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The Face–Time Continuum: Lifespan Changes in Facial Width-to-Height Ratio Impact Aging-Associated Perceptions

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Abstract

Aging influences how a person is perceived on multiple dimensions (e.g., physical power). Here we examined how facial structure informs these evolving social perceptions. Recent work examining young adults' faces has revealed the impact of the facial width-to-height ratio (fWHR) on perceived traits, such that individuals with taller, thinner faces are perceived to be less aggressive, less physically powerful, and friendlier. These perceptions are similar to those stereotypically associated with older adults. Examining whether fWHR might contribute to these changing perceptions over the life span, we found that age provides a shifting context through which fWHR differentially impacts aging-related social perceptions (Study 1). In addition, archival analyses (Study 2) established that fWHR decreases across age, and a subsequent study found that fWHR mediated the relationship between target age and multiple aging-related perceptions (Study 3). The findings provide evidence that fWHR decreases across age and influences stereotypical perceptions that change with age.

Keywords

stereotypes, face perception, bizygomatic width, aging, impression formation

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Stereotypes are heuristics that enable individuals to quickly sort and categorize social information, allowing them to successfully navigate a complex social world. Prior to retrieving stereotype knowledge (e.g., older adults are physically frail), however, individuals must first use a target's identity cues to accurately categorize them (e.g., wrinkles = older adult). As such, these cues can influence social categorization and related stereotypical inferences. The current research examines how one such cue, an individual's facial width-to-height ratio (fWHR), may dynamically change over time as individuals age and be critical in eliciting numerous aging-related perceptions (e.g., physical power, wisdom).

Perceptual Determinants of Stereotypes

Stereotypes refer to associations between specific social groups and meaningful concepts that are learned and shaped by culture and experience (Allport, 1954). Stereotypes are useful in that they conserve an individual's mental resources. However, they can unfairly disadvantage targets by triggering numerous behavioral consequences, some conscious and overt yet others relatively nonconscious and subtle (Cuddy, Fiske, & Glick, 2007; Devine, 1989; Dovidio & Gaertner, 2000; Macrae & Bodenhausen, 2000). For instance, because of the association between older adults and decreased physical and social competence (Fiske, Cuddy, Glick, & Xu, 2002; Zebrowitz, Fellous, Mignault, & Andreoletti, 2003), when speaking with older adults, individuals tend to curtail their speech to short, simple sentences (Caporael & Culbertson, 1986), and avoid conversation topics of a serious or substantive nature (Grainger, Atkinson, & Coupland, 1990).

Before stereotype content can influence one's behavior, however, a potential target must be classified into a social category with which the stereotypic information is associated. People's physical features tell us which categories they might belong to, and accordingly the traits they are most likely to possess (Blair, Judd, Sadler, & Jenkins, 2002; Brewer, 1988; Cloutier, Mason, & Macrae, 2005; Mason, Cloutier, & Macrae, 2006). For instance, facial cues (e.g., wrinkles) activate social categories (e.g., older adult), which in turn activate associated stereotypic content (e.g., physical frailty).

Since another's face is often the first bit of information received about them, it is sensible that this information is used to form an initial impression. Sometimes, however,

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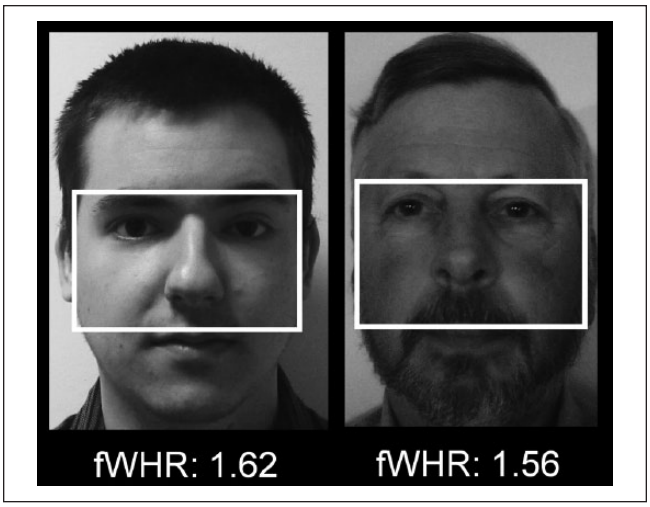

Figure 1. Example of fWHR.
Note. fWHR = facial width-to-height ratio.

facial cues are shared between multiple and distinct social categories. For instance, infants have wide eyes and rounded faces, and some individuals (i.e., baby-faced) retain these characteristics into adulthood (Zebrowitz & Montepare, 1992). Diverse models in person perception research, such as models of kin recognition (DeBruine, 2002; DeBruine, Jones, Little, & Perrett, 2008), compound-cues (Adams, Franklin, Nelson, & Stevenson, 2011), and neural networking (Freeman & Ambady, 2011; Zebrowitz et al., 2003) converge in concluding that shared cues among social groups contribute to similar impressions regarding individuals of these different groups. Thus, consistent with ecological perspectives on person perception (McArthur & Baron, 1983), facial cues that overlap between multiple social groups can lead to confounded perceptions and stereotypical inferences (Freeman, Johnson, Adams, & Ambady, 2012). For example, baby-faced adults and infants elicit similar neural activation (Zebrowitz, Luevano, Bronstad, & Aharon, 2009) and are similarly perceived to be warm and physically weak (Zebrowitz & Montepare, 1992). Indeed, the similarity of facial cues between two target categories can elicit similar perceptions even in situations in which it is not sensible, such as the attribution of human traits to dogs and lions, and vice-versa (Kwan, Gosling, & John, 2008; Zebrowitz et al., 2011).

fWHR and Aging

One facial cue receiving a surge of recent research is male fWHR, a metric linked with testosterone (Lefevre, Lewis, Perrett, & Penke, 2013; Penton-voak & Chen, 2004; Verdonck, Gaethofs, Carels, & de Zegher, 1999). fWHR is a face's bizygomatic width (i.e., the distance between the left and right zygion, or cheekbones) divided by upper facial height (i.e., the distance between the upper lip and mid-brow; Figure 1). Research has demonstrated that males with a larger fWHR are more likely to engage in deception (Haselhuhn & Wong, 2012), exploit the trust of others (Stirrat & Perrett, 2010), and behave aggressively (Carré & McCormick, 2008). Thus, fWHR can be an honest signal of behavior. Accordingly, perceivers utilize this metric to infer a target's attitudes or behaviors. Further, inferences of untrustworthiness (Stirrat & Perrett, 2010), aggression (Carré, McCormick, & Mondloch, 2009; Geniole, Keyes, Mondloch, Carré, & McCormick, 2012; Short et al., 2012), and decreased friendliness (Hehman, Leitner, Deegan, & Gaertner, 2013) are greater for males with a larger fWHR than their thinner faced peers. In females, relationships between fWHR and behavior (Carré & McCormick, 2008; Stirrat & Perrett, 2010), and fWHR and social perceptions (Geniole et al., 2012), have not been observed.

