the perceptual threshold for categorizing others as fat, whereas adaptation to fat bodies heightened it. Thus, whereas Study Set 1 focused on the ability of adaptation to alter category prototypes, Study 6 indicated that adaptation also alters the perceptual threshold for a given category. Study 7 linked these findings to evaluative biases related to body weight, demonstrating that adaptation to fat bodies reduced weight bias against discrete individuals by shifting the threshold for fat categorization upward, whereas adaptation to thin bodies exacerbated weight bias by shifting the threshold for fat categorization downward. Studies 8 and 9 used eye-tracking methodology to test whether and how these adaptation effects emerge under more natural viewing conditions. Specifically, Study 8 demonstrated that perceivers preferentially attended to thin bodies more than fat bodies when both were presented simultaneously. Study 9 replicated this finding with larger social scenes and longer presentation durations, and it linked the preferential gaze tendency to thinner body ideals at posttest. These two studies reveal that perceivers' spontaneous viewing tendencies can act as a natural form of visual adaptation, exacerbating preferences for thin bodies. Study 10 integrated findings from the previous studies, revealing that directing perceivers' visual attention toward thin or fat bodies altered the preferential gaze tendency described above, subsequently shifting evaluative biases that result from visual adaptation.

Collectively, these findings provide support for Hypotheses 2a and 2b, extending my initial insights about the evaluative impact of visual adaptation from gendered facial cues to bodies varying in adiposity. In fact, the primary findings linking visual adaptation to evaluative biases were identical across Study Sets 1 and 2, albeit through different mechanisms. Study Set 1 revealed that visual adaptation enhances social evaluations by altering the prototypicality of gendered facial features, whereas Study Set 2 revealed that visual adaptation enhances social evaluations by altering the threshold for categorizing others as fat. Collectively, then, the data presented here provide robust support for the social evaluative implications of visual adaptation to a diverse set of human features.

Aside from supporting the current hypotheses, findings from Study Set 2 offer theoretical advances to several areas of psychological research. First, they extend emerging literature about the evaluative implications of visual adaptation. Although a handful of studies have demonstrated that visual adaptation alters evaluative judgments related to human features, those studies have relied almost exclusively on adaptation to caricatured facial phenotypes (Principe & Langlois, 2012; Rhodes et al., 2002). The current research extends these findings by demonstrating that visual adaptation also alters a broad set of social evaluations related to body appearance. While some prior work (Robinson & Christiansen, 2014; Winkler & Rhodes, 2005) provided preliminary evidence that visual exposure molds evaluative preferences related to body weight, that work was limited in important ways. For example, the aftereffects in Winkler and Rhodes (2005) were not bi-directional: Adaptation to compressed ("thin") bodies exacerbated weight bias, but adaptation to stretched ("fat") bodies did not alter weight bias. In contrast, the current studies provide clear evidence that body adaptation occurs in both directions, highlighting the potential for visual adaptation paradigms not only to enhance understanding about the formation of weight bias, but also to reduce weight bias.

The preferential gaze tendencies documented in Studies 8-10 also provide theoretical advances to the growing literature on visual adaptation. Whereas previous laboratory studies demonstrated that exposing perceivers to stigmatized group members one at a time in rapid succession can alter evaluative biases for other members of that group (Principe & Langlois, 2012; Rhodes et al., 2003), the ecological validity of this method was limited. Studies 8-9 reveal how visual adaptation functions when perceivers encounter multiple bodies at once: Faced with an array depicting both thin and fat bodies, perceivers preferentially gazed at thin bodies longer than fat bodies, which predicted a preference for thinness downstream. These findings pave the way for new investigations of how visual adaptation effects emerge in vivo, and they contribute to a burgeoning literature demonstrating that perceivers visually engage with some social targets more readily than others (see Bean et al., 2012; Trawalter et al., 2008; Van Bavel & Cunningham, 2012). The field is now well poised to test the evaluative consequences of preferential gaze tendencies for other stigmatized groups.

In addition to these advances for theories of visual adaptation, Study Set 2 provides new insights about the perceptual underpinnings of weight bias. The psychological factors guiding the development and maintenance of weight bias have only recently become a topic of serious inquiry, and existing studies have done a fine job highlighting the roles that disgust sensitivity and lay theories about the malleability of weight play in the expression of anti-fat bias (Lieberman et al., 2012; Park et al., 2007; Puhl & Brownell, 2003; Vartanian, 2010b). The current work builds upon that foundation by implicating low-level perceptual processes in the emergence of weight bias. Specifically, Study Set 2 reveals that exposure to thin bodies exacerbates perceivers' tendency to evaluate thin bodies more favorably than fat bodies. This conclusion may seem counterintuitive given that rates of overweight and obesity are very high in the U.S. (Hedley et al., 2004; Flegal et al., 2012), but it is consistent with a severe overrepresentation of thin people in popular media (Klein & Shiffman, 2005) as well as the fact that perceivers visually attend toward thin bodies more than fat bodies when presented with both simultaneously (Studies 8 and 9). Weight bias may be rampant in part because perceivers are consistently exposed to thin bodies, either via media depictions or personal gaze preferences.

Findings from Study Set 2 also help to resolve a tension in the literature on social evaluations drawn from body cues. Previous researchers convincingly argued that a certain amount of body fat is critical for reproductive success (see Singh, 1993). In fact, body fat is positively associated with the ability for women to conceive (Kaye et al., 1990), and women with very low levels of body fat stop menstruating prematurely (Frisch, 1990; Frisch & McCarthur, 1974). At the same time, contemporary research has consistently shown that Western perceivers express a great deal of prejudice against fat women (Puhl & Heuer, 2009), and that perceivers actually prefer female body shapes that fall outside the range of natural human variation (Johnson & Tassinary, 2007). If heavier bodies indicate better health and fertility than extremely thin bodies, then why have Western body ideals become progressively thinner over the past century (Garner, Garfinkel, Schwartz, & Thompson, 1980; Spitzer, Henderson, & Zivian, 1999), and why do contemporary Americans prefer body shapes that do not exist in nature (Johnson & Tassinary, 2007)? Study Set 2 suggests that visual adaptation helps calibrate body ideals, insofar as repeated visual exposure to thin bodies results in aftereffects that dictate a strong preference for thinness. Indeed, recent data provide evidence for natural variations in weight-related attitudes as a function of population demographics: Perceivers living in countries with higher prevalence of obesity had a higher perceptual threshold for labeling others as fat relative to perceivers who lived in countries with lower prevalence rates of obesity (Johnson et al., 2015). Along with findings like these, the current studies paint a more complete picture of the myriad psychological processes involved in the formation of attitudes related to body weight.

