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Mothers are sensitive to men's beards as a potential cue of paternal investment.

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ABSTRACT

Mating strategy theories assert that women's preferences for androgen dependent traits in men are stronger when the costs of reduced paternal investment are lowest. Past research has shown that preferences for facial masculinity are stronger among nulliparous and non-pregnant women than pregnant or parous women. In two studies, we examine patterns in women's preferences for men's facial hair – likely the most visually conspicuous and sexually dimorphic of men's secondary sexual traits – when evaluating men's masculinity, dominance, age, fathering, and attractiveness. Two studies were conducted among heterosexual pregnant women, mothers, non-contractive and contraceptive users. Study 1 used a between-subjects sample (N = 2103) and found that mothers had significantly higher preferences for beards when judging fathering than all other women. Pregnant women and mothers also judged beards as more masculine and older, but less attractive, than non-contractive and contraceptive users. Parous women judged beards higher for age, masculinity and fathering, but lower for attractiveness, than nulliparous women. Irrespective of reproductive status, beards were judged as looking more dominant than clean-shaven faces. Study 2 used a within-subjects design (N = 53) among women surveyed during pregnancy and three months post-partum. Judgments of parenting skills were higher for bearded stimuli during pregnancy among women having their first baby, whereas among parous women parenting skills judgments for bearded stimuli were higher post-partum. Our results suggest that mothers are sensitive to beardedness as a masculine secondary sexual characteristic that may denote parental investment, providing evidence that women's mate preferences could reflect sexual selection for direct benefits.

KEY WORDS: facial hair; beards; attractiveness; motherhood; pregnancy.

1. Introduction

Female choice via direct and indirect mechanisms of sexual selection underpins the evolution of male ornaments in many species (Kokko et al., 2003, 2006). Under indirect selection, preferences evolve for traits associated with male quality that can enhance offspring survival, such as immunity. Under direct selection, preferences evolve for characters that tangibly enhance the survival of the mother and offspring, such as resources and protection (Kokko et al., 2003, 2006). Men's secondary sexual characters are similarly developed to male nonhuman primates from species whose mating systems are polygynous (Dixson, Dixson, and Anderson, 2005; Puts et al., 2016) and social systems are multilevel in their compositions (Grueter, Isler, and Dixson, 2015), suggesting that sexual selection shaped male-typical (i.e. masculine) traits during the course of human evolution.

Women's preferences for masculine traits could have evolved under both indirect (Gangestad and Thornhill, 2008) and direct (Puts, 2010; Scott et al., 2013) sexual selection. Masculine facial traits, defined as a prominent jaw, protruding brow ridge, robust midface, thin lips and deeply set eyes, emerge as androgens exert their effects during foetal development (Whitehouse et al., 2015), puberty (Marečková et al., 2011) and young adulthood (Roosenboom et al., 2018). Androgens may reduce immune response (Muehlenbein and Bribiescas, 2005), so that male facial masculinity may indirectly communicate genetic quality via disease resistance (Rhodes et al., 2003; Thornhill & Gangestad, 2006) and immune response (Rantala et al., 2012), although this pattern may be mediated by facial adiposity (Rantala et al., 2013). Indeed, Phalene et al. (2017) reported that facial masculinity and facial muscularity were jointly associated with male immune response. Alternatively, facial masculinity may communicate direct benefits such as competitive ability and resource provisioning (Puts, 2010; Scott et al., 2013). Facial masculinity is positively associated with men's upper body strength (Windhager et al., 2011; Fink et al., 2007), fighting ability (Sell et al., 2017) and social dominance (Geniole et al., 2015; Hill et al., 2013). Augmenting facial masculinity experimentally also enhances judgments of men's age, masculinity, and social dominance (DeBruine et al., 2006; Perrett et al., 1998), suggesting intra-sexual selection has influenced masculine craniofacial morphology and that facial masculinity communicates direct benefits to women.

Although mating success is higher among men with more masculine faces (Hill et al., 2013; Kordsmeyer et al., 2018; Peters et al., 2008; Rhodes et al., 2005), women's preferences for facial masculinity vary across studies (Rhodes, 2006), so that masculine male faces were preferred in some samples (DeBruine et al., 2006) while less masculine male faces were preferred in others (Dixson et al., 2017b; Perrett et al., 1998). As reproduction imposes fewer costs on men than women, men are hypothesised to expend more energetic resources towards mating effort than parental investment (Puts, 2010; Gray et al., 2017). Men with more masculine faces state less interest in long-term relationships (Boothroyd et al., 2008, 2011), have more short-term relationships (Polo et al., 2019; Rhodes et al., 2005), and both express more interest in and engage in more extra-pair relationships (Arnocky et al., 2017; Rhodes et al., 2013). Facially masculine men are also judged as less caring and paternally investing (Kruger, 2006; Perrett et al., 1998) and women accurately judge sexual infidelity from facially masculine traits in photographs of anonymous men (Rhodes et al., 2013; Sutherland et al., 2018). Thus, despite the potential direct and indirect benefits of selecting masculine men as mates, facially masculine men may be costly as long-term partners through reduced investment in parenting.