Thus, young males with low-fWHR are perceived as less physically intimidating, less aggressive, less socially dominant, friendlier, and more trustworthy (Carré et al., 2009; Hehman, Leitner, Deegan, & Gaertner, 2013; Hehman, Leitner, & Gaertner, 2013; Stirrat & Perrett, 2010). Intriguingly, the content of these perceptions is shared with stereotypical perceptions of the elderly, which include physical frailty, decreased social competence, and greater friendliness (Brewer, Dull, & Lui, 1981; Cuddy, Norton, & Fiske, 2005; Fiske et al., 2002; Kite & Johnson, 1988; Zebrowitz et al., 2003; Zebrowitz & Montepare, 1992). Drawing from the person perception research discussed above (DeBruine et al., 2008; Freeman & Ambady, 2011; Zebrowitz et al., 2003), similarities between impressions of older adults and younger low-fWHR individuals could be explained by overlapping phenotypic cues. Just as baby-faced adults are treated in a manner more similar to infants (Zebrowitz & Montepare, 1992), older adults and younger low-fWHR individuals may be evaluated more similarly if they share overlapping facial cues.

Because of the shared perceptions involving older adults and younger low-fWHR individuals, one likely candidate for this shared facial cue is fWHR. Given that fWHR is linked to aggression and pubertal testosterone (Carré & McCormick, 2008; Verdonck et al., 1999), and is utilized for a variety of perceptual judgments (Carré et al., 2009; Hehman, Leitner, Deegan, & Gaertner, 2013; Hehman, Leitner, & Gaertner, 2013; Stirrat & Perrett, 2010), fWHR may be an ecologically important cue to which perceivers are sensitively attuned. However, since fWHR is based on the underlying bone structure of the face, one may not intuitively expect it to vary with age. That said, the dermal layer of the face does indeed change greatly over time. Due to environmental exposure and natural structural degradation, the elastin and collagen in the dermis deteriorates as individuals age (Hamlin & Kohn, 1971; Yasui et al., 2013), resulting in sagging skin. While research examining fWHR draws conclusions about the underlying skull, measurement with living participants utilizes points on the facial surface acting as proxies for the region of interest of the skeletal structure. Importantly, these

surface structures (e.g., upper lip, brow) may be influenced by the process of aging (Hamlin & Kohn, 1971).

To our knowledge, no research has yet explored how fWHR might change over time, but this temporal change may be an important determinant of age-related perceptions. Here, we hypothesized that fWHR would decrease across the life span due to biologically and environmentally determined changes in the physical anatomy upon which perceptions of fWHR are based. Further, these changes may help determine stereotypical perceptions of individuals across the life span. More specifically, a negative relationship between age and fWHR would explain the shared content of perceptions regarding both older adults and younger low-fWHR individuals. As a face increases in age, biological factors may decrease its fWHR and thereby alter a number of judgments, such as perceived power. Observing such a relationship would implicate fWHR as an important determinant in stereotypical perceptions across the life span.

It is important to examine whether fWHR decreases across the lifespan and how it may contribute to and maintain age-related stereotypes because such stereotypes considerably impact the everyday experiences of older individuals. More than 44 million of the U.S. population are currently above 65 years (U.S. Census Bureau, 2010), yet the stereotyped perceptions of this large population by those younger are largely negative in nature (Kite & Johnson, 1988), and cluster around decreased power. Models of stereotype-driven behaviors posit that social groups low in power will be victims of passive harm through exclusion and deprivation (Cuddy et al., 2007), a prediction largely in accordance with ageism research revealing psychological abuse in hospitals and retirement homes (Bonnie & Wallace, 2003), or the denial of important medications to older adults (Jacobson, 2006). Being the target of such stigmatization and social exclusion can, in turn, have devastating effects on emotional, mental, and physical health (Baumeister & Leary, 1995; Eisenberger, Lieberman, & Williams, 2003; Pascoe & Smart Richman, 2009).

The Current Research

Thus, since fWHR is a critical factor in shaping perceptions of young adults, decreases in fWHR over time might additionally be a driving mechanism responsible for social perceptions that change as individuals age. In addition, age itself could provide a shifting context through which fWHR differentially impacts social perceptions. To better understand how perceptions of individuals across the life span might be driven by changing facial morphology, we adopted a two-prong approach. First, in Study 1, we independently manipulated age and fWHR using computer-generated faces, thereby permitting a direct, well-controlled test of our hypothesis that age provides a shifting context through which fWHR influences perceptions. While manipulating fWHR afforded precision, by itself it lacks generalizability to actual human population. Thus, in Studies 2A/2B and 3, we measured the fWHR of real faces varying in age to examine whether fWHR indeed contributes to aging-related perceptions. As such, Study 2A/2B initially sought to establish that fWHR changes as a function of a person's actual age, potentially implicating the cue in aging-related perceptions. Study 3 then directly examined whether the dynamics of fWHR over the life span indeed significantly contributes to aging-related social perceptions.