In terms of application, understanding the evaluative implications of visual adaptation to human bodies may help to guide the development of new strategies for mitigating weight bias. Study 7 revealed that just three minutes of visual exposure to fat bodies significantly reduced weight bias, and Study 10 revealed that directed gaze manipulations can overcome the biased tendency for perceivers to gaze at thin bodies more than fat bodies. Because previous attempts to reduce weight bias have been met with limited success despite often involving expensive or time-consuming methods (Daníelsdóttir, et al., 2010; Lee et al., 2014; Puhl & Heuer, 2009), these findings highlight an important step forward in the scientific quest to curtail weight bias. Specifically, Studies 6-10 suggest that simply increasing the representation of fat bodies in perceptually salient domains may help to alleviate weight bias. Policymakers around the world have already begun nudging media organizations in this direction. For example, the French legislature recently banned advertisements depicting models with BMIs < 18, with violations punishable by up to 6 months in prison (Stampler, 2015). Similar policies in other countries seek to ban photoshopping of models to make them appear unrealistically thin (Weissman, 2014). The adoption of these policies affords psychologists a unique opportunity to track weight bias as a function of cultural shifts in visual representations of thin and fat bodies.

That being said, three points about the current studies deserve empirical attention in the near future. First, it bears repeating that the aftereffects I observed were relatively impervious to moderation by perceiver characteristics. Although the threshold shifts that occurred as a function of visual adaptation in Study 6 were especially pronounced among perceivers with low BMI and high appearance-related self-esteem, and the evaluative shifts that occurred as a function of visual adaptation in Study 10 were especially pronounced among perceivers low in moral disgust sensitivity, the overall pattern of effects across studies provides limited evidence of moderation by perceiver-level factors. I suspect that part of the reason for these null results is that adaptation aftereffects are relatively low-level phenomena that rely on basic visual processes. I also recognize that the absence of statistical significance does not necessarily indicate the absence of an effect. Therefore, it will be important for future researchers to continue clarifying the perceiver-level factors that might (moral disgust sensitivity) and might not (self-perceived weight status; motivations to control prejudice) moderate evaluative aftereffects.

Second, throughout Study Set 2, visual adaptation altered evaluative judgments of discrete and visible targets. Adaptation did not, however, alter overall ratings of weight bias measured in terms of individual differences (e.g., the anti-fat attitudes measure developed by Crandall, 1994). This makes theoretical sense, insofar as visual adaptation impacts evaluations by modulating the perception of physical phenotypes (e.g., body weight); thus, I would only expect adaptation to impact evaluations of social targets that a perceiver can actually see. Still, the point deserves more attention in the future. It will be especially important to consider whether and how visual adaptation alters other forms of weight bias that arise on the basis of visible features, such as implicit bias and behavioral discrimination against fat targets. These sorts of dependent measures will reduce concerns about demand characteristics and also probe the generality of evaluative aftereffects that emerge as a function of visual adaptation. As we continue to hone our understanding of visual adaptation and its implications for various forms of social evaluation, we may be able to provide more nuanced recommendations to applied scientists working to correct social injustices related to body weight.

Lastly, it remains unclear how long these evaluative aftereffects last. Previous studies indicated that higher-level visual aftereffects decay relatively quickly (Webster et al., 2005), but more recent studies suggested that aftereffects involving facial features can last up to a week (Carbon & Ditye, 2011). In fact, one team has shown traces of face aftereffects after multiple days even when the adaptation and test periods occurred in different settings (Carbon & Ditye, 2012). These findings raise the intriguing possibility that visual adaptation may have enduring effects on social evaluation, but the existing studies rely exclusively on aftereffects involving facial distortions rather than evaluative judgments. Future research will be necessary to determine the decay rate of evaluative aftereffects in general, and body-related evaluative aftereffects specifically.

In summary, weight bias has deep roots in human perception. Perceivers tend to gaze at thin bodies more than fat bodies, resulting in a relatively low threshold for categorizing others as fat as well as weight bias against targets with high relatively high levels of adiposity. But the news is not all bad: Overcoming preferential gaze tendencies by experimentally exposing perceivers to fat bodies reliably reduces weight bias. Relatively minor changes to one's visual environment can recalibrate body ideals and mitigate weight biases common among Western perceivers.

CONCLUSION

Social Implications of Visual Adaptation to Human Features

Impression Formation: Past and Present

Love at first sight. Don't judge a book by its cover. You never get a second chance to make a first impression. Despite their hackneyed generality, these anecdotes nicely summarize conclusions from empirical research on impression formation. Indeed, recent studies in the social and cognitive sciences have shown that human perceivers begin forming evaluative impressions of others' attractiveness, trustworthiness, dominance, and likeability after mere milliseconds of visual exposure (Johnson & Tassinary, 2007; Todorov, Pakrashi, & Oosterhof, 2009; Willis & Todorov, 2006). Although these impressions emerge rapidly, they are nevertheless associated with serious consequences ranging from the electoral success of politicians (Hehman, Carpinella, Johnson, Leitner, & Freeman, 2014) to financial profitability among CEOs (Rule & Ambady, 2008b), capital sentencing of criminal defendants (Eberhardt, Davies, Purdie-Vaughns, & Johnson, 2006), and explicit prejudice directed at members of stigmatized groups (Lick & Johnson, 2014). Therefore, understanding the proximal underpinnings of first impressions – especially impressions associated with prejudice – represents a critical topic for research.

Early theories highlighted social categorization as a fundamental precursor of impression formation generally and prejudice expression more specifically. Indeed, volumes of research have revealed that perceivers rapidly and unconsciously sort others into groups on the basis of their age, sex, race, sexual orientation, and other attributes (Allport, 1954; Ito & Urland, 2003; Macrae & Martin, 2006; Stroessner, Haines, Sherman, & Kantrowitz, 2010; Rule & Ambady, 2008a; Taylor, Fiske, Etcoff, & Ruderman, 1978). Moreover, categorization predicts negative impressions of those belonging to stigmatized groups (Bodenhausen & Macrae, 1998; Dovidio et al., 1986; Gilbert & Hixon, 1991; Grant & Holmes, 1981; Sinclair & Kunda, 1999). For example, merely recognizing an African American man's race activates stereotypes associated with that race category (e.g., aggressive), which in turn arouse negative evaluative impressions and give rise to discriminatory behavior (Bargh, Chen, & Burrows, 1996). These observations and others like them have revealed that social categorization helps explain how and why perceivers form prejudiced evaluations of others on the basis of minimal exposure (Brewer, 1988; Devine, 1989; Fiske & Neuberg, 1990).

