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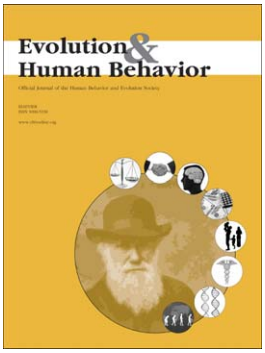

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Beards and the big city: Displays of masculinity may be amplified under crowded conditions

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Abstract

Facial hair is a prominent secondary sexual trait, particularly given the importance of the face in interpersonal communication. Bizarrely by animal standards, men expend considerable effort every day trimming, waxing or shaving this androgen-dependent trait. Why some men shave this cue of masculinity off, and why women's preferences for facial hair vary so dramatically, remains largely unresolved. Using a large cross-cultural sample, we explore city- and nation-level variation in preferences for beards and in facial hair grooming patterns to test how economic and demographic conditions alter frequency-dependence in preferences for beardedness. We found that women's preferences for beards were strongest in countries with lower average incomes. Beards were most common in cities with larger populations, in countries where women express stronger preferences for facial hair and life expectancy was higher. Frequencies of non-beard facial hair styles (e.g. moustaches, goatees) were most common in large cities, but were unrelated to any demographic factors. Our results suggest a role for female choice in shaping large-scale patterns of facial hair grooming and highlight that under crowded conditions with high anonymity, displays of masculinity may be amplified.

Keywords

Sexual selection; human evolution; masculinity; cross-cultural variation

1. Introduction

The persistence of individual variation in secondary sexual trait expression presents one of the more enduring puzzles in evolutionary biology. The most compelling explanations for this variation in non-human animals hinge on costly trait expression coupled with underlying variation in individual quality; on average only the best quality individuals can afford to bear the costs of extreme trait expression, and thus to reap the rewards thereof (Andersson, 1994; Zahavi, 1975).

Human secondary sexual traits offer additional layers of complexity. Sex-dependent physical traits represent some of the most dramatically altered and groomed characteristics: body shape can be emphasised or obscured with clothing, complexion and facial features by make-up, and hair can be styled, dyed, removed or trimmed. These practices alter, emphasise or conceal traits that have shaped individual sexual signalling in ancestral populations (Cunningham & Shamblen, 2003). Further, variation among cultures, within-society hierarchical norms and more idiosyncratic social factors all influence patterns of grooming and dress (Barber, 1995).

The cultural malleability of grooming patterns sometimes leads to the potentially erroneous conclusion that the underlying behaviours are influenced only by esoteric cultural processes. Studies suggest that fashions in facial hair (Barber, 2001; Robinson, 1976) and dress hem length (Barber, 1999) respond to local economic cues in ways that are predicted by evolutionary theory. For example, male facial hair patterns confer greater attractiveness in experimental trials where those patterns are rare than when they are common (Janif, Brooks, & Dixson, 2014), raising the possibility that negative frequency dependence may maintain some of the variation in grooming patterns.

In no secondary sexual trait is the intersection between biological underpinnings and sociocultural influences more evident than in men's beardedness. On the one hand, beards have all the hallmarks of a sexually selected trait; they are markedly sexually dimorphic, emerge under the actions of androgens in early adolescence and only reach full expression in adulthood (Hamilton, 1958, 1964; Hamilton, Terada, & Mestlert, 1958). On the other hand, fashions in beardedness vary markedly among and within cultures (Robinson, 1976; Peterkin, 2001; Reynolds, 1950). Women's preferences for beards also vary, so that beards are judged to be attractive in some studies (Dixson et al., 2016; Dixson & Rantala, 2016; Janif et al., 2014; Pellegrini, 1973; Reed & Blunk, 1990), but not others (Dixson & Brooks, 2013; Dixson, Tam, & Awasthy, 2013; Dixson & Vasey, 2012; Geniole & McCormick, 2015; Muscarella & Cunningham, 1996). However, beards consistently enhance ratings of men's age, masculinity, and social dominance (Dixson & Vasey, 2012; Muscarella & Cunningham, 1996; Neave & Shields, 2008; Saxton, Mackey, McCarty, & Neave, 2016; Sherlock, Tegg, Sulikowski & Dixson, 2016). Compared to clean-shaven men, bearded men report feeling more masculine (Wood, 1986), endorse male-typical gender roles in heterosexual relationships (Oldmeadow & Dixson, 2016), and have higher levels of serum testosterone (Knussman & Christiansen, 1988), which may predict social dominance (van Honk, Bos, & Terburg, 2014).

In addition to women's preferences for beards being highly variable, men exert daily effort trimming or shaving this masculine trait (Elsner, 2012). Even though patterns in grooming fluctuate with prevailing fashions, there is some evidence that beards become more fashionable during conflict (Robinson, 1976), at times of economic hardship (Robinson, 1976) and under male-biased sex ratios (Barber, 2001). These are exactly the conditions that elevate male-male competition for status and mates, consistent with evidence that beards represent a 'performance of masculinity' (Wood, 1986) and that they enhance percieved social dominance (Dixson et al., In Press; Dixson & Vasey, 2012; Muscarella & Cunningham, 1996; Neave & Shields, 2008). The importance of male-male relative to male-female signalling in determining individual men's grooming decisions as well as the collective dynamics that underpin beard fashions, remains largely unresolved (but see Janif et al., 2014).

In non-human animals, social environmental conditions can shape both the investment in sexually selected traits (Kasumovic, 2013) and the strength of preferences for those attractive traits (Jennions & Petrie, 1997; Kokko, Brooks, Jennions, & Morley, 2003). In mammals, androgens are positively associated with mating effort, including intra-sexual competition and mate guarding, and ornaments that communicate rank, dominance and sexual attractiveness (Dixson, 2012). However, investment in androgen dependent traits may come at the expense of other somatic traits (Muehlenbein & Bribiescas, 2005) and, in species with bi-parental care, paternal investment (Gettler, 2014).