This paradoxical role of masculinity in men's value as long-term partners has prompted investigation into the possible contextual mating strategies underpinning variation in women's preferences for facial masculinity (Dixson et al., 2016; Holzleitner & Perrett, 2017; Jones et al., 2019). Among the potential mechanisms are women's' short-term mating strategies and reproductive condition (Motta-Mena & Puts, 2017; Jones et al., 2019). The social costs associated with selecting masculine partners may be reduced under conditions favouring short-term mating strategies (Gangestad & Thornhill, 2008) and facial masculinity preferences are stronger among young reproductively capable women than post-menopausal women (Little et al., 2010; Marcinkowska et al., 2018c). Within pre-menopausal women, preferences for masculine traits may become more pronounced during the peri-ovulatory period of the menstrual cycle, when offspring fitness could be increased via indirect genetic benefits (Gangestad & Thornhill, 2008). While several studies yielded support for ovulatory shifts in women's short-term mate preferences for masculine faces (Gildersleeve et al., 2014; but see Wood et al., 2014), researchers often used counting methods from questionnaire data to characterise fertility, which is markedly less accurate than quantifying hormones (Blake et al., 2016). Recent studies in which the peri-ovulatory phase was verified hormonally have not reported ovulatory shifts in women's preferences for short-term mating strategies (Jones et al., 2018a) or mate preferences for masculine facial shape, facial symmetry, upper body musculature, or masculine voices (Dixson et al., 2018a; Jones et al., 2018a; Jünger et al., 2018a,b; Marcinkowska et al., 2016, 2018a, 2018b), so that ovulatory shifts in mate preferences may not be as robust as early studies suggested (Jones et al., 2019).

Rather than becoming stronger when fecundability is higher, women's preferences for masculine traits may be reduced at times when a more prosocial and paternally investing, but less physically masculine partner, could be beneficial. Pregnancy, lactation, and the early years of child rearing are periods during which mothers and their children are highly vulnerable (Hrdy, 2016). At these times, preferences for men displaying well developed masculine characters may decrease and preferences for cues to paternal investment may be prioritised. Motherhood is also associated with pronounced endocrine changes, beginning with conception, dramatically changing during pregnancy, at birth and with lactation (Motta-Mena & Puts, 2017). During pregnancy, median progesterone in the 1^{st} trimester is approximately 30.6 ng/mL, rises to 56.9 ng/mL in the 2^{nd} trimester and to 161 ng/mL in 3^{rd} trimester (Schock et al., 2016) and drops dramatically postpartum (Buckwalter et al., 1999; Wilcox et al., 1985). Estradiol has median levels of 2.32 nmol/l during the 1^{st} trimester, rising to 9.00 nmol/l in the 2^{nd} trimester and 22.6 nmol/l in the 3^{rd} trimester (Schock et al., 2016), dropping to 3.7 nmol/l postpartum (Buckwalter et al., 1999; Wilcox et al., 1985). While not reaching the same absolute levels as progesterone and estrogen, women's testosterone also increases throughout pregnancy, rising from a median of 0.84 nmol/l in the 1^{st} trimester to 1.10 nmol/l during the 2^{nd} trimester and 1.04 during the 3^{rd} trimester (Schock et al., 2016). Endocrine changes during pregnancy may be associated with women's preferences for masculine traits. Over the menstrual cycle women's facial masculinity preferences are positively associated with estradiol (Roney & Simmons, 2008; Roney et al., 2011; but see Dixson et al., 2018a), testosterone (Welling et al., 2008; but see Marcinkowska et al., 2019) and progesterone among single but not partnered women (Marcinkowska et al., 2018; DeBruine et al., 2019). Preferences for facial masculinity are lower among pregnant women compared to nulliparous women (Limoncin et al., 2015) and are lower post-partum compared to during pregnancy (Cobey et al., 2015; Marcinkowska et al., 2018c). During the first year of child rearing, mothers had higher preferences for less masculine faces than nulliparous and pregnant women (Escasa-dorne, Manlove, & Gray, 2017; Cobey et al., 2015), possibly due to endocrine changes postpartum (Cobey et al., 2015). Thus, biosocial factors may explain stronger preferences for facial masculinity among women entering the third trimester of pregnancy than early motherhood as a reflection of higher perceived paternal investment.