Although existing theories of impression formation have been incredibly fruitful, they have consistently taken the act of categorization as their starting point. This work has clearly demonstrated that the act of noticing someone's social group memberships predicts evaluative judgments of them, but it has simultaneously obscured other important aspects of categorization that might play a role (see Park & Judd, 2005). Might there be factors proximal to the act of categorization that also predict evaluative impressions? And if so, what can be gained by incorporating them into established theories? Here, I argue that theories of impression formation could benefit from a more careful consideration of the mental representations on which categorizations are based. Theoretically, perceivers store representations of various social categories in memory, and they compare novel targets to those representations in order to determine whether or not the targets belong to the category in question (Dotsch & Todorov, 2012; Smith & Zarate, 1990). Two aspects of these category representations seem especially important to the study of impression formation. First is the *category threshold*, which indicates the perceptual boundary at which a category begins. Targets with phenotypic features that exceed the threshold will be categorized as members of the group, whereas targets with features that do not exceed the threshold will not be categorized as members of the group. To make this point more concrete, consider the category “fat.” If a perceiver’s threshold for categorizing another person as fat is a BMI of 25, then a target with a BMI of 24 would not be categorized as fat whereas a target with a BMI of 26 would not. Thresholds are therefore critical to understanding impression formation because they predict whether or not targets will be categorized as members of a stigmatized group in the first place.

A second aspect of perceivers’ category representations is the *category prototype*, which indicates the central tendency of all exemplars contained within a given category. Perceivers readily extract prototypes based on their experiences with individual members of a category (Bransford & Franks, 1971), and they evaluate individual category members based on their fit within the prototype (Posner & Keele, 1964). Indeed, perceivers report more favorable affective responses to prototypical relative to non-prototypical category members (Gordon & Holyoak, 1983), and this observation holds for an impressive array of stimuli ranging from birds, fish, automobiles, dogs, and wristwatches (Halberstadt & Rhodes, 2000; 2003) to hypothetical people (Forgas, 1985; Perry, 1994) and real people depicted in photographs (Langlois & Roggman, 1990; Rhodes & Tremewan, 1996). In fact, the preference for prototypes appears stable within persons throughout development (Vingilis-Jaremko & Maurer, 2013) and between persons in diverse cultural contexts (Apicella et al., 2007). Thus, prototypes help to explain evaluative judgments within a category, such that targets with prototypical features tend to be evaluated more positively than targets with non-prototypical features.

Thus, thresholds and prototypes are two aspects of category representation that predict evaluative judgments of individual category members. Perhaps surprisingly, however, these concepts have received short shrift in social cognitive theories of impression formation, which have historically taken the act of categorization as their starting point. Still, incorporating these two aspects of category representation into our theories seems like a worthwhile venture, especially given recent evidence suggesting that both category thresholds and category prototypes malleable. Indeed, the application of visual adaptation paradigms in social perception research has revealed that category representations are efficiently calibrated on the basis of recent visual exposure: As perceivers are exposed to members of a given category, the threshold and prototype for that category shift, altering social evaluations of subsequently encountered individuals (Lick & Johnson, 2014c; Principe & Langlois, 2012; Rhodes et al., 2003).[17] These findings are exciting because they offer a mechanistic explanation for how evaluative judgments are calibrated on the basis of visual exposure to members of diverse social groups, and also because they may spur the development of simple and cost-effective interventions aimed at reducing social ills that result from biased first impressions. I review these developments here, beginning with a historical overview of research on visual adaptation before describing contemporary studies that highlight the utility of this approach for the psychological study of impression formation.

Early Research on Visual Adaptation: Low-Level Visual Aftereffects

Human perception is remarkably plastic. For millennia, researchers and laypeople alike

[17] At first glance, these findings may seem reminiscent of several other psychological phenomena. For example, evaluative aftereffects might appear similar to the mere exposure effect, wherein repeated exposure to a stimulus enhances evaluations of that stimulus (Zajonc, 1968; see also Pliner, 1982; Reber et al., 2004). Importantly, however, the mere exposure effect relies on repeated exposure to the same stimulus over time. In contrast, visual adaptation paradigms expose perceivers to a general feature (e.g., large noses) that generalizes to a whole class of stimuli (e.g., faces). Evaluative aftereffects are also distinct from other phenomena such as object priming and contrast effects. For example, visual adaptation often results in repulsive aftereffects, such as when adaptation to male faces causes a neutral face to appear female (Webster et al., 2004). Priming, on the other hand, generally leads to attractive effects, such as when priming perceivers with a female face increases the speed of sex categorizations for subsequent females (Tulving & Schacter, 1990). Moreover, the strength of visual aftereffects increase logarithmically as a function of the duration of the adaptation (Leopold et al., 2005), whereas both priming and contrast effects tend to be similar in magnitude when based on a single exposure or multiple repeated exposures (Schacter & Buckner, 1998). Finally, higher-level visual aftereffects last for considerably longer (up to a week; Strobach & Carbon, 2013) than traditional priming and contrast effects, which often decay in a matter of seconds (Macknik & Livingstone, 1998). Thus, there is strong evidence to suggest that visual adaptation and its attendant aftereffects are distinguishable from other cognitive mechanisms that emerge following exposure to a stimulus.

have recognized that prolonged exposure to a particular stimulus (*adaptation*) results in noteworthy perceptual changes that alter the appearance of subsequently encountered stimuli (*aftereffects*). Aristotle (ca 330 B.C.) was perhaps the first to document this fact when he described the striking effects of visual adaptation to motion: “When persons turn away from looking at objects in motion, e.g., rivers, and especially those which flow very rapidly, they find that the visual stimulations still present themselves, for the things really at rest are then seen moving” (Ross, 1931, p. 459). Purkinje (1825) and Addams (1834) later rediscovered the motion aftereffect and brought it to the attention of the scientific community. From then on, empirical interest in this phenomenon has boomed, resulting in an impressive body of research about visual adaptation and its perceptual aftereffects.