Study 1

We first sought to test whether fWHR influenced social perceptions differently across different ages. We dissociated the potential effects of fWHR and age on perceptions by separately manipulating these factors using computer-generated faces. Participants were presented computer-generated faces that independently varied in both age and fWHR, and evaluated these faces along several dimensions. Orthogonally manipulating fWHR and age afforded us the opportunity to examine their independent effects, and whether fWHR influenced perceptions differentially depending on the age of the target. In other words, because age and fWHR were manipulated to vary independently, age was treated as a theoretical moderator of the relationship between fWHR and perceptions of aggression, wisdom, and warmth. These characteristics were selected both to replicate established relationships between fWHR and perceptions that are unrelated to aging (i.e., aggression; Carré et al., 2009), as well as examine the role of fWHR in stereotypical perceptions associated with aging (i.e., wisdom, warmth; Fiske et al., 2002; Zebrowitz et al., 2003). An interaction between fWHR and age on any of these perceptions would be evidence that changes in age influence the manner in which fWHR affects perceptions. Based on the logic that fWHR contributes to the maintenance of age-related stereotypes, we hypothesized that fWHR would moderate perceptions of traits stereotypic of a particular age group. An advantage of this approach is that it allows us to examine the ages at which fWHR most strongly informs aging-related social perceptions.

Participants and Design

One hundred and seventy-six participants evaluated male faces through Amazon's Mechanical Turk in exchange for monetary compensation. Participants were completely anonymous, though prior research reports that users of Mechanical Turk are more diverse than undergraduate psychology students and provide a valid source of data (Buhrmester, Kwang, & Gosling, 2011; Paolacci, Chandler, & Ipeirotis, 2010). On a between-subjects basis, participants evaluated all faces on a 1 (*not at all*) to 7 (*very much*) scale regarding one of three dimensions: aggression (n = 44), wisdom (n = 69), and warmth (n = 63).

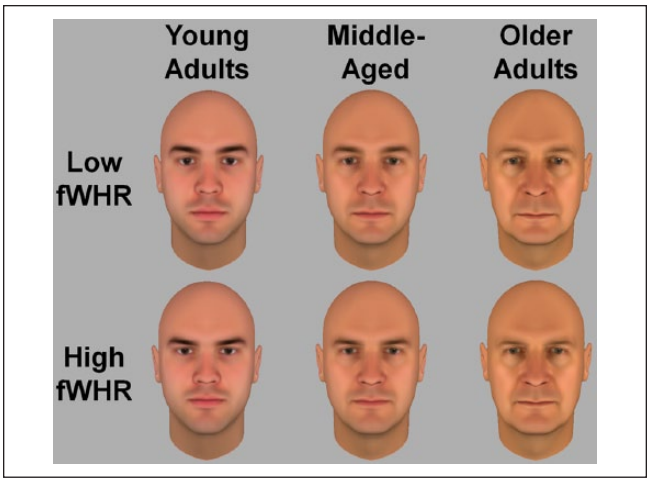

Figure 2. Example of computer-generated target identity in each condition.
Note. fWHR = facial width-to-height ratio.

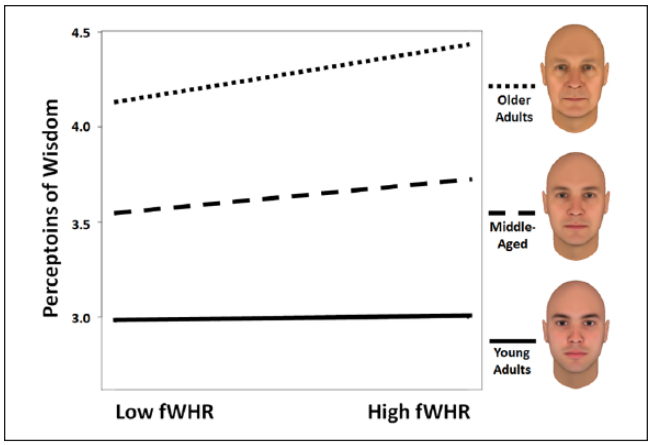

Figure 3. Relationships between fWHR and perceptions of wisdom for targets varying in age from Study 1.
Note. fWHR = facial width-to-height ratio.

Stimuli and Procedure

Using FaceGen (Singular Inversions, 2012), 30 White male computer-generated identities were created. All facial stimuli were directly oriented with a neutral expression and presented on gray backgrounds. All other factors (e.g., symmetry, internal facial structure) were allowed to vary randomly. Each identity was morphed along the age continuum to create three visual conditions: young adult (aged ~18), middle-aged (aged ~40), and older adult (aged ~70).[1] Targets in these three conditions were further manipulated such that, for each target, one version with high-fWHR ($M = 1.68$, $SE = .06$) and one with low-fWHR ($M = 1.53$, $SE = .06$) were produced, resulting in 180 total targets across 6 conditions. fWHR was manipulated by increasing the height of the brow-ridge and decreasing the mouth height, thereby influencing the horizontal borders of fWHR (Figure 2), utilizing benchmarks from previous research with real faces (Hehman, Leitner, & Gaertner, 2013).[2] Faces were presented in random order.

Normed Ratings

In addition, because the manipulation of fWHR adjusted the eye and brow areas of the face, and these areas are involved in emotional expression, it is possible that variations in perceived affect might contribute to our anticipated effects. To alleviate this concern, a separate sample of Mechanical Turk participants ($n = 31$) rated the perceived emotional expression of targets along a 1 (*very happy*) to 7 (*very angry*) continuum. Ratings of each stimulus were averaged and included in analyses as a statistical control.

Results

To account for the interdependence of target ratings within each participant, we analyzed data using multi-level modeling (Raudenbush, Bryk, & Congdon, 2004). Participants were treated as random (all intraclass correlation coefficients > .09). To examine how age and fWHR might jointly influence perceptions, participant perceptions were regressed on contrast coded variables representing differences in fWHR (low = −1, high = 1), age (young adult = −1, middle-aged = 0, older adult = 1), and their interaction. We present results for each trait separately below.

Aggression. Previous research has repeatedly demonstrated a positive relationship between fWHR and perceptions of aggression (Carré et al., 2009; Geniole et al., 2012; Short et al., 2012). This relationship was replicated when examining the effect of fWHR on perceptions of aggression ($\gamma_{10} = .514$, $SE = .040$, $p < .001$). Age of target did not influence these evaluations, however. No other effects were evident. This model explained 21% of the variance in aggression perceptions. These effects did not vary when emotional expression was included as a covariate.