While many quite basic questions concerning men's beard growth, grooming and women's preferences for men's facial hair remain, for now, unanswered, it may be instructive to learn from the study of androgen-dependent facial shape. A more masculine face, characterised by a larger brow-ridge, narrower eyes and a more robust midface, reflects sexual maturity, testosterone levels (Gangestad & Eaton, 2013; Scott, Clark, Boothroyd, & Penton-Voak, 2013), physical strength (Sell et al., 2009) and perceived formidability (Puts, 2010; Sell, Cosmides, & Tooby, 2014; Geniole et al., 2015). All of which suggests greater willingness among masculine looking men to engage in intra-sexual competition to attract mates (Puts, 2010; Scott et al., 2013).

Like beards, however, facial masculinity either contributes little to male facial attractiveness or even reduces it (Perrett et al., 1998; Rhodes, 2006). Moreover, masculine men are judged as being less interested in long-term relationships and less paternally investing (Kruger, 2006; Perrett et al., 1998), suggesting they are perceived as socially costly mates. These judgments may reflect an important social truth, as masculine men report more interest in short-term relationships and are rated as being less suitable for long-term relationships (Boothroyd, Jones, Burt, DeBruine, & Perrett, 2008; Boothroyd, Jones, Burt, & Perrett, 2007), engage more often in short-term relationships (Rhodes, Simmons, & Peters, 2005) and women can retrodict the degree of men's sexual infidelity from their facial masculinity (Rhodes, Morley, & Simmons, 2013).

Plasticity in response to prevailing cultural and ecological conditions may drive variation in women's preferences for men with masculine faces, such that masculine features might enhance a man's attractiveness under some conditions but diminish it under others. For example, women express stronger preferences for masculine faces within countries where health is compromised and infectious disease more prevalent (DeBruine, Jones, Crawford, Welling, & Little, 2010; DeBruine, Jones, Little, Crawford, & Welling, 2011; DeBruine, Little, & Jones, 2012). This has been interpreted as evidence for facultative trade-offs whereby the costs of selecting a masculine mate are offset by the potential benefits in terms of offspring health (DeBruine et al., 2010). However, questions have been raised about the strength of the supporting evidence for this adaptive scenario (Batres & Perrett, 2014; Scott et al., 2014) and the lack of skeptical weighing of alternative interpretations (Scott et al., 2014). For instance, a re-analysis of one cross-national study (DeBruine et al., 2010) revealed that income inequality was a stronger predictor of female preferences for facial masculinity than health (Brooks et al., 2011).

Another alternative explanation is that the size and complexity of social groups augments sexual selection on masculine traits (Grueter, Isler, & Dixson, 2015). In male primates, facial color pattern complexity is enhanced among species living in larger social groups (Santana, Alfaro, Noonan, & Alfaro, 2013) and men have a similar degree of secondary sexual trait expression to those nonhuman primates that live in large, multilevel social systems (Grueter et al., 2015) and where polygyny forms part of the mating system (Dixson, Dixson, & Anderson, 2005). Several evolutionary mechanisms may explain this pattern, including the recognition of conspecifics from out-group members in highly sympatric species (Santana et al., 2013; Santana, Lynch Alfaro, & Alfaro, 2012), or sexual selection shaping signals of age, dominance rank, and attractiveness (Dixson et al., 2005; Grueter et al., 2015). In humans, attractiveness of male facial masculinity is strongest in cultures where urban development is higher and social group sizes are larger (Scott et al., 2014). Within such large multilevel social systems, wherein the prevailing "visual diet" comprises high frequencies of anonymous conspecifics, masculine signals may become important indicators of facial distinctiveness and attractiveness (Scott et al., 2014).

Here we follow approaches used to study men's facial masculinity to test how economic, cultural and environmental forces shape men's decisions to cultivate a bearded appearance and women's preferences for facial hair. We use a large internet-based study measuring preferences for men's faces varying in beardedness among participants from 87 countries. We then obtained standardized estimates of facial hair-grooming patterns in a variety of urban centres across 37 countries, using a new method based on scoring social media profile pictures. We tested whether facial hair frequencies are associated with the population size of the settlement, with nation-level estimates of women's preference for beards and for facial masculinity, and with national socioeconomic, demographic and developmental metrics.

Given that facial hair may be involved in the cultural performance of masculinity (Hellmer & Stenson, 2016; Oldmeadow & Dixson, 2016a,b), we

predicted that men would be more bearded in large urban settings where anonymous conspecifics are in more frequent contact and the need to clearly display gender, dominance, and attractiveness may become amplified (Scott et al., 2014). Because facial hair may communicate dominance intra-sexually (Dixson & Vasey, 2012; Muscarella & Cunningham, 1996; Neave & Shields, 2008), we also predicted that beardedness would be most frequent and judged as more attractive in countries where formidability in a mate may be prioritised, such as countries with higher homicide rates, higher income inequality (Brooks et al., 2011), poorer health and shorter life expectancy (DeBruine et al., 2010).

2. Methods

2.1. Facial hair stimuli

Thirty-six men (mean age+s.d = 27.08+5.61 years) of European descent were photographed when clean-shaven, at the end of five days of regrowth (light stubble), 10 days of regrowth (heavy stubble) and at least four weeks of untrimmed growth (full beard). Photographs were taken under controlled lighting from 1.5 m and cropped to show only the neck and face (Janif et al., 2014; Figure S1). From this stimulus set twenty males (mean age ± SD = 23.95 ± 3.43 years, range 20-31) were selected when in clean-shaven conditions and at the end of a ten-day period of beard growth, allowing us to test how men's facial attractiveness is affected by the presence and absence of facial hair with observable natural pattern.