Today, adaptation has become so central to the study of perception that it is considered the “psychologist’s microelectrode” (Frisby, 1979). The reason for this is because visual adaptation provides a behavioral method for probing the functional properties of the neural architecture underlying human perception. It is now clear that perceptual aftereffects occur because adaptation to a given feature alters the activity of neurons that respond to that feature (Ibbotson, 2005). For example, repeated exposure to downward motion causes the neurons that code for downward motion to reduce their firing rate. When a stationary object appears in the visual field, those neurons remain selectively inactive, resulting in an imbalance of neural activity that causes the stationary object to appear as it if is drifting upward (Blakemore & Campbell, 1969; Bednar & Mukkulainen, 2000). This neural mechanism generalizes across adaptation to multiple stimulus features, helping to explain aftereffects related to motion (Blakemore & Campbell, 1969; Bednar & Mukkulainen, 2000), color (Barbur, Weiskrantz, & Harlow, 1999; McCullough, 1965), size (Blakemore & Sutton, 1968), and orientation (Coltheart, 1971; Gibson & Radner, 1937). In general, then, visual adaptation occurs when prolonged exposure to a particular stimulus feature decreases the activity of neurons coding for that feature, which biases the perception of subsequent stimuli in the opposite direction of adaptation. Although it can result in perceptual illusions, adaptation is considered highly functional insofar as it reduces energy expenditure by removing redundant information from visual processing (Barlow, 1990; Leopold, Bondar, & Giese, 2006).

Contemporary Research on Visual Adaptation: Higher-Level Visual Aftereffects

As described above, adaptation is a functional property of human perception that rapidly tunes the visual system to its environment. This process is ubiquitous in low-level vision, characterizing the perception of many different stimulus features (e.g., color, motion, size, orientation). Given the common neural mechanism underlying these various adaptation effects, contemporary researchers have pondered: Does adaptation also occur in higher-level vision? That is, might perceivers adapt to features contained in the faces and bodies of other people, and if so, how are these higher-level aftereffects related to those documented for lower-level stimulus properties?

The past decade bore witness to an impressive number of studies indicating that visual adaptation affects higher-level vision. Initial work served as an existence-proof of the phenomenon by adapting perceivers to figural distortions in facial photographs: Adaptation to faces that were digitally altered to have their features compressed inward toward the center made unaltered faces appear distorted in the opposite direction (i.e., expanded outward from the center; Rhodes, Jeffery, Watson, Clifford, & Nakayama, 2003). Other work built upon this finding by documenting implications of adaptation to more natural variations in facial appearance. For example, several studies revealed that adaptation to a particular facial identity (“Dan”) biased the perception of subsequent faces away from that identity, making them appear to have features that were the mathematical opposite of Dan's features ("anti-Dan;" Leopold et al., 2001; Rhodes & Jeffery, 2006). Aside from synthetic distortions and facial identities, perceivers also adapt to more natural phenotypes, shifting the threshold for categorization along a given dimension. For example, adaptation to male faces causes observers' face prototype to become male-typed, leading them to categorize an androgynous face as female (and vice-versa; Webster, Kaping, Mizokami, & Duhamel, 2004). Similar effects occur for adaptation to faces varying in their racial phenotype (White / Asian), emotion expression (angry / happy; Webster et al., 2004), and biological age (young / old; O'Neil, Mac, Rhodes, & Webster, 2014).

The perceptual effects of adaptation to social features are not restricted to faces; similar processes occur for the perception of human bodies. For example, adaptation to female bodies that were digitally compressed to appear thin caused similarly compressed bodies to appear normative and unaltered bodies to appear fat, whereas adaptation to female bodies that were digitally expanded to appear fat caused similarly expanded bodies to appear normative and unaltered bodies to appear thin (Winkler & Rhodes, 2005). These effects replicate with male bodies that vary more naturally in adiposity rather than being digitally stretched or compressed (Robinson & Christiansen, 2014). Even more intriguing, some recent evidence suggests that adaptation is not restricted to static images: Exposure to biological motion displays moving in one direction biases the perceived motion of subsequently encountered images toward the opposite direction (Barraclough et al., 2012). Collectively, these results suggest that human vision adapts not only to low-level stimulus features, such as color and orientation, but also higher-level features contained in the face and body. Such higher-level adaptation effects alter both the threshold for categorization along a given dimension and the perceptual norm, or prototype, for a given category.

One important question about these higher-level aftereffects is whether they represent the same phenomenon as the lower-level aftereffects that have been documented for centuries. While they have generally gone by the same name, lower-level aftereffects and higher-level aftereffects have some notable differences. For example, higher-level aftereffects survive changes in size, orientation, and viewpoint between adapting and test stimuli, whereas lower-level aftereffects generally do not (Jeffery, Rhodes, & Busey, 2006; Rhodes et al., 2003). Furthermore, higher-level adaptation can result in measurable aftereffects that last up to one week, whereas lower-level aftereffects typically decay within a matter of seconds (Carbon & Ditye, 2011; Carbon & Ditye, 2012). Despite these differences, current consensus is that adaptation to low-level stimulus features and higher-level stimulus features reflect the same basic neural process. Evidence for this claim comes in two varieties. First, lower-level aftereffects and higher-level aftereffects follow similar temporal dynamics: Both grow logarithmically stronger as a function of adaptation duration and both show a power-law relationship between extremity of the adaptation and strength of the aftereffect (Leopold, Rhodes, Muller, & Jeffery, 2005). Second, lower-level aftereffects and higher-level aftereffects rely on the same neural coding principles (Strobach & Carbon, 2013). As with lower-level aftereffects, adaptation to higher-level features systematically reduces neural activity in brain regions associated with face and body perception (Burkhardt et al., 2010; Calder et al., 2007; Fu et al., 2014; Furl, Rijsbergen, Treves, & Dolan, 2007; Hummel et al., 2012; Kovacs et al., 2006; Winston, Henson, Fine-Goulden, & Dolan, 2004). In fact, the strength of the perceptual aftereffect following adaptation to human faces can be predicted by the amount of decrease in BOLD activation across occipito-temporal regions associated with face processing (Cziraki, Greenlee, & Kovacs, 2010).