Like facial masculinity, beardedness is androgen dependent (Randall, 2008) and one of the most visually salient and sexually dimorphic of men's secondary sexual traits (Dixson et al., 2005; Grueter et al., 2015). While bearded men may have higher mating success than clean-shaven men (Barber, 2001), women's preferences for men's beardedness vary across studies. Clean-shaveness is preferred over beardedness in some samples (Dixson & Vasey, 2012; Geniole & McCormick, 2015; Muscarella & Cunningham, 1996), while full beards are preferred in others (Dixson et al., 2016; Janif et al., 2014; Pelligrini, 1973). Research measuring preferences over the menstrual cycle has not reported associations between women's preferences for beards and their likelihood of conception when using self-reported measures (Dixson & Brooks, 2013; Dixson & Rantala, 2016,2017; Dixson, Tam, & Awasthy, 2013) or when determining the peri-ovulatory phase hormonally (Dixson et al., 2018a,b). While craniofacial masculinity and beards both develop under the actions of testosterone, facial hair also requires the conversion of testosterone to dihydrotestosterone via 5-alpha reductase activity within hair follicles rather than directly due to testosterone (Randall, 2008), as may be the case for craniofacial masculinity (Whitehouse et al., 2015; Roosenboom et al., 2018). The association between DHT activity and facial hair may be unrelated to health or immunity (Dixson et al., 2016), suggesting that beards do not incur the kinds of biological costs to men as other masculine facial characters and therefore may not communicate indirect genetic benefits to women that informs their short-term mate preferences.

Facial hair may instead communicate direct benefits such as social status, social dominance and protection (Puts, 2010) that determine women's mate preferences for long-term and potentially paternally investing partners (Dixson & Brooks, 2013; Neave & Shields, 2008). Beards consistently enhance perceptions of men's age, masculinity (Dixson & Brooks, 2013; Neave & Shields, 2008), dominance (Dixson et al., 2017a; Sherlock et al., 2017; Saxton et al., 2016), social status (Dixson & Vasey, 2012) and aggressiveness (Dixson & Vasey, 2012; Muscarella & Cunningham, 1996). However, unlike facial masculinity there is no evidence that men's beardedness is associated with body size, physical strength, or direct aggressiveness (Dixson et al., 2018c). Instead, facial hair may enhance intimidation by elaborating on masculine craniofacial structure (Dixson et al., 2017a; Sherlock et al., 2017) and agonistic facial displays (Craig et al., 2019; Dixson & Vasey, 2012). Bearded men report higher feelings of masculinity (Wood, 1986) and have higher serum testosterone (Knussman & Christiansen, 1988) than clean-shaven men. Again, in contrast to facial masculinity women judge beards as more attractive for long-term relationships (Neave & Shields, 2008), ascribe beards higher ratings of parenting skills (Dixson & Brooks, 2013; Stower et al., 2019) and facial hair is preferred under social conditions characterised by higher male-male competition (Barber, 2001; Dixson et al., 2017a; Dixson et al., 2019). Beards may therefore communicate direct benefits that are preferred under circumstances when resources and protection would be beneficial to the survival of mothers and infants. To our knowledge, the only study that has measured women's preferences for facial hair across different reproductive stages found that pregnant women gave higher attractiveness ratings to full beards than non-pregnant women (Dixson et al., 2013). However, that study employed a small sample size of 42 pregnant women and stimuli that did not control for variation in craniofacial masculinity, which influences attractiveness judgments of beards (Dixson et al., 2017a). Thus, further research on how pregnancy, parity and the transition to motherhood are associated with mate preferences for men's beards is warranted.