These faces were selected as they conformed to one of four categories of facial hair distribution. Five stimuli per category were selected. Categories were defined using Setty's (1971) protocol, hereafter referred to as heavy, medium, light, and very light facial hair. Heavy facial hair was defined as hair continuously distributed around the lips, cheeks, jaw, and lower neck, extending continuously to the temporal region of the scalp. Medium facial hair was similar in distribution to heavy facial hair, with the exception of bare areas around the lip (the inferior labial region) and additional bare areas on the cheeks, and a less continuous extension to the temporal region. Light facial hair was similar to medium facial hair except for reduced hair under the lower lip of the front jaw, less continuous distribution on the cheeks, and patchy or no connection to the temporal region. Finally, very light facial hair refers to reduced hair around the lower lip extending to the lower jaw and marked reductions in hair density and distribution on the cheeks, lower jaw, neck, and temporal region (Figure S1).

2.2. Participants and procedure

Studies were undertaken on-line (www.socialsci.com). Each participant saw 20 pairs of faces showing the same male's face after 10 days of facial hair growth and when clean-shaven. Participants were asked to select the image they considered to be most sexually attractive in each pair. The position of the clean-shaven and hairy image in each pair (left or right) was randomised. After rating the 20 pairs of images, participants provided information on their sexual

orientation using the Kinsey scale (Kinsey, Pomeroy, & Martin, 1948), their age, and country of residence.

We estimated each individual's preference for beards as a slope by assigning clean shaven faces a value of 0 and very light, light, medium and heavy facial hair scores of 1 to 4 respectively. We estimated the least squares regression slope of these five values on the number of times each level of facial hair was preferred (corrected for number of times presented). The slope-based method we use here turns a fairly granular set of alternative levels of beard growth into ordinal variation and then into a slope. This is just one way of calculating directional preference for beards, but (as expected) it gives preference scores that are strongly correlated with counts of the number of responses favoring heavy beard ($r=0.958$, $P<0.001$, $N= 3720$) or medium beards ($r=0.788$, $P<0.001$, $N= 3720$) and negatively with the proportion of clean shaven men preferred ($r=-0.857$, $P<0.001$, $N= 3720$). A total of 4535 participants (3814 females and 719 males) from 87 countries completed surveys. As in previous research (Petterson, Dixson, Little & Vasey, 2015; 2016; Valentova et al., In Press), there were significant effects of sexual orientation on face preferences (ESM1). Thus, all subsequent analyses used only the responses of women who reported sexual attraction to men.

2.3. Geographic variation in preferences for beards

To test for associations between beards and socioeconomic and demographic data we fitted a Multi-Level Mixed Model (MLMM) with preference for beards as the response variable. At the first (individual subject) level, we included subject age as an individual-level fixed covariate and random intercepts and slopes (of age) for country, permitting the relationship between age and preference for beard to vary among countries. At the second (country) level, we fitted as covariate effects the national-level predictor variables. The following eight measures: preference for masculinized faces and the National Health Index (NHI; (DeBruine et al., 2010); the Gini index of income inequality from the United Nations Statistics Division (except for Iceland not available, for which we used the CIA World Factbook estimate); homicide rates from the United Nations Office on Drugs and Crime for 2001-2005; life expectancy at birth from the 2007 UN Statistical Division; education as the mean number of years of female education (CIA World Factbook); gender empowerment from United Nations Statistical Division 2006 data; sex ratio and the Human Development Index from the United Nations Human Development Report 2014.

2.4. Geographic variation in men's beardedness

Variation in men's facial hair styles was quantified by one author (EFM), blind to the predictions of the current study, who scored photographs of men's Facebook profile pictures (www.facebook.com). We used a dummy Facebook profile that had no friends or pictures and had not 'liked' any other pages, thus minimising sampling interference from Facebook algorithms. The researcher then performed a series of custom searches for men aged 25-40 years in the city of interest, sampling the first 100 men for whom facial hair pattern could be scored

unambiguously from their profile picture. Only photographs where facial hair (including clean-shaven appearances) was clearly discernible were used, so that images where the lighting was poor or facial hair was obscured (i.e. by a hat or head tilting) were not used.

In each of 37 countries we conducted separate searches for the largest and third largest settlement, resulting in at least 200 profiles per country. In some cities a sample size of 100 individuals could not be achieved (not all Facebook users list their city, sex and age). In such cases we also sampled from the next largest settlements we then went to the 4th and 5th largest settlements to ensure we had at least 200 men per country (i.e. Croatia, Czech Republic, Denmark, Northern Ireland, Scotland and Wales). Because of the good coverage of FB membership and good data on cities in the USA, we sampled a further 9 US cities, drawn at random, from #4 (Houston, TX) to #44 (Miami, Fl), so that 10 Cities were sampled in total for the USA. In total we sampled 93 cities.

Each profile picture was scored as the most appropriate of ten possible facial hair styles: 0 = clean-shaven, 1 = stubble, 2 = moustache, 3 = goatee (without moustache), 4 = Goatee (with moustache), 5 = Sideburns, 6 = Sideburns and moustache, 7 = moustache and soul patch, 8 = Full beard (trimmed), 9 = Full beard (bushy; Fig. S3). For our analyses we created three categories; 1) the 'clean-shaven' category included the percentage of men with no facial hair of any kind (category 0). 2) the 'beard' category included the percentage of men with trimmed and bushy full beards (8&9), and 3) the 'non-beard facial hair' category included the percentage of men in all classes of facial hair except clean-shaven and full beards (1-7).