How is it that the same neural coding mechanism can underlie lower-level and higher-level visual aftereffects yet result in noticeably different outcomes (e.g., higher-level aftereffects surviving changes in size, orientation, and viewpoint between adapting and test stimuli)? One explanation is that the visual system is organized hierarchically, with lower cortical areas processing basic stimulus properties (e.g., color and motion) and higher cortical areas processing more complex stimulus (e.g., facial identity). Adaptation to low-level stimulus features affects neurons in the lower cortices, which are highly sensitive to changes in stimulus presentation (Ibbotson, 2005). Adaptation to higher-level stimulus features affects neurons in the higher cortices, which represent stimulus categories more abstractly rather than in terms of their individual elements (Cziraki et al., 2010; Hummel et al., 2012). Higher-level visual adaptation is thought to alter the conceptual representation of a category by acting on neurons with more complex and larger receptive fields than those in the lower cortices (Kovács, Cziraki, Vidnyánszky, Schweinberger, & Greenlee, 2008). This is why, for example, perceivers can adapt to the average gender phenotype of a group of faces and still show aftereffects for the perception of gender on subsequently encountered individuals (Nagy, Zimmer, Greenlee, & Kovacs 2012), and also why adaptation to gendered face silhouettes results in aftereffects for forward-oriented faces (Davidenko, Winawer, & Witthoft, 2006). Put another way, higher-level visual adaptation alters the conceptual representation of a category rather than merely its low-level retinotopic features.

After the Effect: Evaluative Implications of Higher-Level Visual Adaptation

As the above review attests, evidence for adaptation and aftereffects in higher-level vision has accrued at a remarkable pace. The growth of this literature is due in part to its implications for cognitive models of face processing. In particular, higher-level aftereffects provided empirical support for the norm-based coding mechanism implied by Valentine's (1991) influential face space model. Broadly construed, this model proposes that perceivers encode faces as points within a multi-dimensional space, where each dimension represents a feature that varies across the population (e.g., nose size). The center of the face space represents the prototypical face, which takes on average values for all of the phenotypic dimensions described by the space. Theoretically, each newly encountered face is coded in relation to this prototype, with similar faces falling close to the norm and dissimilar faces falling further from the norm. Faces falling too far from the norm are perceived as belonging to a different category altogether. Research on higher-level visual aftereffects has provided compelling support for this norm-based coding mechanism of face perception. For example, Rhodes and colleagues (2003) demonstrated that visual adaptation to figurally distorted faces shifted perceivers' prototype for facial phenotypes: Adaptation to extremely compressed faces caused a slightly compressed face to appear increasingly normative, whereas adaptation to extremely expanded faces caused a slightly expanded face to appear increasingly normative. Similar effects emerge for perceptions of other phenotypic features, including eye spacing (Little, DeBruine, Jones, & Waitt, 2008), symmetry (Rhodes, Louw, & Evangelista, 2009), and race / gender typicality (Webster et al., 2004). Altogether, these findings suggest that face space is calibrated to match the features perceivers encounter most often, and relatively brief exposure to faces with a particular phenotype can shift the center of face space and alter the perception of subsequent faces.

The observation that visual adaptation shifts perceptual norms and category thresholds is not only relevant to models of face coding; as noted in the introduction, it also has important implications for theories of impression formation. Indeed, given perceivers' robust preference for prototypical category members (Forgas, 1985; Gordon & Holyoak, 1983; Halberstadt & Rhodes, 2000; Halberstadt & Rhodes, 2003; Langlois & Roggman, 1990; Perry, 1994), the fact that visual adaptation shifts the prototype for a given category should impact social evaluations of individuals belonging to that category. For example, adaptation to faces with a particular phenotype should make that phenotype appear increasingly prototypical, and in doing so, lead to more favorable evaluations of targets who embody it (as well as less favorable evaluations of targets who do not). Similarly, shifting the threshold for categorization along a stigmatized dimension alters the likelihood that some targets will face negative evaluations: If adaptation to male faces decreases the threshold for female categorizations, then more targets will be categorized as female, increasing the likelihood that those targets will experience biases related to sex category membership. It is worth noting that although adaptation may alter social evaluations via two distinct pathways (i.e., category prototypes and category thresholds), both of these pathways result in the same evaluative outcome: Adaptation to a given stimulus feature enhances evaluations of targets with similar features. With regard to prototypes, adaptation to masculine female faces may cause masculine features to appear more normative for women, resulting in favorable evaluations of similar women. With regard to category thresholds, adaptation to bodies with high adiposity may increase the threshold for categorizing others as fat, resulting in more favorable evaluations of bodies with high adiposity. So regardless of the specific mechanism, adaptation should enhance evaluations of targets that share features with the adapting stimuli. Researchers have only recently begun testing these evaluative implications of visual adaptation to higher-level features, but the results are remarkably consistent.

Early work highlighted adaptation's impact on attractiveness ratings. In the first study of this sort, adaptation to faces that were digitally altered to have their features compressed inward toward the center or expanded outward from the center caused faces with similar distortions to appear increasingly attractive (Rhodes et al., 2003). Similar effects have been documented with other facial distortions, such as features that are displaced to be unnaturally high or low on the face (Cooper, Geldart, Mondloch, & Maurer, 2006). Although these findings clearly showed that adaptation alters attractiveness ratings of human faces, one critique is that the adapting stimuli were digitally distorted to have features that do not exist in nature (e.g., facial compression inward toward the center). Since then, however, similar aftereffects have emerged following adaptation to more natural facial features. For example, adaptation to especially "cute" infants reduced the apparent cuteness of infants with average features (Golle, Lisibach, Mast, & Lobmaier, 2013), and adaptation to highly attractive adult faces – whether captured in real photographs or classic paintings – resulted in the same pattern (Hayn-Leichsenring, Kloth, Schweinberger, & Redies, 2013). Moreover, adaptation to faces with bilateral asymmetries improved attractiveness ratings of adults with similar asymmetries (Rhodes, Louw, & Evangelista, 2009). Thus, whether manipulated digitally via computerized distortions or more ecologically via naturally occurring differences, adaptation to a particular facial feature makes faces with that feature appear increasingly attractive and faces without that feature appear increasingly unattractive.

As compelling as these attractiveness aftereffects are, if visual adaptation is to inform theories of impression formation, then it should also affect broader evaluative dimensions along with perceivers judge others. For example, some scholars have argued that trustworthiness is one of the primary evaluative dimensions along which perceivers evaluate others' faces (Todorov, 2008). Does adaptation affect this primary dimension of face evaluation? Recent evidence suggests the answer is yes. Indeed, adaptation to femininity – a correlate of facial trustworthiness – led to higher trustworthiness ratings of feminine faces but lower trustworthiness ratings of masculine faces (Buckingham et al., 2006). Similarly, adaptation to angry expressions – another correlate of facial trustworthiness – increased the apparent trustworthiness of neutral faces, presumably by making those faces appear happier than they actually were (Engell, Todorov, & Haxby 2010).