To this end, we conducted two studies in which women judged bearded and clean-shaven faces for attractiveness, fathering skills, masculinity, dominance, and age across different reproductive conditions. In Study 1, we compared judgments of facial hair in a large sample of women (N = 2103) in five analyses. In Analysis 1, we tested whether reproductive status impacts on women's judgments of beards among women who were either pregnant, were early in motherhood (defined as having had a baby within a year), were not using hormonal contraceptives or were using hormonal contraceptives. While women's preferences for facial masculinity are higher among childless women than mothers (Limoncin et al., 2015), women judge beards as more attractive for long-term relationships and as potential fathers (Dixson & Brooks, 2013; Neave & Shields, 2008; Stower et al., 2019). In Analysis 1, we hypothesised that women in early motherhood would rate bearded men (compared to clean-shaven men) lower on attractiveness and higher on parenting ability compared to women during pregnancy, not using hormonal contraceptives or using hormonal contraceptives. Among mothers, parity may be associated with shifts towards parenting effort over mating effort (Motta-Mena & Puts, 2017) that impact on preferences for masculine facial features (Escasa-dorne et al., 2017; Limoncin et al., 2015). Indeed, nulliparous women gave higher attractiveness ratings for male facial masculinity than pregnant women and mothers (Escasa-dorne et al., 2017). In Analysis 2, we tested the hypothesis that judgments of parenting skills in bearded stimuli will be stronger, but attractiveness ratings lower, among mothers than among nulliparous women.

Trade-offs in women's preferences for masculine men may also occur during pregnancy, possibly in concert with rising levels of reproductive hormones as mothers approach their 3rd trimester (Brett & Baxendale, 200; Buckwalter et al., 1999; Wilcox et al., 1985). In Analysis 3, we compared judgments of bearded faces among pregnant women when accounting for how many weeks into their pregnancy they were. We predicted that attractiveness judgments for beards may be stronger as women approach the 3rd trimester of pregnancy (Cobey et al., 2015). Similarly, when breastfeeding is chronic ovarian functioning can be suppressed (Ellison, 2003), which may be associated with lower preferences for androgen dependent traits in men among breastfeeding women (Escasa-dorne et al., 2018). In Analysis 4, we tested the hypothesis that breastfeeding mothers would judge bearded males as less sexually attractive than non-breastfeeding mothers. Reproductive hormones remain lower among mothers with young children than mothers with older children, partly due to interrupted sleep patterns (Kuzawa et al., 2010), so that women with younger children may have lower preferences for masculine facial traits than women with older children (Cobey et al., 2015; Escasa-dorne et al., 2017). In Analysis 5, we tested the hypothesis that women's attractiveness judgments of men's beards would be positively associated with the age of their youngest child. Finally, increases in reproductive hormones during pregnancy are most pronounced in the 3rd trimester and decline during the early months postpartum (Schock et al., 2016; Buckwalter et al., 1999). Cobey et al. (2015) suggested that this represents the point at which changes in women's preferences for facial masculinity are most pronounced. In a within-subject design, they reported women's preferences (N = 28) for male facial masculinity were significantly stronger in the third trimester of pregnancy than 3 months postpartum (Cobey et al., 2015). In Study 2, we tested women's judgments of beardedness among 53 women recruited during the third trimester of their pregnancies in Study 1 and again during the first three months post-partum. We hypothesized that women's judgments of fathering abilities for bearded males would be highest during the early months postpartum than during the 3rd trimester of pregnancy. We also explored whether judgments of beardedness were specific to parity, such that women having their first child may be more sensitive to cues of paternal investment postpartum compared to women with more children.

2. Methods

2.1 Participants

A total of 2419 women (Mean age = 30.71, SD = 11.03) completed this study online. Participants were recruited via mailing lists at the Early Child Development Centre and student mailing lists in the School of Psychology at the University of Queensland (Brisbane, Australia). Participants provided their age, ethnicity, and completed the Kinsey scale for sexual orientation (Kinsey, Pomeroy, & Martin, 1948). Participants then indicated if they were pregnant, how many children they had and their children's ages (in years and months), and if they currently use hormonal contraceptives. We removed 25 participants who did not report their age and a further 65 participants for either not reporting their sexual orientation or for reporting homosexual sexual preferences, as sexual orientation impacts on face preferences (Petterson et al., 2015, 2016, 2018), including facial hair (Valentova et al., 2017). A further 274 participants were removed for not completing the face ratings in the survey. For Study 1, this left a final sample of 2103 heterosexual women (Mean age = 30.85, SD = 11.35). Participants ethnicities were as follows: European (75.6%), Asian (15.7%), African (3.6%) other (5.1%). The total sample was then partitioned into subsets for our 5 analyses, which are described below.

Analysis 1. **Reproductive status and judgments of facial hair.** This analysis tested whether variation in women's reproductive status impacts on judgments of men's beards. Of the final sample, 1286 (31.91 years ± 13.52) were not using hormonal contraceptives, 278 (28.19 years ± 8.10) were using contraceptives, 387 (29.41 years ± 4.99) had a child under one year of age, and 152 (30.43 years ± 5.04) were pregnant. For pregnant participants, the due dates for their babies were determined by ultrasound and blood tests (85.5%), calculation from last menses with an ovulation tests (12.5%) and 2% elected not to answer this question.