We obtained population size and, where possible, density for each city from www.citypopulation.de. Where there were multiple ways to search we looked at each city as an agglomeration rather than restricting our population size to the city's municipal limits because we were interested in the size of the urban centre as a whole. We tested for associations with the same nation-level data as in the section above, plus the preference for beards.

3. Results

3.1. Geographic variation in preferences for beards

We fitted a Multi-Level Mixed Model (MLMM) with preference for beards as the response variable. At the first (individual subject) level, we included subject age as an individual-level fixed covariate ($F_{1,\ 1962.1}$=40.8, P<0.001; younger women had stronger preferences for beards), and random intercepts and slopes (of age) for country, permitting the relationship between age and preference for beard to vary among countries. At the second (country) level, we fitted the national-level predictor variables as fixed covariate effects. We added national-level covariates via a process of forward-selection and backward-elimination with criteria for inclusion being a P-value less than 0.1. We found no evidence of a significant association between preference for beards and national aggregate preference for facial masculinity (from DeBruine et al., 2010; $F_{1,\ 18.7}$=0.060, P=0.809). The

stepwise model fitting approaches resulted in a model in which countries with lower Gross National Income (in Purchasing Power parity; $F_{1, 18.5}$=5.35, P=0.032) tended to have women with stronger preferences for beards.

3.2. Geographic variation in men's beardedness

Frequencies of facial hair styles varied cross-nationally (Figure S4). Analyses of Variance revealed significant variation among the 37 countries in the three major categories of facial hair. Univariate tests showed that country influenced the proportion of men who were clean-shaven ($F_{36, 56}$ = 3.53, p < 0.001), the number of men with beards (i.e. bushy and trimmed beards; $F_{36, 56}$ = 3.14, p < 0.001), and the number of men with facial hair other than full beards ($F_{36, 56}$ = 2.07, p = 0.007). The proportion of variation among cities in facial hair patterns that is due to among country variation (as opposed to among cities within-country) was high: clean shaven (repeatability: r = 0.49 ± 0.11 S.E), beard (full and trimmed; r = 0.45 ± 0.11 S.E) and males with facial hair excluding beards (r = 0.29 ± 0.12 S.E).

Next we fitted separate multi-level mixed models (MLMM) of factors predicting the frequency of beards and the frequency of non-beard facial hair. These two frequencies were not significantly correlated across cities (r=0.093, N=93, P=0.373), suggesting that they are somewhat independent, despite the three categories of facial hair having to sum to 1. The frequency of clean-shaven men is significantly, negatively correlated with both beard (r=-0.728, N=93, P<0.001) and non-beard facial hair (r=-0.751, N=93, P<0.001).

The first level of each MLMM was at the city, where we fitted country as a random factor, including a random intercept, and city population size (log_e transformed) as a covariate, plus random slopes and intercepts for population size within countries. Next, we added national-level covariates via a process of forward-selection and backward-elimination with criteria for inclusion being a P-value less than 0.05; both approaches converged on the same preferred model. This approach to model fitting has limitations, but it has the benefit of simplicity for an exploratory analysis of a relatively small sample such as the one considered here. The final MLMM for beard frequency included city population size, preference for beards, and (log_{10}) life expectancy. Cities with high frequencies of beards were larger ($F_{1, 91.3}$ = 28.94; P<0.0001; Fig. 1A), were in countries with strong average preferences for beards ($F_{1, 33.4}$ = 10.66; P=0.003; Fig 2) and high life expectancy ($F_{1, 32.1}$ = 5.56; P=0.025).

The MLMM of non-beard facial hair frequency included only city population size among the possible covariates; cities with high frequencies of non-beard facial hair were larger ($F_{1, 23.1}$ = 6.09; P=0.021; Fig. 1B). None of the national-level correlates were significantly associated with the frequency of non-beard facial hair.

4. Discussion

Our results reveal considerable geographic variation in both preferences for beards and in the frequency of facial hair styles. Cities where beards are common

tend to be in countries where preferences for beards are strongest. These cities also tend to be bigger, and located in countries with high life expectancy. Likewise, the proportion of men who wear non-beard facial hair (e.g. moustaches, goatees) is higher in big cities.

Prevailing environmental conditions are associated with variation in women's preferences for masculine facial traits. Women's preferences for masculine faces were stronger in cultures with lower National Health Index (NHI) and higher pathogen loads (DeBruine et al., 2010; 2012) and where income inequality is greater (Brooks et al., 2011). However, recently it was reported that irrespective of pathogens and income inequality, women judge masculine facial shape as more attractive and aggressive in large-scale, urbanized societies than in smaller-scale societies (Scott et al., 2014). We found that preferences for experimentally masculinised male faces and beards were not associated and that NHI did not contribute to national preferences for beards. Other measures previously found to predict preferences for facial masculinity, including the Gini index of income inequality (Brooks et al., 2011), and Human Development Index (Scott et al., 2014), were also not associated with national preferences for beards. Instead, preferences for beards were strongest in countries where incomes were low and population density high. These results support recent experimental studies (Dixson et al., In Press; Sherlock et al., 2016) in suggesting that cross-national preferences for beards and experimentally masculinized faces are independent and may be influenced by different socio-economic and demographic forces.

The greater frequency of facial hair in larger urban centres suggests that exaggerated displays of masculinity may be more salient under urban conditions with high levels of anonymity, wherein intra-sexual competition and the need to signal attractiveness may also be stronger (Grueter et al., 2015). Within urban settings, beard frequencies are known to track economic conditions, possibly because those conditions alter the local mating market and thus the intensity of competition among men for status and female attention. Perhaps the best example comes from Barber's (2001) analyses of photographs in the *London Illustrated News Magazine* (Robinson, 1976), in which facial hair was found to grow more popular when women of marriageable age were scarce (Barber, 2001). Female scarcity gives women more power to choose and pits men against one another in competition for mates (Baumeister & Vohs, 2004; Guttentag & Secord, 1983) and may drive men to augment their masculinity (Barber, 2001). Interestingly, when we entered sex ratio at the country level, which is a well established proxy of mating markets both across and within cultures (Schmitt, 2005; Kandrik, Jones & DeBruine, 2015), it did not make it into our final models. However, we were unable find consistent sex ratio for our sample of cities. Thus, future research ascertaining how mating market forces like sex ratios operate on men's beardedness and women's preferences for facial hair at finer city-level scales would be valuable.