The most recent work on this topic has revealed that adaptation alters not only single dimensions of social evaluation, such as attractiveness and trustworthiness, but also more global impressions. In one series of studies, adaptation to male and female faces with extremely gendered phenotypes altered a broad set of social evaluations tapping the overall positivity of first impressions. Specifically, adaptation to hyper-masculine men and women led to globally favorable evaluations of targets with masculine phenotypes, and adaptation to hyper-feminine men and women led to globally favorable evaluations of targets with feminine phenotypes (Lick & Johnson, 2014c). Other studies lend further support this association between adaptation and general impressions: Adaptation to cross-species morphs of human / chimpanzee faces resulted in more positive affective responses over the *zygomaticus major* muscle group to similar faces (Principe & Langlois, 2012). Thus, adaptation alters generalized social judgments: Following adaptation, targets who share features with the adapting stimulus receive more globally favorable evaluations than others.

A handful of studies have begun to push these findings beyond face stimuli, suggesting that visual adaptation also calibrates social evaluative judgments drawn from other phenotypic cues. For example, adaptation to human bodies varying in adiposity alters explicit biases related to body weight: Perceivers adapted to thin bodies tend to show biased preferences for thin relative to fat targets, where perceivers adapted to fat bodies show less bias (Lick, Hunger, Tomiyama, & Johnson, 2015; Mele, Cazzato, & Urgesi, 2013; Winkler & Rhodes, 2005).

Adaptation to fat bodies even shifts the threshold at which perceivers consider a person to be healthy: Compared to perceivers adapted to thin exemplars, those adapted to fat exemplars considered heavier targets to be more healthy (Robinson & Kirkham, 2013). Altogether, these findings indicate that higher-level visual adaptation has broad implications for impression formation, whether the adaptation involves exposure to features contained in the face or body.

As the above review attests, a number of recent studies have forged links between visual adaptation and evaluative judgments of social stimuli. Relatively fewer studies have probed the mechanisms driving these effects, but preliminary data appear to support both of the accounts outlined above. The first is that adaptation enhances social evaluations by altering category thresholds. Several studies have provided evidence for this mechanism in the domain of body perception. For example, one research team showed that adaptation to male and female figures with low body mass index shifted the threshold for fat categorization downward (i.e., perceivers chose a thinner body as appearing fat after adaptation than before), whereas adaptation to male and female figures with high body mass index shifted the threshold for fat categorization upward (i.e., perceivers chose a fatter body as appearing fat after adaptation than before; Lick et al., 2015). These shifts in fat category thresholds helped to explain evaluative judgments related to body weight: Adaptation to fat bodies reduced explicit biases against fat targets because it shifted the threshold for fat categorization upward (Lick et al., 2015). Using a different method, Winkler and Rhodes (2005) found that adaptation to female bodies that were digitally compressed to appear thin caused unaltered bodies to appear fat, resulting in a stronger preference for thin bodies at posttest relative to pretest. Thus, one way in which adaptation enhances social evaluations is by altering the threshold for categorizing targets into a stigmatized group.

Other studies have highlighted prototype shifts as a mechanism underlying evaluative aftereffects. Rhodes and colleagues (2003) showed that adaptation to facial distortions led to correlated shifts in perceptual norms and attractiveness judgments: As faces that shared features with the adapting stimulus appeared increasingly normative, they were also rated as more attractive. A similar effect emerged in Lick and Johnson (2014), where shifts in perceived gender norms for men's and women's faces tracked shifts in global evaluations that occurred as a function of visual adaptation to highly gendered exemplars. Altogether, these findings pinpoint perceptual norms as a second mechanism by which adaptation enhances social evaluations.

Adaptation and Aftereffects in Vivo

Emerging findings therefore suggest a robust and generalizable link between visual adaptation and impressions of social stimuli. Specifically, adaptation to a given feature results in more favorable evaluations of stimuli with similar features, but less favorable evaluations of stimuli with dissimilar features. Still, the effects described up to this point emerged in carefully controlled laboratory settings. If adaptation has a strong and generalizable impact on impression formation, then natural variability in people's exposure to various stimulus features should result in evaluative aftereffects outside of the laboratory. Several lines of work have begun to provide evidence for adaptation effects in vivo, increasing the ecological validity of recent laboratory findings and lending further support to conclusions about the social evaluative consequences of visual adaptation. For example, some researchers have tested whether and how perceivers' natural gaze patterns set up visual adaptations without their conscious intent. Using eye-tracking technology, one team found that college-aged perceivers tended to gaze at thin bodies more often and for longer durations than fat bodies, and this preferential gaze tendency predicted stronger explicit biases against fat targets at posttest (Lick et al., 2015). Similar effects occur for faces: Without specific instructions, perceivers tended to gaze at attractive faces longer than unattractive faces when both were presented simultaneously, and this tendency predicted stronger preferences for the attractive faces at posttest (Jones, DeBruine, & Little, 2008). These studies suggest that perceivers' spontaneous viewing tendencies are biased toward some social targets over others, and that such preferential gaze tendencies act set up visual adaptations that heighten preferences for the stimuli with which perceivers visually engage.

Other studies have probed whether and how media exposure might induce visual adaptations that guide impression formation. Because visual media are a ubiquitous aspect of contemporary social life (Featherstone, 2009; Polivy & Herman, 2004; Schroeder, 2002), it seems reasonable to expect that the overrepresentation of certain phenotypes in popular media might result in adaptations that guide evaluative judgments of real people. Indeed, in one study, perceivers who reported more exposure to popular magazines that feature hyper-feminine women on the covers (e.g., *Cosmopolitan*) had a more feminized prototype for female faces and showed stronger preferences for feminine women, as well as stronger prejudice against masculine women, compared to those who reported less exposure to such magazines (Lick & Johnson, 2015b). A follow-up study provided experimental evidence by using magazine covers as stimuli in a traditional adaptation experiment: Perceivers exposed to magazine covers featuring hyper-feminine women showed stronger preferences for feminine women and stronger biases against masculine women compared to those in a control condition (Lick & Johnson, 2015b). These findings suggest that the overrepresentation of certain phenotypes in popular media may calibrate perceivers' preferences for various features.