Wisdom. Increases in both fWHR ($\gamma_{10} = .082$, $SE = .021$, $p < .001$) and age ($\gamma_{20} = .647$, $SE = .085$, $p < .001$) led to increased perceptions of wisdom. These main effects were further qualified by a fWHR × Age interaction ($\gamma_{30} = .071$, $SE = .016$, $p < .001$; Figure 3), decomposed using techniques specified by Preacher, Curran, and Bauer (2006). Results revealed that while fWHR was unrelated to perceptions of wisdom for young adults ($\gamma = .011$, $SE = .021$, $p = .616$), increased fWHR predicted greater perceptions of wisdom in the middle-aged ($\gamma = .082$, $SE = .021$, $p < .001$). The slope was steepest, however, for older adults ($\gamma = .153$, $SE = .031$, $p < .001$). Thus, results indicate that increases in fWHR are indeed associated with increased perceptions of wisdom, but increasingly for older adults, and that fWHR progressively becomes a cue utilized for assessing wisdom as individuals age. Thirty-two percent of the variance in perceptions of wisdom was

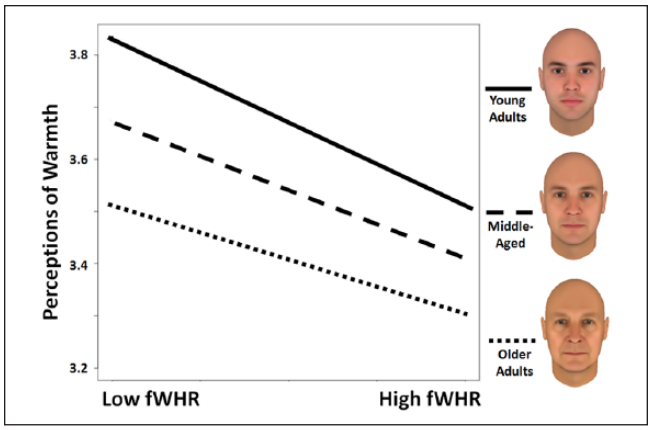

Figure 4. Relationships between fWHR and perceptions of warmth for targets varying in age from Study 1.
Note. fWHR = facial width-to-height ratio.

explained by this model. These effects did not vary when emotional expression was included as a covariate.

Warmth. Main effects of both fWHR ($\gamma_{10} = -.132$, $SE = .019$, $p < .001$) and age ($\gamma_{20} = -.131$, $SE = .036$, $p = .001$) were evident on perceptions of warmth. These effects were further qualified by a fWHR × Age interaction ($\gamma_{30} = .029$, $SE = .013$, $p = .023$; Figure 4). Simple slopes revealed that while fWHR was significantly associated with decreased perceptions of warmth for older adults ($\gamma = -.103$, $SE = .024$, $p < .001$), middle-aged ($\gamma = -.132$, $SE = .019$, $p < .001$), and young adults ($\gamma = -.161$, $SE = .022$, $p < .001$), relationships became progressively stronger as targets were more youthful. This model explained 8% of the variance in perceptions of warmth. These effects did not vary when emotional expression was included as a covariate.

Discussion

The results of Study 1 support our hypotheses that age provides a changing context through which fWHR is evaluated. Thus, fWHR differentially informs perceptions across the life span. Specifically, fWHR has a larger effect on the perceived wisdom of older than younger faces, a larger effect on the perceived warmth of younger than older faces, and an equal effect on the perceived aggression of younger and older faces. Critically, in situations in which fWHR moderated perceptions across age groups, specific perceptions (e.g., wisdom) were associated with specific age groups (e.g., older adults), and fWHR enhanced perceptions of this trait. Thus, fWHR acted to magnify the perception of traits associated with particular age groups. Importantly, this is not true for social perceptions not linked to particular age groups. Indeed, fWHR's impact on perceptions of aggression was consistent across all ages, as aggressiveness is not a stereotype associated with a particular age group. Thus, though previous research has exclusively focused on the perceptions of fWHR in younger adults, the current results reveal that age and fWHR can independently and interactively inform these important social perceptions.

Study 2

Study 1 provided evidence that the changing context of age allowed fWHR to differentially influence aging-related social perceptions. With this initial evidence, Study 2 sought to examine the relationship between fWHR and age in real faces. Because the social perceptions associated with low-fWHR individuals are similar in nature to those associated with older individuals (Carré et al., 2009; Zebrowitz & Montepare, 1992), and because of biologically determined structural degradation of the face over time (Hamlin & Kohn, 1971), we hypothesized that fWHR might decrease across the life span. We tested this possibility in two large archival analyses. Faces were selected from publicly available databases and coded for fWHR. In addition, because previous research has found that relationships between fWHR and behavior (Carré & McCormick, 2008; Tsujimura & Banissy, 2013) are partially (Deaner, Goetz, Shattuck, & Schnotala, 2012) or fully (Mayew, 2013) attenuated when controlling for bodyweight, we additionally included these variables in the model when possible to eliminate this potential confound.

Study 2A

Sampling. Male facial photographs, age, and physical characteristics were collected from the Florida Department of Corrections database (www.dc.state.fl.us), which contains ~102,000 convict mugshots. We sampled from this database by randomly generating 8 unique letters of the alphabet, and collecting information for 50 convicts whose surname began with each letter, for a total of 400 mugshots. Targets' age ranged from 20 to 77. Convicts were removed if they were statistical outliers (±3 *SD*), missing data, or mugshots were not suitable for accurate coding due to low resolution or head rotation, resulting in a final sample of 387.

Coding. Using Irfanview, each face was coded by four raters, blind to both the hypotheses and targets' age, weight, and height, following the procedure used in previous studies (Carré et al., 2009). Specifically, each face's bizygomatic width was divided by its upper facial height to estimate fWHR (see Figure 1 for example). fWHR was consistent across coders ($\alpha = .78$) and ratings were averaged.