Other consequences of city size, such as greater income inequality, could also alter mating market dynamics. Income inequality leads to more intense male-male competition (Daly & Wilson, 1988). However, we saw no such

association, however, between inequality and full beard frequency. The relationship between income inequality and city size is complex (Royuela, Veneri, & Ramos, 2014), but again more detailed analysis at the level of cities might expose important links between urbanisation, the mating market and signals of masculinity.

The links between facial hair fashions, city size, and development might owe as much to the dynamics of fashion as to local economic conditions. Men living in larger cities might be more likely to follow fashion trends or to express their individuality through grooming. In experimental settings, beards are more attractive when they are rare than when they are common; and, likewise, clean-shavenness is more attractive when it is relatively rare (Janif et al., 2014). This negative frequency-dependent component to preferences for facial hair might be more intense in larger than smaller settlements because of differences in the rate at which people encounter various facial hair types. Likewise, the need to stand out in larger settlements may result in a greater variety of facial hair grooming patterns there.

The fact that countries with stronger preferences for beards had higher frequencies of full beards suggests that local beard frequencies may be driven, at least in part, by female choice. There is considerable discussion about whether the primary function of facial hair is in signalling to other men (Dixson & Vasey, 2012; Puts, 2010; Sherlock et al., 2016), to women (Barber, 1995; 2001) or both (Dixson et al., 2005; Grueter et al., 2015). The association between women's preferences for beards and facial hair frequency suggests at least some role for male-female signalling. Causation, however, might flow in the opposite direction if high local frequencies of beards, arising for reasons other than female choice, tend to influence women's preferences. While this is a possibility, studies showing negative frequency dependence (Janif et al., 2014) suggest that high beard frequencies might be more likely to erode preferences for beards. If this effect operates outside the lab and at the bigger scales we consider in this study, then it would be more likely that standing local preference for beards is driving beard frequencies more than the reverse.

Our results provide insights into the cultural, ecological and economic underpinnings of beardedness. However, there were some important limitations to our methods. Firstly, while we controlled for the ethnicity of our stimuli, we only presented males of European descent, which does not reflect the ethnicities of all the cultures where preferences were measured. This may also explain the discrepancies between preferences for beardedness in the current study and facial masculinity preferences taken from archival data in which only the preferences of people of European descent were measured (DeBruine et al, 2010). Finally, the use of social media profile pictures was effective for generating a database of beardedness for our cross-cultural comparison. However, the sample will not be fully representative of either the individuals themselves or the visual diet of each city.

While our cross-cultural study captures only a snapshot of the social consequences of beard growth, our results suggest a relationship between

variation in men's grooming habits, the attractiveness of facial hair, and local social and mating market dynamics. Industrialized human social systems are large in size and multi-levelled in their composition and interactions between anonymous conspecifics are frequent (Grueter et al., 2015). The preliminary findings we outline here suggest that the performance of masculinity via growing a beard is shaped by social, economic and demographic factors in a number of ways that mandate more direct testing.

References

Andersson, M. B. (1994). *Sexual selection*: Princeton (NJ): Princeton University Press.

Barber, N. (1995). The evolutionary psychology of physical attractiveness: Sexual selection and human morphology. *Ethology and Sociobiology, 16*, 395-424.

Barber, N. (1999). Women's dress fashions as a function of reproductive strategy. *Sex Roles, 40*, 459-471.

Barber, N. (2001). Mustache fashion covaries with a good marriage market for women. *Journal of Nonverbal Behavior, 25*, 261-272.

Batres, C., & Perrett, D. I. (2014). The influence of the digital divide on face preferences in El Salvador: People without internet access prefer more feminine men, more masculine women, and women with higher adiposity.

Baumeister, R. F., & Vohs, K. D. (2004). Sexual economics: Sex as female resource for social exchange in heterosexual interactions. *Personality and Social Psychology Review, 8*, 339-363.

Boothroyd, L. G., Jones, B. C., Burt, D. M., DeBruine, L. M., & Perrett, D. I. (2008). Facial correlates of sociosexuality. *Evolution and Human Behavior, 29*, 211-218.

Boothroyd, L. G., Jones, B. C., Burt, D. M., & Perrett, D. I. (2007). Partner characteristics associated with masculinity, health and maturity in male faces. *Personality and Individual Differences, 43*, 1161-1173.

Brooks, R., Scott, I. M., Maklakov, A. A., Kasumovic, M. M., Clark, A. P., & Penton-Voak, I. S. (2011). National income inequality predicts women's preferences for masculinized faces better than health does. *Proceedings of the Royal Society B: Biological Sciences, 278*, 810-812. doi: 10.1098/rspb.2010.0964

Cunningham, M., & Shamblen, S. (2003). Beyond Nature Versus Culture: A Multiple Fitness Analysis of Variations in Grooming. In E. Voland & K. Grammer (Eds.), *Evolutionary Aesthetics* (pp. 201-237): Springer Berlin Heidelberg.

Daly, M., & Wilson, M. (1988) *Homicide*. Transaction Publishers.