Although not designed specifically to test the real-world implications of evaluative aftereffects, other work provides additional evidence for the emergence of evaluative aftereffects in vivo. For example, several studies have documented age-related changes in the perceived attractiveness of facial arrangements as a function of perceptual experience. Specifically, children's preference for the vertical placement of features on a face changes as they grow taller: 4-year-olds and 9-year-olds prefer features in a low position on the face, presumably because they tend to view faces by looking upward, whereas 12-year-olds and adults prefer features in the middle position on the face, presumably because they tend to view faces at eye-level (Cooper, Geldart, Mondloch, & Maurer, 2006; Geldart, 2011). Using quasi-experimental designs, others have found that students who attend same-sex schools have more extreme preferences for sexually dimorphic features that match the sex of their school relative to students who attend mixed-sex schools (Saxton, Little, DeBruine, Jones, & Roberts, 2009). Additional evidence comes from research on imprinting, which suggests that people tend to choose romantic partners whose facial features approximate those they interact with regularly. For example, people's romantic partners often share facial characteristics with their opposite-sex parent (Bereczkei, Hegedus, & Hajnal, 2009; Little, Penton-Voak, Burt, & Perrett, 2003), and people with older parents tend to rate unknown others who appear older as more attractive than those who appear younger (Perrett et al., 2002). Similarly, infants reared primarily by female caretakers tend to gaze longer at female faces relative to male faces, which has been interpreted as a preference for female phenotypes; the opposite is true for infants reared primarily by male caretakers (Quinn et al., 2002). In the domain of body weight, one recent study found that parents of overweight children think their children look "just right," perhaps because they have adapted to the children's body size (Duncan, Hansen, Wang, Yan, & Zhang, 2015). Finally, there is some evidence to suggest that people in close relationships (e.g., siblings, spouses) share more consensus in their attractiveness ratings of others than do strangers (Bronstad & Russell, 2007). This effect does not appear to be driven by genetic similarity, as there are no differences in consensus between biologically-related siblings and non-biologically-related spouses; instead, it is likely driven by the fact that people in close relationships with one another share more visual experiences than do strangers (Bronstad & Russell, 2007). Altogether, these findings reveal that the impact of visual adaptation on impression formation need not be constrained to the laboratory. Naturally occurring differences in gaze preference, media exposure, and social contact guide impression formation as predicted by theories of visual adaptation.

Theoretical Implications and Practical Applications

In summary, visual adaptation has played a critical role in theory development across multiple subdisciplines of psychology, especially the cognitive and vision sciences. Initially considered the "psychologist's microelectrode" for its ability to probe the neural coding mechanisms underlying object perception, more recent work has used visual adaptation methods to reveal important truths about higher-level social perception. For example, visual adaptation methods have provided compelling support for the norm-based coding principle of Valentine's (1991) face space model. This work only emerged within the past decade, but it has already garnered enough scientific interest to be the focus of thorough reviews (Webster, 2011). My goal here has not been to re-hash those points, but rather to summarize newer insights about the evaluative implications of visual adaptation to higher-level stimulus features. As described above, visual adaptation has broad and previously unrecognized implications for social evaluation. Specifically, emerging research suggests that adaptation not only shifts mental representations and perceptual features of a given stimulus category, but also evaluative judgments of individuals belonging to that category. This emerging literature offers exciting new developments for theories of impression formation as well as possibilities for interventions aimed at reducing the harmful consequences of biased first impressions.

Classic theories of impression formation pinpointed categorization as a strong predictor of social evaluative judgments. In general, these theories proposed that it was the act of categorizing someone as a member of a stigmatized group that led to negative evaluations and discriminatory behaviors (see Brewer, 1988; Devine, 1989; Fiske & Neuberg, 1990). Research on evaluative aftereffects augments this observation by clarifying that it is not just the act of categorization, but also a target's fit with the representation of their category that predicts impression formation. Indeed, social targets who are prototypical for a given category tend to be evaluated favorably (Forgas, 1985; Gordon & Holyoak, 1983; Halberstadt & Rhodes, 2000; Halberstadt & Rhodes, 2003; Langlois & Roggman, 1990; Perry, 1994), and the above review attests that relatively visual adaptation to members of a given category can alter the appearance of that prototype, with concomitant effects on social evaluation. Moreover, adaptation alters the threshold for categorization along a given dimension, forestalling some negative social evaluations by reducing the likelihood that targets will be categorized as members of a stigmatized group. These observations are critical to our understanding of impression formation because they reveal that human preferences and prejudices related to social categories are not fixed, but malleable on the basis of visual exposure.

The power of this conclusion lies in its ability to predict both extremes of impression formation – the positive and the negative. Indeed, visual adaptation helps to explain why contemporary perceivers prefer women with hyper-feminine facial features and extremely thin bodies: They are exposed to these phenotypes in perceptually salient domains, such as media, and they engage with them more readily than other women under natural viewing conditions. The same mechanism helps to explain why contemporary perceivers express prejudice against women with masculine facial features and heavier bodies: They have less exposure to these phenotypes, which makes them appear non-prototypical and subsequently results in negative social evaluations. Visual adaptation therefore offers a mechanistic account for differences in perceivers' evaluations of targets within a given category, specifying that adaptation shifts the category prototype and calibrates evaluative preferences toward that prototype.

Aside from its contributions to theories of impression formation, visual adaptation also offers new possibilities for application. Indeed, several studies have shown that relatively brief adaptation to individuals belonging to stigmatized social groups (e.g., masculine women, overweight individuals) reduces explicit bias against other members of that group (Lick & Johnson, 2014; Lick et al., 2015). These findings suggest that visual adaptation may be a useful technique for reducing prejudices that have been notoriously difficult to overcome. Social cognitive theories that focused primarily on acts of categorization offered little in the way of prejudice reduction because it seems unlikely that psychologists could ever rid the human mind of categories (Park & Judd, 2005). After all, categories simplify the social world by allowing perceivers to make predictions about others on the basis of minimal information; without them, perceivers would be forced to individuate every person they encounter, which would be so computationally intensive that it would quickly become paralyzing (Fiske & Taylor, 1991). Visual adaptation sidesteps this issue by altering the representation of a category rather than attempting to eliminate the category entirely. Moreover, it does so readily, as evaluative aftereffects can be observed after just minutes of exposure to a particular phenotype. While it is still too early to offer strong recommendations about the use of visual adaptation techniques in interventions designed to reduce prejudice, the field is now ripe for additional studies that harness the perceptual system's adaptability in an attempt to reduce interpersonal bias.