Analysis 2. Women's parity and judgments of facial hair. Here we tested whether mothers differ from non-mothers in their judgments of men's beards. We used data from women not using hormonal contraceptives (n = 1756, mean age 31.37, SD = 11.88) to compare judgments among nulliparous (i.e. childless) women (n = 1088, mean age 27.75, SD = 10.76) and mothers (n = 668, mean age 37.27, SD = 11.25).

Analysis 3. Women's judgments of facial hair during pregnancy. To examine how mate preferences vary over the course of women's pregnancies, we tested whether how far along in weeks women were into their pregnancy impacted on their judgments of men's facial hair. Of the 152 pregnant women, 149 (mean age 30.38, SD = 5.01) provided information on their stage of pregnancy from which we calculated how far along in weeks they were into their pregnancy (Mean = 23, SD = 9.88, range 3-40).

Analysis 4. Breastfeeding and women's judgments of facial hair. We also tested whether breastfeeding was associated with women's judgments of men's beardedness. Of the 387 women (mean age 29.41, SD = 4.99) who completed surveys when in early motherhood, 359

(93%, mean age 29.54, SD = 4.99) were breastfeeding and 28 (7%, mean age 27.75, SD = 4.4.72) were not breastfeeding.

Analysis 5. The age of women's offspring and their judgments of facial hair. As hormones associated with mate preferences change over the course of motherhood, we predicted the age of the youngest infant was associated with mother's judgments of men's facial hair. Of the total sample of 889 (35.15 years, SD = 10.72) mothers, 839 (35.52 years, SD = 10.58) provided the ages of their youngest child (mean = 69.98 months, SD = 113.7). Among the total of 387 women who completed surveys during their first year of motherhood, 349 (mean age 29.41, SD = 4.99) provided the ages of their last-born child (mean age = 6.14 months, SD = 3.45). We compared judgments of beards with the age of the youngest infant in the full sample of mothers and again among only mothers with infants under 1 year of age.

In Study 2, we tested whether judgments of men's facial hair differed as women transition from pregnancy to early motherhood using a within-subjects design. We asked the 152 pregnant women who completed Study 1 whether they would be willing to be contacted again, 12 weeks after their anticipated due date. We received agreement to be re-contacted from 100 of the 152 pregnant women from Study 1, of which 53 (Mean age 30.85, SD = 4.43) completed the surveys and were used in subsequent analyses.

2.2. Facial hair photographs

Thirty-seven men (mean age ± SD = 27.9 ± 5.75 years) of European ethnicity were photographed when clean-shaven and with 4-8 weeks of natural beard growth posing with a neutral facial expression. Photographs were taken using a digital camera (8.0 megapixels resolution) with subjects 150 cm from the photographer under controlled lighting (Dixson et al., 2017a; Janif et al., 2014). Composite stimuli were constructed using the Webmorph software package (DeBruine and Tiddeman, 2016) by identifying 189 facial landmarks on the images and averaging the shape and color information of the photographs. To create a composite bearded face and a composite clean-shaven face, we randomly selected five males from the total pool of 37. For each of the five males we used their bearded and clean-shaven versions to create a composite with a full beard and when clean-shaven. Thus, the pairs of composites represented the same five individuals when bearded and when clean-shaven (Figure 1). This process was undertaken 10 times to create the 10 pairs of bearded and clean-shaven composite stimuli. This approach has been used in past studies on women's preferences for men's beardedness (Dixson et al., 2018b; McIntosh et al., 2017; Stower et al., 2019).

Figure 1. Four pairs of facial hair stimuli used in this study. Images show composite images using the same 5 individuals when clean-shaven (top row) and fully bearded (bottom row).

Participants viewed pairs of faces showing the same composite man bearded and clean-shaven and were asked to judge the faces in a two-alternative forced choice test (2AFC). Past research has demonstrated the validity of 2AFC paradigms over Likert scales in characterizing women's hypothetical and actual preferences for masculine facial traits (DeBruine, 2013). Studies quantifying women's preferences for facial symmetry using 2AFC may reflect whether women can detect facial asymmetries rather than the strength of their preferences for symmetry (Lewis, 2017). However, 2AFC paradigms have been effective in identifying men and women's preferences for bodily attractiveness (Dixson & Rantala, 2016; Marcincowska et al., 2018a; Singh et al., 2010), women's preferences for facial masculinity (DeBruine et al., 2006; Marcinkowska et al., 2019; Scott et al., 2014), and beardedness (Dixson et al., 2018b).