Results. To examine the relationships between fWHR ($M = 1.70$, $SD = .15$) and age ($M = 41.96$ years, $SD = 11.41$), weight ($M = 179.73$ lbs., $SD = 31.96$), and height ($M = 69.13$ inches, $SD = 2.98$) of targets, fWHR was simultaneously regressed on these variables to derive coefficients from 5,000 bootstrap estimates, producing bias-corrected confidence

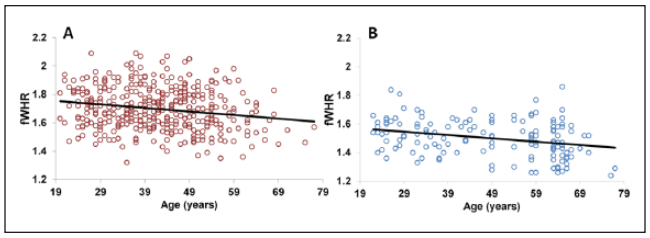

Figure 5. Facial width-to-height ratio as a function of age in (A) Study 2A and (B) Study 2B.
Note. fWHR = facial width-to-height ratio.

intervals (Efron & Tibshirani, 1995; Stine, 1989). Unstandardized regression coefficients are presented alongside highly conservative 99.5% confidence intervals (CIs), and are considered significant if the intervals between the two values (e.g., [1, 2]) do not include zero (Cumming, 2008). Height was not related to fWHR, $B = -.0022$, 99.5% CI [−.0085, .0041], $\beta = -.043$, $p = .439$, and body-weight was related, $B = .0012$, 99.5% CI [.0005, .0017], $\beta = .246$, $p = .00001$. Our analysis of interest revealed that, as hypothesized, age was negatively related to fWHR, $B = -.0029$, 99.5% CI [−.0045, −.0013], $\beta = -.220$, $p < .00001$ (Figure 5A). fWHR decreased by .003 for every 1 year increase in target age. In addition, this relationship remained unchanged when height and weight were not included in the model.

This relationship was linear across time. We had considered that one factor driving the decrease of fWHR over the life span might be the breakdown of the dermis layer due to aging and environmental exposure, and it was thus possible that fWHR did not decrease until a certain age, at which it began to deteriorate at a more dramatic rate. To examine this statistically, a quadratic predictor of age was entered into the model, but this effect was not significant beyond the linear relationship.

Study 2B

One potential concern regarding these results is that convicts may not be representative of the general human population. Accordingly, we thought it prudent to replicate the results in a nonconvict population.

Sampling. Data for Study 2B was acquired from the MORPH Longitudinal database (Ricanek & Tesafaye, 2006), containing 13,000 targets in 55,000 images.[3] To ensure an equal representation of targets across the life span, we randomly selected 26 male photographs from each decade (i.e., 20-29 through 70-79) for a total of 156 photographs. Targets aged 70 to 79 were limited ($n = 5$), so the age range of 60 to 69 was oversampled to compensate ($n = 45$).

Coding. Coding was identical to Study 2A. Photos were removed from analysis if targets were not displaying an emotionally neutral face, displayed heads too rotated for accurate coding, or were otherwise difficult to code accurately, leaving 152 targets for analysis. fWHR was consistent across coders ($\alpha = .87$) and ratings were averaged.

Results. To examine the relationships between fWHR ($M = 1.50$, $SD = .13$) and age ($M = 48.83$ years, $SD = 15.48$), fWHR was again simultaneously regressed on these variables in a manner identical to Study 2A. Replicating Study 2A, age was negatively correlated with fWHR, $B = -.0024$, 99.5% CI [−.0044, −.0006], $p = .00016$ (Figure 5B). fWHR decreased by .002 for every 1 year increase in target age.

Discussion

Replicating effects across two large samples, Study 2 provides strong evidence supporting our hypothesis that fWHR decreases with age, potentially due to the structural degradation of the dermis over time. The relationship between age and fWHR indicates that older adults and younger low-fWHR individuals share structural facial cues. In turn, consistent with recent models of person perception (Freeman & Ambady, 2011; Zebrowitz et al., 2003), facial similarities between these two social groups might partially account for similarities in how they are perceived. Evidence for this possibility was pursued in Study 3.

Study 3

Though Study 1 demonstrated that fWHR informs social perceptions differently across ages, and Study 2 demonstrated that fWHR decreases across the lifespan, these relationships do not necessitate that a lower fWHR is responsible for traditional stereotypes of older adults. Stronger evidence for this conclusion would be if fWHR mediated the relationships between targets' actual age and social perceptions related to age. Accordingly, Study 3 tested whether decreasing fWHR with age might drive a number of important social perceptions that change as individuals age.

In addition to fWHR, a number of other facial cues change with age. To more rigorously isolate the mediating influence of fWHR from these other cues, a multiple mediation model was implemented. Participants evaluated faces on aging-related dimensions, and we tested whether fWHR statistically mediated the relationships between age and perceptual judgments, while controlling for the mediating influence of other aging-related facial cues. In addition to the aging-related social perceptions examined in Study 1, we expanded our analysis to include perceptions of physical and social power, two additional variables dually associated with both fWHR and aging.

Methods

Participants. Eighty-five participants evaluated male faces in a computer-based task through Amazon's Mechanical Turk

in exchange for monetary compensation.

Stimuli and procedure. Target faces were randomly sampled from the real faces coded in Study 2.[4] Ten White faces from each database, within each decade (i.e., 20s-70s) were randomly selected for a total of 60 faces. Again, due to a limited number of faces within the 70s (n = 4), the 60s were oversampled (n = 20). Faces were presented in random order, and on a between-subjects basis, participants evaluated all faces on a 1 (*not at all*) to 7 (*very much*) scale regarding one of four dimensions related to aging: physical power (n = 16), social power (n = 24), wisdom (n = 20), and warmth (n = 25).

Normed ratings. In addition, to assess whether effects of fWHR were independent from other factors related to perceived age, a separate sample of Mechanical Turk participants (n = 16) rated the perceived age of each target along a slider bar with increments of 1 year, ranging from 20 to 100 years of age. By including perceived age in the multiple mediation model with fWHR, this factor captures variance in social perceptions from all other factors that are not better explained by fWHR, helping to isolate fWHR's effects on these social perceptions.

Results

Initial analyses confirmed that targets accurately conveyed their age, as perceived age-ratings were strongly correlated with targets' actual ages, $r(60) = .934$, $p<.0001$.[5] Study 2 revealed that targets' actual age was correlated with fWHR, and thus we wished to examine the influence of fWHR on social perceptions while controlling for additional facial features predictive of perceived age. To this end, we employed structural equation modeling testing a multiple mediation path model. Perceived age-ratings for each target were averaged and included as a mediator alongside targets' fWHR (Figure 6). As such, we tested whether fWHR might be responsible for aging-related social perceptions while controlling for the mediating influence of other aging-related features. Tests of mediation were conducted using 95% confidence intervals of the estimated indirect effect derived from 5000 bias-corrected and accelerated bootstrapped samples (Preacher & Hayes, 2008). We present results for each trait separately below.