Of course, the appeal of visual adaptation paradigms for the study of impression formation should not sponsor over-zealous claims. It would be unreasonable to expect that visual adaptation can replace classic theories of impression formation or eradicate all forms of intergroup bias. Indeed, many negative social impressions derive from processes that may not be grounded in category representations. Consider, for example, social groups associated with strong negative stereotypes (e.g., Black men). Although adaptation to Black male faces might cause those faces to appear more prototypical and subsequently improve social evaluations of them, adaptation alone is unlikely to eliminate the deeply ingrained belief that Black men are dangerous. This example suggests that visual adaptation may have its greatest value for understanding and altering biases related specifically to visible features, and not those rooted in negative stereotypes. It also bears noting that adaptation has a dark side, insofar as the benefits of exposing perceivers to the features of a stigmatized group can work in reverse. Indeed, repeated adaptation to features of stigmatized group members might eventually create a bias against the currently preferred group. All of this is to say that visual adaptation cannot and should not take the place of existing work on impression formation. Instead, visual adaptation is one part of a complex cognitive system that gives rise to interpersonal prejudice. It can help to explain and perhaps even alter some evaluative biases that were not adequately captured by existing models, but it will likely be most useful when integrated into the broader nomological network of social and cognitive processes involved in impression formation.

Current Limitations and Future Directions

Although the study of evaluative aftereffects has quickly gained traction, there are a number of outstanding questions to fuel future research. Four issues in particular seem critical for the next stage of theory development. First, the sensory specificity of evaluative aftereffects remains unclear. The existing literature has focused almost exclusively on the evaluative implications of visual adaptation, but there is some indication that adaptation is a general perceptual principle that applies across sensory modalities. Indeed, several studies have demonstrated that adaptation to auditory cues results in similar perceptual distortions as adaptation to visual cues (Belin & Zatorre, 2003; Bestelmeyer et al., 2010; Schweinberger et al., 2008). For example, adaptation to male voices made an androgynous voice sound female (Schweinberger et al., 2008), and adaptation to angry voices made a neutral voice sound fearful (Bestelmeyer et al., 2010). Although these findings indicate that adaptation and aftereffects occur in the auditory domain, it remains to be seen whether auditory adaptations predict social evaluations. Previous studies have shown that perceivers evaluate others based on their vocal characteristics (Ko, Judd, & Blair, 2006; Ko, Judd, & Stapel, 2009), so it will be intriguing to test whether and how adaptation to various auditory cues alters these evaluations. Extending findings about evaluative aftereffects from vision to audition and other sensory modalities may reveal broad and generalizable impacts of sensory exposure on social evaluation.

A second question that will require attention in the near future involves adaptation's effects on various types of social evaluation. With one exception, the evaluative aftereffects documented to date involve explicit judgments – perceivers are asked to report how attractive, trustworthy, or likeable a target appears before and after adaptation. The use of such explicit reports is justifiable insofar as perceivers often use their conscious attitudes to guide downstream behavior toward social targets, but it also bears noting that explicit reports are susceptible to socially desirable responding. Moreover, research in social psychology has consistently shown that implicit evaluations are more difficult to control than explicit evaluations, yet still predictive of behavior (Gaertner & Dovidio, 1986; Greenwald et al., 2014). So the question remains: Does adaptation only alter relatively explicit, controllable forms of social evaluation, or does it also alter more implicit, automatic evaluations? At least one study suggests that adaptation can affect the latter: Principe and Langlois (2010) found that adaptation to cross-species morphs of human / chimpanzee faces resulted in more positive affective responses to similar morphs, as indicated by electrical activity over the *zygomaticus major* muscle group involved in smiling. Replicating and extending these findings with other measures of implicit evaluation will help to clarify the extent of adaptation's effects on social evaluation.

A third issue future studies will need to resolve involves the decay rate of evaluative aftereffects. Previous work demonstrated that adaptation to higher-level stimulus features results in aftereffects that last considerably longer than those following adaptation to lower-level stimulus features; in fact, higher-level aftereffects persist for up to one week despite changes in the setting of the adaptation period and the test period (Carbon & Ditye, 2011; Carbon & Ditye, 2012). Importantly, however, studies highlighting the relatively slow decay of higher-level aftereffects have dealt with perceptual distortions rather than evaluative judgments. Additional work is necessary to extend these insights to the evaluative implications of adaptation to human features. This seems like an especially worthwhile venture, because evidence of long-lasting evaluative aftereffects would provide impetus for the development of intervention techniques that make use of visual adaptation paradigms to mitigate social biases.

Finally, there are unresolved methodological questions about the impact of task context on higher-level visual adaptation and its evaluative aftereffects. Existing studies vary markedly in the instructions they provide participants, where some require perceivers to make explicit category judgments before evaluating targets while others do not. The impact of these task demands on the formation of evaluative aftereffects remains unclear. To make this issue more concrete, consider a study in which perceivers evaluate female faces that vary in terms of their gender typicality (i.e., masculinity / femininity). If perceivers are given no instruction and simply evaluate the faces, will they show an evaluative bias against masculine women? Or must perceivers be thinking specifically about gender in order to demonstrate this bias? Even more importantly, will adaptation to masculine female faces shift the mental representation of women toward a masculine appearance if perceivers are not primed to think in terms of gender? There is some evidence to suggest that perceivers hold multiple face representations corresponding to different social groups (e.g., different representations for men and women; Jaquet & Rhodes, 2008). Task context, both in terms of the instructions provided to participants and the types of faces they see during testing, could impact which representation the adaptation affects. Does it shift the representation of female faces? Adult female faces? Black adult female faces? Although there is some evidence to suggest that higher-level aftereffects can transfer across social categories (e.g., from male to female faces or White to Asian faces; Jaquet & Rhodes, 2008; Jaquet, Rhodes, & Hayward, 2007), the strength of the aftereffect is noticeably weaker when adapting and test stimuli belong to different categories. Moving forward, it will be critical to understand how task context moderates the evaluative effects of adaptation to a given phenotype, as these contexts may provide some clues about situations in which adaptation will and will not impact evaluative judgments.

Conclusion

In conclusion, research at the intersection of vision science and social cognition has begun to highlight the evaluative implications of adaptation to human features. This work has shown that repeated exposure to a given feature alters the mental representation of social categories, and in doing so, enhances social evaluations of people with similar features. In this way, research on evaluative aftereffects has drawn attention to category representations as critical to the formation of first impressions. Human preferences and prejudices are calibrated on the basis of ongoing visual exposure that alters (1) the threshold for categorizing individuals as members of a category and (2) the prototype for members of that category. Although still relatively young, this field is maturing with impressive speed, due in part to its deep implications for theories of social evaluation and for practical applications aimed at reducing some longstanding forms of interpersonal bias. If the productivity of the past decade is even mildly predictive of the next decade, we will soon have a much deeper knowledge of the role that perceptual exposure plays in social evaluation and impression formation.

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