Participants judged faces on five traits: 1) Physical Strength (participants were asked "Who looks stronger?") hereafter referred to as dominance, 2) Age ("Who looks older?"), 3) Masculinity ("Who looks most like a man?"), 4) Attractiveness ("Who looks most sexually attractive?"), and 5) Parental Figure ("Who looks like the most suitable father?" hereafter referred to fathering). The trait questions were blocked and the order in which participants saw the rating blocks was also randomized. Within the trait blocks, the presentation of face pairs was randomized. Participants selected whether the bearded or clean-shaven face in each pair of faces was higher for the trait they were judging. Four pairs of faces were presented in each block. The position of the clean-shaven and bearded image in each pair was randomized, appearing either on the right or left. This study was pre-approved by the Human Ethics Committee at the University of Queensland (#1876).

2.3. Statistical analyses

Study 1 employed general linear models (GLMs) and Bayesian GLMs using JASP (Wagenmakers et al., 2017). Five analyses were undertaken in which the mean proportion of selections for bearded over clean-shaven faces for each trait rating (age, masculinity, dominance, attractiveness and fathering abilities) was the dependent measure in the GLMs. Effect sizes in the models are eta square (η^2) and all effect sizes for post-hoc Bonferroni tests are Cohen's D. Bayesian analyses were undertaken to ascertain the presence or absence of a hypothesized effect over the competing null effect. The Bayes Factor (BF_{10}) provides an estimation of the strength of support a hypothesis receives relative to another competing hypothesis. A BF_{10} of 1-3 is considered weak evidence, a BF_{10} of 3-10 is considered moderate evidence and a BF_{10} above 10 is considered strong evidence (van Doorn et al., 2019).

In Analysis 1, selections for beards were compared against women's reproductive status (pregnant, mothers, non-hormonal contraceptive users and hormonal contraceptive users), which was a fixed factor in the GLMs. There was a significant difference in ages between the women in the four reproductive status categories, $F(3, 2099) = 11.14$, $p < .001$. Thus, age was entered as a covariate in our analyses.

Analysis 2 used data only from women not using hormonal contraceptives (n = 1756, mean age 31.37, SD = 11.88) to compare judgments among nulliparous women (n = 1088, mean age 27.75, SD = 10.76) and mothers (n = 668, mean age 37.27, SD = 11.25). Nulliparous and parous women differed significantly in age, $t(1754) = 17.54$, $p < .001$. Thus, parity (nulliparous, parous) was a fixed factor and participant's age was entered as a covariate in our analyses.

Analyses 3 tested whether how far into pregnancy (in weeks) our pregnant participants were at the time of completing the surveys influenced judgements of beardedness. Of the 152 pregnant women, 149 (mean age 30.38, SD = 5.01) provided information on the stage of the pregnancy from which we calculated how far along in weeks they were into their pregnancy (Mean = 23, SD = 9.88, range 3-40). Weeks into pregnancy was entered as a covariate in the GLMs.

In Analyses 4, we tested whether breast feeding influenced judgments of men's beardedness. Of the total of 387 women (mean age 29.41, SD = 4.99) who completed surveys when in early motherhood, 359 (93%, mean age 29.54, SD = 4.99) were breastfeeding and 28 (7%, mean age 27.75, SD = 4.73) were not breastfeeding. Differences in age between women currently breastfeeding and not breastfeeding were not statistically significant, $t(385) = 1.83$, $p = .068$. We ran GLMs and Bayesian GLMs where breastfeeding (yes, no) was a fixed factor.

In Analysis 5, we tested whether the age of the mother's infants influenced their judgments of men's beardedness. Of the total sample of 889 (35.15 years, SD = 10.72) mothers, 839 (35.21 years, SD = 10.58) provided the ages of their youngest child (mean = 69.98 months, SD = 113.7). Among the 387 women who completed surveys during their first year of motherhood, 349 (mean age 29.41, SD = 4.99) provided the ages of their last-born child (mean age = 6.14 months, SD = 3.45). We ran GLMs and Bayesian GLMs where the age of infants (in months) was a covariate in separate analyses for mothers with infants under 1 year of age and the full sample of mothers.