Physical power. fWHR was expected to positively correlate with perceptions of physical power. Testing this hypothesis in the model specified above revealed independent main effects of both fWHR (B = 1.784, SE = .324, $p < .0001$) and perceived age ($B = -.059$, SE = .011, $p < .0001$). Greater fWHR was independently associated with greater inferences of physical power, while perceived age was associated with less. Perceived age partially mediated the relationship between actual age and perceptions of physical power, 95% CI [−.0650, −.0227]. Supporting the possibility

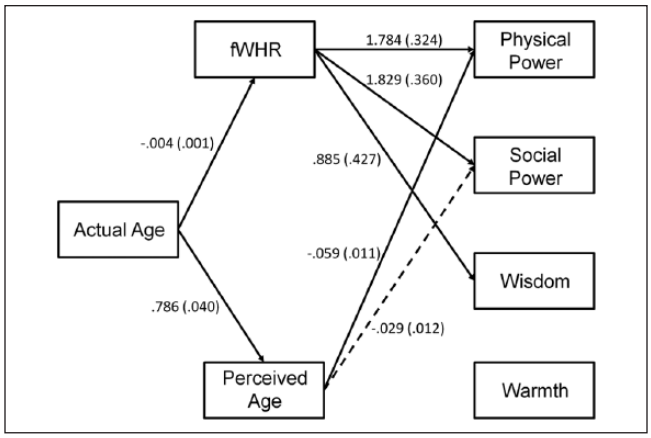

Figure 6. Unstandardized coefficients (standard errors in parentheses) of each significant path from the multiple mediation models tested in Study 3.
Note. Solid paths represent significant indirect effects. Dashed paths indicate significant paths between variables that did not mediate the relationship between actual age and perceptions. fWHR = facial width-to-height ratio.

that aging-related changes in fWHR were responsible for changes in perceived physical power, fWHR additionally partially mediated the relationship between actual age and physical power, 95% CI [−.0120, −.0019]. Finally, actual age had a remaining marginally significant direct effect on perceptions of physical power (B = .017, SE = .009, p = .069). In total, the model explained 75% of the variance in perceptions of physical power.

Social power. Similarly, perceptions of social power were influenced both by fWHR (B = 1.829, SE = .360, $p < .0001$) and perceived age ($B = -.029$, SE = .123, p = .021). Both younger and individuals with higher fWHR were perceived as more socially powerful. Only fWHR partially mediated the relationship between age and perceptions of social power, 95% CI [−.0126, −.0018]; however, perceived age did not, 95% CI [−.0465, .0026]. Actual age had a remaining direct effect on perceptions of social power (B = .026, SE = .010, p = .015). This model explained 35% of the variance in perceptions of social power.

Wisdom. Only fWHR (B = .885, SE = .427, p = .043) was associated with greater perceptions of wisdom, as perceived age was not ($B = -.006$, SE = .015, p = .662). In turn, fWHR fully mediated the relationship between age and perceptions of wisdom, 95% CI [−.0084, −.0005], as no direct effect of actual age on perceptions of wisdom (B = .017, SE = .012, p = .165) persisted when including mediators in the model. This model explained 9% of the variance in perceptions of wisdom.

Warmth. Contrary to Study 1, when controlling for perceived age, fWHR did not predict evaluations of warmth (B = .217, SE = .311, p = .488) and thus mediation was not

evident. The direct path between actual age and perceptions of warmth was also not significant (B = .006, SE = .009, p = .483), and no other effects were present.

Discussion

The results of the present study support the hypothesis that decreasing fWHR over the life span impacts changing social perceptions across the life span. fWHR remained predictive of trait ratings when controlling for other aging-related facial cues, and mediated the relationship between age and perceptions of physical power, social power, and wisdom. Previous research has demonstrated that these traits are associated with both older adults and younger low-fWHR individuals. Thus, that fWHR mediates these relationships is interpreted as support for our hypothesis that the shared content of these perceptions is a function of shared structural facial cues.

We note, however, that while the direction of social perceptions regarding both physical and social power is consistent with decreasing fWHR across the life span, it is inconsistent regarding perceptions of wisdom (i.e., fWHR decreases with age, but perceptions of wisdom are associated with older individuals). This seemingly paradoxical finding indicates that different processes may be responsible for these diverse effects. With perceptions of physical and social power, results indicate that fWHR may actively contribute to stereotypes of the elderly. With wisdom, however, fWHR might simply influence, rather than actively contribute to, this perception. Should a target be categorized as old, then fWHR contributes to perceptions of wisdom, whereas with younger targets, fWHR is unrelated to perceptions of wisdom. The percentages of variance explained by each model is consistent with this interpretation, as the mediation models of physical and social power respectively explained 75% and 35% of the variance in perceptions, whereas the wisdom model explained only 9%. Thus, other factors are certainly contributing to perceptions of wisdom, and fWHR can only explain this effect to a smaller degree.

One inconsistency between Studies 1 and 3 is the relationship between fWHR and warmth. Greater fWHR was associated with decreased warmth in Study 1, though the model explained only 8% of the variance. In Study 3, however, no such relationship was found. We believe this difference highlights both the advantages and disadvantages of using digitally generated facial stimuli. Stimuli in Study 3 were "noisier" real faces presented alongside unavoidable cues to identity and demeanor, whereas the digitally generated faces in Study 1 precisely manipulated fWHR while controlling all other facial features. Thus, the relatively weak relationship we observed between fWHR and perceptions of warmth did not hold under more stringent testing with externally valid real faces in Study 3. These results highlight the importance of using both types of stimuli in concert when examining inferred traits from faces.

General Discussion

The results of the current studies reveal that fWHR influences critical social perceptions that evolve as individuals age. Results across 539 photographs in two samples reveal that after adolescence, as individuals age the face becomes thinner relative to its height with fWHR decreasing by approximately .003 every year in a linear fashion (Study 2). Importantly, age changes the lens through which this decreasing fWHR is perceived (Study 1), and this changing fWHR uniquely contributes to aging-related social perceptions (Study 3). Previous research from diverse perspectives has converged on the premise that facial cues common to two different categories of faces can elicit similar social perceptions (DeBruine, 2002; Freeman & Ambady, 2011; Zebrowitz et al., 2003). Due to the similarity in social perceptions of both older adults (e.g., physical frailty, warmth) and younger low-fWHR individuals (e.g., low physical strength, friendliness), we found that shared facial cues facilitate these similar perceptions.