DeBruine, L. M., Jones, B. C., Crawford, J. R., Welling, L. L. M., & Little, A. C. (2010). The health of a nation predicts their mate preferences: cross-cultural variation in women's preferences for masculinized male faces. *Proceedings of the Royal Society B: Biological Sciences, 277*, 2405-2410. doi: 10.1098/rspb.2009.2184

DeBruine, L. M., Jones, B. C., Little, A. C., Crawford, J. R., & Welling, L. L. M. (2011). Further evidence for regional variation in women's masculinity preferences. *Proceedings of the Royal Society B: Biological Sciences, 278*, 813-814. doi: 10.1098/rspb.2010.2200

DeBruine, L. M., Little, A. C., & Jones, B. C. (2012). Extending parasite-stress theory to variation in human mate preferences. *Behavioral and Brain Sciences, 35*, 86-87. doi: doi:10.1017/S0140525X11000987

Dixson, A. F. (2012). *Primate Sexuality: Comparative Studies of the Prosimians, Monkeys, Apes, and Humans*: Oxford University Press.

Dixson, A., Dixson, B., & Anderson, M. (2005). Sexual Selection and the Evolution of Visually Conspicuous Sexually Dimorphic Traits in Male Monkeys, Apes, and Human Beings. *Annual Review of Sex Research, 16*, 1-19.

Dixson, B. J., & Brooks, R. C. (2013). The role of facial hair in women's perceptions of men's attractiveness, health, masculinity and parenting abilities. *Evolution and Human Behavior, 34*, 236-241.

Dixson, B. J. W, Lee, A. J., Sherlock, J. M., & Talamas, S. N. (In Press). Beneath the beard: Do facial morphometrics influence the strength of judgments of men's beardedness? *Evolution and Human Behavior.*

Dixson, B. J., & Rantala, M. J. (2015). The role of facial and body hair distribution in women's judgments of men's sexual attractiveness. *Archives of Sexual Behavior*, 1-13.

Dixson, B. J.W., Sullikowski, D., Gouda-Vossos A., Rantala, M. J., & Brooks R. C. (2016). The masculinity paradox: Facial masculinity and beardedness interact to determine women's ratings of men's facial attractiveness *Journal of Evolutionary Biology*.

Dixson, B. J., Tam, J. C., & Awasthy, M. (2013). Do women's preferences for men's facial hair change with reproductive status? *Behavioral Ecology, 24*, 708-716.

Dixson, B. J., & Vasey, P. L. (2012). Beards augment perceptions of men's age, social status, and aggressiveness, but not attractiveness. *Behavioral Ecology*. doi: 10.1093/beheco/arr214

Dwight, E. R. (1976). Fashions in Shaving and Trimming of the Beard: The Men of the Illustrated London News, 1842-1972. *American Journal of Sociology, 81*, 1133-1141.

Elsner, P. (2012). Overview and trends in male grooming. *British Journal of Dermatology, 166*, 2-5. doi: 10.1111/j.1365-2133.2011.10782.x

Gangestad, S. W., & Eaton, M. A. (2013). Toward an integrative perspective on sexual selection and men's masculinity. *Behavioral Ecology, 24*, 594-595.

Geniole, S. N., Denson T. F., Dixson B. J., Carré, J.M., & McCormick, C. M. 2015. Evidence from meta analyses of the facial width-to-height ratio as an evolved cue of threat. *PloS ONE*. 10(7): e0132726. doi:10.1371/journal.pone.0132726

Geniole, S. N., & McCormick, C. M. (2015). Facing our ancestors: judgements of aggression are consistent and related to the facial width-to-height ratio in men irrespective of beards. *Evolution and Human Behavior*. 36, 279–285

Gettler, L. T. (2014). Applying socioendocrinology to evolutionary models: fatherhood and physiology. *Evolutionary Anthropology, 23*, 146-160.

Grueter, C. C., Isler, K., & Dixson, B. J. (2015). Are badges of status adaptive in large complex primate groups? *Evolution and Human Behavior, 36*, 398-406. doi: http://dx.doi.org/10.1016/j.evolhumbehav.2015.03.003

Guttentag, M., & Secord, P. F. (1983). *Too many women? The sex ratio question*: Beverly Hills, CA: Sage.

Hamilton, J. B. (1958). Age, sex and genetic factors in the regulation of hair growth in man: a comparison of Caucasian and Japanese populations (Vol. 399): New York: Academic Press.

Hamilton, J. B. (1964). Racial and genetic predisposition. *Clinical Obstetrics and Gynecology, 7*, 1075-1084.

Hamilton, J. B., Terada, H., & Mestlert, G. E. (1958). Studies of Growth Throughout the Life Span in Japanese: II. Beard Growth in Relation to Age, Sex, Heredity, and Other Factors. *Journal of Gerontology, 13*, 269-281. doi: 10.1093/geronj/13.3.269.

Hellmer, K., & Stenson, T. J. (2016). Contradicting Data and Comments on Oldmeadow and Dixson's (2015)"The Association Between Men's Sexist Attitudes and Facial Hair". *Archives of sexual behavior*, *4*(45), 783-784.

Janif, Z. J., Brooks, R. C., & Dixson, B. J. (2014). Negative frequency-dependent preferences and variation in male facial hair. *Biology letters, 10*(4), 20130958.

Jennions, M. D., & Petrie, M. (1997). Variation in mate choice and mating preferences: A review of causes and consequences. *Biological Reviews, 72*, 283-327. doi: 10.1111/j.1469-185X.1997.tb00015.x

Kandrik, M., Jones, B. C., & DeBruine, L. M. (2015). Scarcity of female mates predicts regional variation in men's and women's sociosexual orientation across US states. *Evolution and Human Behavior*, *36*, 206-210.

Kasumovic, M. M. (2013). The multidimensional consequences of the juvenile environment: towards an integrative view of the adult phenotype. *Animal Behaviour, 85*, 1049-1059.