In Study 2, the mean proportion of selections for bearded over clean-shaven faces was the dependent measure in a 2 pregnancy (pregnant and nursing) repeated-measures ANOVA and Bayesian repeated-measures ANOVA. Ages in this sample did not differ significantly from the total sample (One sample t-test against the sample mean age of 30.43; $t(52) = 1.66$, $p = .104$). All women stated how far along in weeks they were into their pregnancy (Mean = 20.53, SD = 9.76, range 3-40) and how many weeks postpartum they were (Mean = 14.43, SD = 2.95, range 6-21). We repeated these analyses including parity as a between-subjects factor comparing women with one child (n = 12, mean age 29.50, SD = 5.21) and more than one child (n = 41, mean age 31.24, SD = 4.16). Although the sample sizes between groups differed, the assumption of equality of variances between samples was not violated (Levenes's test during pregnancy: $F(1,51) = 3,13$, $p = .083$; postpartum: $F(1,51) = 0.31$, $p = .582$) and participants' ages did not differ significantly between groups, $F(1,51) = 1.21$, $p = .234$.

3. Results

3.1. Study 1: Women's reproductive status and preferences for men's facial hair

Analysis 1. **Reproductive status and judgments of facial hair.** The GLM revealed a small but significant effect of reproductive status on preferences for beardedness when judging attractiveness, while Bayesian analyses did not show evidence for the hypothesised model (Table 1). Attractiveness judgments of beards were higher among contraceptive users, followed by non-pregnant women, mothers, and pregnant women (Figure 2A). However, post-hoc Bonferroni tests revealed that the only differences between women using contraceptives and pregnant women were approaching significance, $p < .094$, $d = 1.95$. When judging fathering abilities, there was also a significant effect of reproductive status on preferences for beards and strong support for the hypothesised model in Bayesian GLM ($BF_{10} = 16.899$; Table 1). Bonferroni tests revealed that mothers preferred beards more than women not using hormonal contraceptives, $p < .001$, $d = 0.25$. Judgments did not differ significantly for other comparisons (Figure 2B).

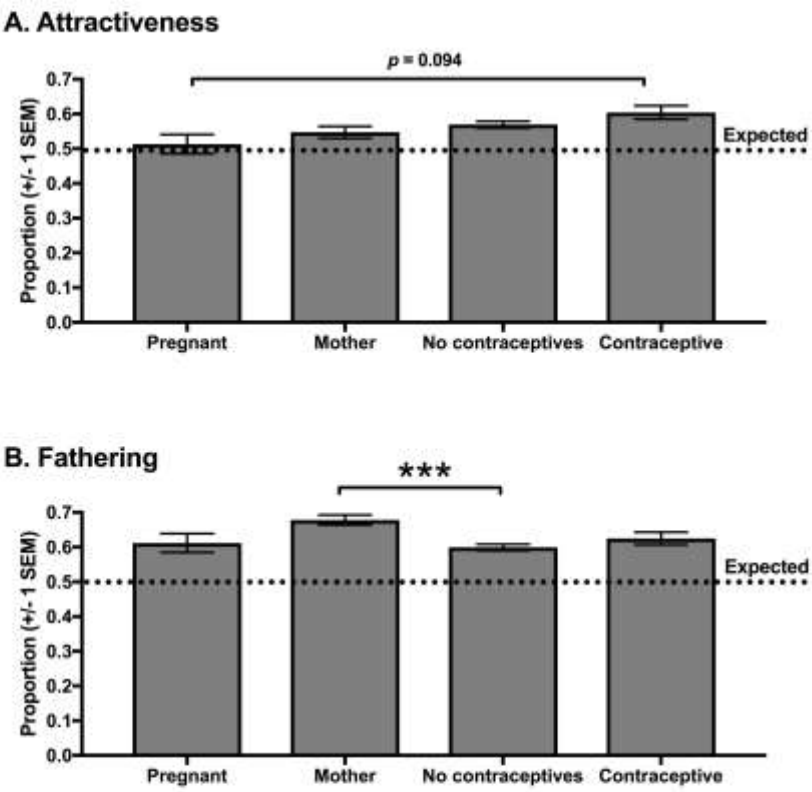

Figure 2. Mean proportion of bearded images (± 1 SEM) selected as most physically attractive (**A.**) and higher for fathering abilities (**B.**) among women who were pregnant, in early motherhood, not using contraceptives, and using contraceptives. ******* = $p < .001$.

There was a significant effect of reproductive status on selections of bearded faces when judging masculinity and weak support for the hypothesised model in Bayesian GLM

(Table 1). Bonferroni tests showed that pregnant women selected beards more often than women not using contraceptives, $p = .080$, $d = 0.21$ (Figure 3B). There was a significant main effect and weak support from the Bayesian GLM of reproductive status on selections for beards when judging age (Table 1). Beards were judged to be older among mothers compared to women not using contraceptives, $p = .010$, $d = 0.182$ (Figure 3C). There was no main effect of reproductive status on dominance judgments and weak support for the null model in Bayesian analyses (Table 1).