Facial cues can drive bottom-up social categorization (Cloutier et al., 2005), and cues shared by social categories at the nexus of race, gender, and emotion can bias social perceptions (Freeman et al., 2012). This previous work is important in revealing how cues shared across social groups can bias the basic perception of faces, but has generally treated cues as static over time. Such an approach fails to consider how facial cues might change with age. Interestingly, both age and fWHR were concurrently vital in eliciting some of the novel effects reported here. Relationships between fWHR and warmth were contingent upon target age, and increased perceptions of wisdom based on fWHR were exclusive to older adults (Study 1). Thus, research examining social perception only among younger adults might be overlooking important unique and interactive effects involving perceptions of a significant proportion of human population. The current research is novel in providing evidence for how facial cues evolving over time may contribute to and impact perceptions of certain stereotypes, and while we focused on aging-related stereotypes, other research examining gender, racial, and emotional cues might consider how these perceptions are dynamically shaped across the lifespan.

Indeed, results from Study 3 indicate that the decrease of fWHR over time plays an important role in changing perceptions as individuals progress from younger to older adults. fWHR mediated the relationship between age and multiple perceptions (i.e., physical power, social power, wisdom) demonstrated by previous research to be associated with aging (Brewer et al., 1981; Fiske et al., 2002; Zebrowitz et al., 2003). Study 1 also found that the relationship between fWHR and these perceptions was dependent on the age of the target. In other words, fWHR was a more valuable metric for informing perceptions at certain ages. Other research has demonstrated that less dominant women were more sensitive to fWHR when evaluating the trustworthiness of males

(Stirrat & Perrett, 2010), and that the relationship between fWHR and judgments of aggression was weaker regarding female than male faces (Geniole et al., 2012). Thus, the current results are consistent with this work in demonstrating the importance of context in perceptions influenced by fWHR, yet reveal how the ongoing nature of time comprises a continuously shifting context.

Specific Perceptions

The degree to which fWHR played a role in each perception varied, sometimes fully mediating the relationship between age and perceptions, sometimes partially mediating, and responsible for explaining between a minor 8% to a robust 75% of the variance depending on the specific trait. In spite of these differences, overall we found that a decreasing fWHR with age was a significant component involved in numerous social perceptions traditionally associated with aging. Though varying slightly in meaning, the variables assessed in the current research generally cluster around social perceptions varying along the two orthogonal dimensions thought to underlie face-evaluation: dominance/competence (e.g., aggression, physical power, social power, wisdom) and valence (e.g., warmth; Oosterhof & Todorov, 2008). The goal of the present work was not to explore the nuances among these various traits, but rather to explain the role of fWHR in aging-related perception more broadly. That we find a generally consistent effect of fWHR on these various traits is therefore consistent with prior work finding that they are underpinned by more fundamental social dimensions leading them to considerably covary. Thus, we would speculate that any number of traits beyond those explored in the current work would be candidates for the effects reported in the current research.

Regarding the traits examined here, fWHR mediated the relationship between age and both inferred physical and social power. Decreases in physical and social power are associated with aging (Zebrowitz et al., 2003), and that fWHR predicts these perceptions is consistent with characterizations of testosterone as a tendency toward social dominance (Eisenegger, Haushofer, & Fehr, 2011) and associated with high-fWHR individuals (Haselhuhn & Wong, 2012; Hehman, Leitner, & Gaertner, 2013).

Though wisdom has long been associated with age, exactly why fWHR might be a reliable predictor of this evaluation remains unclear. One possibility is that the process of overgeneralization, when facial cues shared by multiple social groups elicit similar social perceptions between groups (Zebrowitz et al., 2003), might be at play in our results. Though fWHR might be informative of target behavior along dimensions of physical strength, inferences drawn from this metric might be over-extended to influence perceptions along other, unrelated dimensions (e.g., wisdom, warmth). For example, it is plausible that inferences more directly tied to fWHR, such as physical strength, "smear" over into inferences less directly tied to fWHR, such as wisdom/competence, consistent with the dominance face-evaluation dimension (Oosterhof & Todorov, 2008). Thus, although its primary communicative value is more likely to lie in its adaptive signaling of power and physical ability, fWHR might indirectly inform important social perceptions in a manner that is not necessarily adaptive or accurate (e.g., wisdom). It is important to better understand the factors driving perceptions of wisdom because it is one of the few positive attributions given older adults (Kite & Johnson, 1988; Richman, 1977), and because the passing of wisdom from the old to the young might be a valuable benefit of older adults to the family and society at large (Nussbaum, 2012). Furthermore, wisdom is only beginning to receive a resurgence in research due to health implications for older adults (Bang & Montgomery, 2012; Webster, Westerhof, & Bohlmeijer, 2012). Future research might further examine how and why characteristics of facial structure contribute to perceptions of wisdom as individuals age.

Perceptions Versus Accuracy

Importantly, we note that the current research focused on the perceptions drawn from facial cues, rather than the accurate prediction of traits from these cues. Indeed, the actual characteristics of targets were unavailable, and thus the accuracy of participants' social perceptions could not be assessed. However, previous research has demonstrated that, among younger individuals, target fWHR permits accurate judgment of physical strength, aggression, trustworthiness, and prejudice (Carré et al., 2009; Hehman, Leitner, Deegan, & Gaertner, 2013; Stirrat & Perrett, 2010; Windhager, Schaefer, & Fink, 2011). Indeed, some evidence indicates that fWHR is an honest signal of physical ability (Sell et al., 2009; Stirrat, Stulp, & Pollet, 2012), and current results indicate that fWHR might reflect an accurate metric of physical ability across the life span. We stress, however, that this accuracy may only be evident at a superficial level. To the extent that physical abilities deteriorate as individuals age (Beckett et al., 1996), the change in fWHR with age might covary with these decreasing physical abilities. Yet whether fWHR remains an accurate indicator at a more fine-grained level, representing physical dominance to the same degree across the entire life span, remains an open question. Future research might thus examine whether fWHR predicts physical abilities among older adults, and to what extent variations in fWHR (and thus perceived physical abilities) might contribute to the sub-categories of the elderly documented by previous research (Brewer et al., 1981).