Kinsey, A. C., Pomeroy, W. B., & Martin, C. E. (1948). *Sexual behavior In the human male*: Philidelphia: Saunders.

Knussman R, & Christiansen, K. (1988). Attributes of masculinity and androgen level. *Homo, 39*, 45-50.

Kokko, H., Brooks, R., Jennions, M. D., & Morley, J. (2003). The evolution of mate choice and mating biases. *Proceedings of the Royal Society of London. Series B: Biological Sciences, 270*, 653-664. doi: 10.1098/rspb.2002.2235

Kruger, D. J. (2006). Male facial masculinity influences attributions of personality and reproductive strategy. *Personal Relationships, 13*, 451-463.

Muehlenbein, M. P., & Bribiescas, R. G. (2005). Testosterone‐mediated immune functions and male life histories. *American Journal of Human Biology, 17*, 527-558.

Muscarella, F., & Cunningham, M. R. (1996). The evolutionary significance and social perception of male pattern baldness and facial hair. *Ethology and Sociobiology, 17*, 99-117.

Neave, N., & Shields, K. (2008). The effects of facial hair manipulation on female perceptions of attractiveness, masculinity, and dominance in male faces. *Personality and Individual Differences, 45*, 373-377.

Oldmeadow, J. A., & Dixson, B. J. (2016a). The Association Between Men's Sexist Attitudes and Facial Hair. *Archives of Sexual Behavior*, 45, 891-899.

Oldmeadow, J.A., & Dixson, B. J. (2016b). No contradictions, but directions for further research: A reply to Hellmer and Stenson. *Archives of Sexual Behavior*, 45, 785-786.

Pellegrini, R. J. (1973). Impressions of the male personality as a function of beardedness. *Psychology, 10*, 29-33.

Petterson, L. J., Dixson, B. J., Little, A. C., & Vasey, P. L. (2015). Viewing time measures of sexual orientation in Samoan cisgender men who engage in sexual interactions with Fa'afafine. *PloS one*, *10*(2), e0116529.

Petterson, L. J., Dixson, B. J., Little, A. C., & Vasey, P. L. (2016). Reconsidering male bisexuality: Sexual activity role and sexual attraction in Samoan men who engage in sexual interactions with Fa'afafine. *Psychology of Sexual Orientation and Gender Diversity*, *3*(1), 11-26.

Perrett, D. I., Lee, K. J., Penton-Voak, I., Rowland, D., Yoshikawa, S., Burt, D. M., . . . Akamatsu, S. (1998). Effects of sexual dimorphism on facial attractiveness. *Nature, 394*, 884-887.

Peterkin, A. (2001). A history of shaving: One thousand beards: Canada: Arsenal pulp press.

Puts, D. A. (2010). Beauty and the beast: mechanisms of sexual selection in humans. *Evolution and Human Behavior, 31*, 157-175.

Reed, J. A., & Blunk, E. M. (1990). The influence of facial hair on impression formation. *Social Behavior and Personality: an international journal, 18*, 169-175. doi: 10.2224/sbp.1990.18.1.169

Reynolds, R. (1950). *Beards: Their Social Standing, Religious Involvements, Decorative Possibilities, and Value Offence and Defence Through the Ages*: Houghton Mifflin Harcourt P.

Rhodes, G. (2006). The evolutionary psychology of facial beauty *Annual Review of Psychology* (Vol. 57, pp. 199-226). Palo Alto: Annual Reviews.

Rhodes, G., Morley, G., & Simmons, L. W. (2013). Women can judge sexual unfaithfulness from unfamiliar men's faces. *Biology letters, 9*(1), 20120908.

Rhodes, G., Simmons, L. W., & Peters, M. (2005). Attractiveness and sexual behavior: Does attractiveness enhance mating success? *Evolution and Human Behavior, 26*, 186-201. doi: 10.1016/j.evolhumbehav.2004.08.014

Robinson, D. E. (1976). Fashions in Shaving and Trimming of the Beard: The Men of the Illustrated London News, 1842-1972. *American Journal of Sociology, 81*(5), 1133-1141.

Royuela, V., Veneri, P., & Ramos, R. (2014). Income Inequality, Urban Size and Economic Growth in OECD Regions. *OECD Regional Development Working Papers, OECD Publishing.* http://dx.doi.org/10.1787/5jxrcmg88l8r-en.

Santana, S. E., Alfaro, J. L., Noonan, A., & Alfaro, M. E. (2013). Adaptive response to sociality and ecology drives the diversification of facial colour patterns in catarrhines. *Nature communications, 4*.

Santana, S. E., Lynch Alfaro, J., & Alfaro, M. E. (2012). Adaptive evolution of facial colour patterns in Neotropical primates. *Proceedings of the Royal Society B: Biological Sciences*. doi: 10.1098/rspb.2011.2326

Saxton, T. K., Mackey, L. L., McCarty, K., & Neave, N. (2016). A lover or a fighter? Opposing sexual selection pressures on men's vocal pitch and facial hair. *Behavioral Ecology*, *27*, 512–519.

Scott, I., Clark, A., Boothroyd, L., & Penton-Voak, I. (2013). Do men's faces really signal heritable immunocompetence? *Behavioral ecology: official journal of the International Society for Behavioral Ecology, 24*, 579-589.

Scott, I. M., Clark, A. P., Josephson, S. C., Boyette, A. H., Cuthill, I. C., Fried, R. L., . . . Jankowiak, W. (2014). Human preferences for sexually dimorphic faces

may be evolutionarily novel. *Proceedings of the National Academy of Sciences, 111*, 14388-14393.

Sell, A., Cosmides, L., & Tooby, J. (2014). The human anger face evolved to enhance cues of strength. *Evolution and Human Behavior, 35*, 425-429.