Though fWHR might consistently and accurately inform perceptions of physical ability across the life span, this is not the case with perceptions of wisdom and warmth. Indeed, that the relationships between fWHR and perceptions of wisdom and warmth were moderated by target age reveal that more complex psychological mechanisms are at play. Ecological perspectives, such as the overgeneralization

hypothesis (Zebrowitz et al., 2003), hold that trait attributions arise from adaptive and functionally significant attunements to perceptual features that are often accurate (McArthur & Baron, 1983). Thus, for example, it is adaptive that we be particularly attuned to baby-faced features so as to compel perceptions of vulnerability and motivate us toward caretaking behavior. However, these perceptual biases toward particular facial features, although adaptive, may sometimes lead our impressions to be prone to error. Accordingly, accurate impressions of certain faces (e.g., infants) may be overgeneralized to other faces sharing overlapping features (e.g., baby-faced adults), thereby leading to systematically erroneous impressions (Zebrowitz, Andreoletti, Collins, Lee, & Blumenthal, 1998).

Furthermore, across all the perceptions in the current research, changes were linear over time. In reality, the deterioration of physical strength is not a linear decline between adolescence and older age (Aoyagi & Shephard, 1992), and different physical abilities such as speed, strength, and endurance peak and decline at different ages across the life span (Larsson, Grimby, & Karlsson, 1979; Thomas & French, 1985). Thus, dissociations between the linearly changing perceptions of aging targets we find here and the nonlinear changes in their actual characteristics are likely to emerge over time. The different trajectories of dynamic change between perceived and actual characteristics would indicate that there might be ages at which expectations of an individual maximally diverge from that individual's actual abilities and traits. The social consequences for such a discrepancy, as well as the source and ramifications of this dissociation, could be examined by future research.

Biological Relationships

We have postulated that changes in fWHR over time is due to factors associated with aging, such as the well-documented relationship between exposure to environmental conditions and structural degradation of the dermis over time (Hamlin & Kohn, 1971; Yasui et al., 2013). However, we note that a limitation of the current work is its cross-sectional rather than longitudinal nature, allowing for ambiguity regarding any causal relationship between age and fWHR. An alternative explanation for the current results might be that higher fWHR men die at a younger age, consistent with link between fWHR and testosterone (Weston, Friday, & Liò, 2007), and tradeoffs between testosterone and health (Folstad & Karter, 1992). Future work might examine longitudinal data sets to test the results reported here.

One limitation of the current research is that we focused on perceptions of male targets only. Perhaps due to the putative relationship with pubertal testosterone, fWHR's ability to predict female behavior has been investigated but not observed (Carré & McCormick, 2008; Stirrat & Perrett, 2010). Furthermore, the impact of female fWHR on social perceptions have been either weak or absent (Geniole et al., 2012). Thus, the current research focused on male fWHR, but future work should identify the psychological mechanisms involved in how fWHR additionally influences perceptions of women across the life span.

Treatment of the Elderly

Though the current results reveal that fWHR informs perceptions across all ages, these results may be particularly important with regard to the elderly, approximately 14% of the current U.S. population (U.S. Census Bureau, 2010). Indeed, decreases in fWHR over time might be a key factor driving negative perceptions associated with the elderly, and potentially contribute to the discrimination and ageism the elderly encounter. Ageism regarding this large population has tremendous mental and physical health implications. For instance, negative attitudes toward the elderly leads to psychological abuse in institutional settings (Bonnie & Wallace, 2003), and contribute to withholding critical treatment options, such as drug prescriptions (Jacobson, 2006).

The elderly have long been associated with reduced power (Brewer et al., 1981; Cuddy et al., 2005; Fiske et al., 2002; Zebrowitz et al., 2003), just as high-fWHR individuals are associated with increased power (Haselhuhn & Wong, 2012). The current research provides evidence that decreases in fWHR over time is one mechanism by which aging-associated perceptions of decreased power manifest. Previous theoretical models of the consequences of stereotypes (Cuddy et al., 2007) posit that social groups associated with low power are victims of "passive harm," when targets are harmed through omission or deprivation. Perceptions of reduced power would certainly reduce care-providers' concern regarding consequences for actual or perceived ageism, and thus decreased fWHR may be a contributor to such behavior. Future research should further examine this potentially important link between facial characteristics of the elderly and ageism.

Conclusion

The current research reveals how fWHR influences important social perceptions that evolve across the life span. fWHR decreases as individuals age, and these decreases are associated with reduced perceptions of power. Thus, the association between fWHR and power may provide the foundation for many social perceptions that change as individuals age from young to old. Finally, as being perceived as powerless might lead to emotional, cognitive, and physical health risks; the current research identifies a structural aspect of the face that may contribute to aging individuals' experience of biases and discrimination.

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Notes

1. FaceGen creates 3D digital face models (Blanz & Vetter, 1999). The structure of these models is based off laser scans of hundreds of individuals' faces varying in gender and age. In all, 100 shape and 100 texture principle components were derived from this entire data set, and digital faces can thus be morphed along these continua. Several of these components are associated with changes related to aging, and by morphing a figure along the age continuum, these components adjust the structure and texture of the face accordingly. Thus, a face can be morphed to reflect the average shape and texture of an individual at different ages.
2. If we define the total height of a face as the distance from the chin to the top of the head, our manipulations had specific measurements as follows. Starting at the chin, the brow was moved to be 61% of the distance up the face in the low condition, and 63% in the high condition. For lip height, the lips were moved 18% of the distance up the face in the low condition, and 22% in the high condition.
3. Though this database is longitudinal, samples ranged across weeks rather than decades, and thus a longitudinal analysis was not suitable for our purposes.
4. There were no differences in perceptions as a result of the different samples.
5. Because we were concerned that the high correlation between actual age and perceived age might cause difficulties in the multiple mediation model, we additionally tested a traditional mediational model in which facial width-to-height ratio (fWHR) alone mediated the relationship between age and our dependent variables. Results remained virtually identical. fWHR persisted in mediating the relationship between perceptions of physical power, 95% CI [−.0138, −.0021]; social power, 95% CI [−.0135, −.0020]; and wisdom, 95% CI [−.0085, −.0004].

Supplemental Material

The online supplemental material is available at http://pspb.sagepub.com/supplemental.

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