Sell, A., Cosmides, L., Tooby, J., Sznycer, D., von Rueden, C., & Gurven, M. (2009). Human adaptations for the visual assessment of strength and fighting ability from the body and face. *Proceedings of the Royal Society of London B: Biological Sciences, 276*, 575-584.

Setty, L. R. (1971). Hair patterns of the face of white and negro males. *Journal of the National Medical Association, 63*, 128.

Sherlock, J. M., Tegg, B., Sulikowski, D., & Dixson, B. J. (2016). Facial Masculinity and Beardedness Determine Men's Explicit, but Not Their Implicit, Responses to Male Dominance. *Adaptive Human Behavior and Physiology*, 1-16.

Valentova, J. V., Varella, M., Bártová, K., Štěrbová, Z., & Dixson, B. J. In Press. Mate preferences and choices for facial and body hair in heterosexual women and homosexual men: Effects of sex, population, homogamy, and imprinting-like effects. *Evolution and Human Behavior*.

van Honk, J., Bos, P. A., & Terburg, D. (2014). Testosterone and dominance in humans: Behavioral and Brain Mechanisms *New Frontiers in Social Neuroscience* (pp. 201-214): Springer.

Wood, D. R. (1986). Self-percived masculinity between bearded and nonbearded males. *Perceptual and Motor Skills, 62*, 769-770.

Zahavi, A. (1975). Mate selection—A selection for a handicap. *Journal of Theoretical Biology, 53*, 205-214.

Captions to Figures

Figure 1. Geographic variation in the frequencies of men's facial hair styles according to population sizes. Data are the proportion of men who had full beards (A.), and who had facial hair other than full beardedness (B.) according to the population size.

Figure 2. The association between the proportion of men in each city with full beards and women's preferences for facial hair.

Figure 1

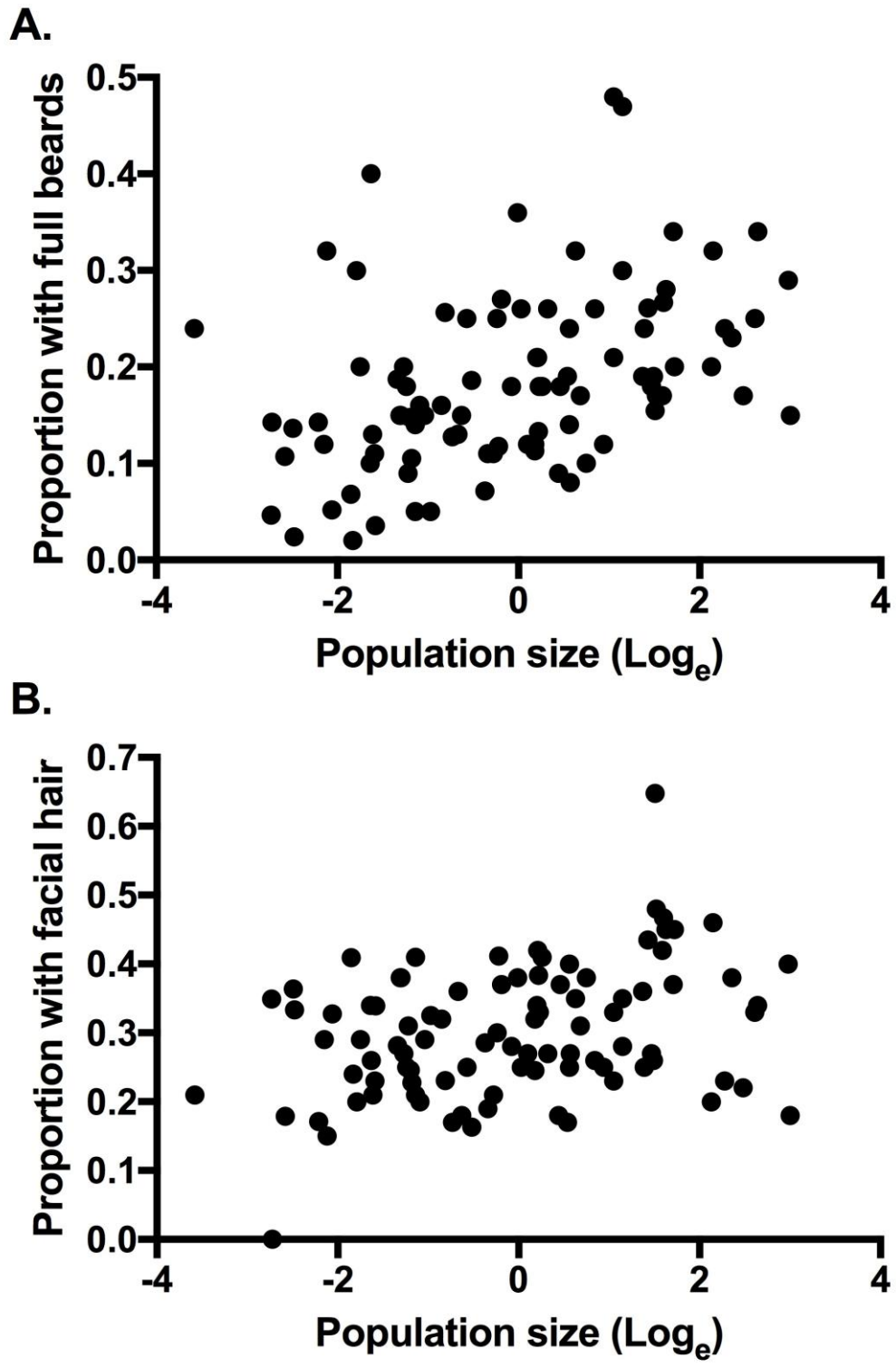

Figure 2