Participant's age was positively associated with preferences for beards when judging age ($r = .120$, $p < .001$) and fathering ($r = .060$, $p = .006$), while associations were negative for judgments of dominance ($r = -.094$, $p < .001$) and attractiveness ($r = -.085$, $p < .001$). Masculinity judgements were negatively associated with age but were not statistically significant ($r = -.026$, $p = .237$). The age x reproductive status interactions in the ANCOVAs were not statistically significant for judgments of age, masculinity, fathering and dominance (all $F(3, 2095) \leq 1.91$, all $p \geq .126$, Table 1). However, the interaction was significant for attractiveness judgments, $F(3, 2095) = 3.80$, all $p = .010$. Attractiveness judgments were significantly negatively associated with age among pregnant women (n = 152, $r = -0.259$, $p < 0.001$), women using hormonal contraceptives (n = 278, $r = -0.168$, $p = 0.005$), and women not using contraceptives (n = 1286, $r = -0.074$, $p = 0.008$). This association was also negative among mothers, but was not statistically significant (n = 387, $r = -0.069$, $p = 0.175$).

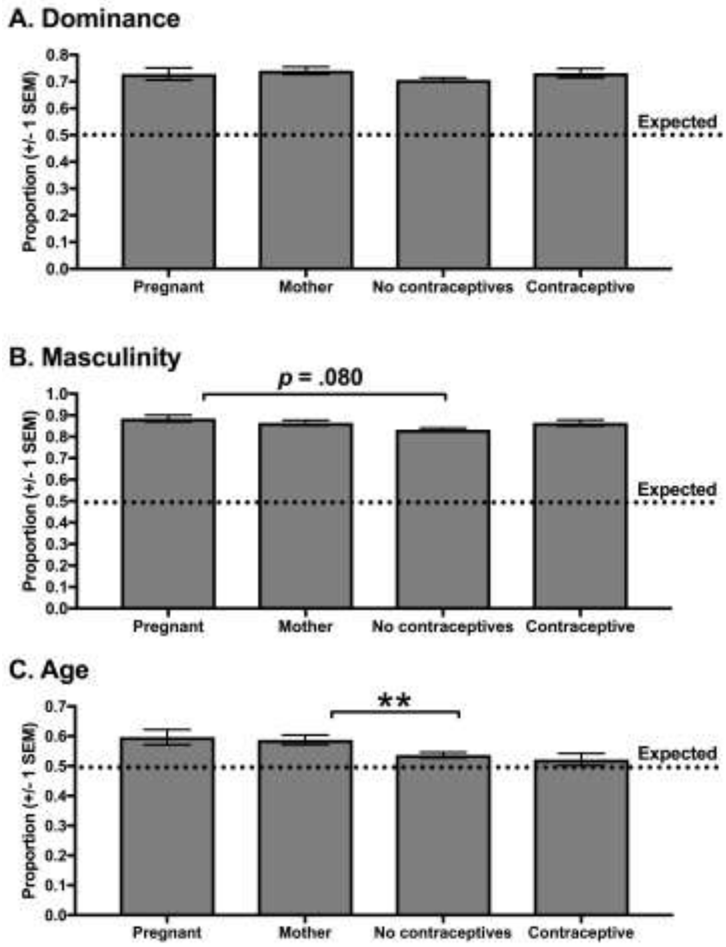

Figure 3. Mean proportion of bearded images (± 1 SEM) selected when judging dominance (**A.**), masculinity (**B.**), and age (**C.**) among women who were pregnant, in early motherhood, not using contraceptives, and using contraceptives. ** = $p < .01$.

This analysis did not account for parity among our sample of women not using contraceptives and it is possible changes in mate preferences among mothers extends beyond that the first year of motherhood. Thus, we repeated our GLM and Bayesian GLM, this time including non-pregnant mothers and non-pregnant non-mothers as an additional category of current reproductive status. Of the 1286 women not using hormonal contraceptives, 890 did not have any children and 396 had children. The mean proportion of selections for bearded over clean-shaven faces for each trait judgment were dependent measures and reproductive status (non-mothers not using contraceptives, mothers not using contraceptives, mothers with a child under 1 year of age (hereafter referred to as 'mothers'), pregnant women and contraceptive using women was a fixed factor, and rater's age was a covariate.

There was a significant effect of reproductive status on judgments of fathering, $F(4,2097) = 6.08$, $p < .001$, $\eta^2 = .011$, which received strong support in Bayesian analyses ($BF_{10} = 247.730$). Mothers gave higher judgments for beards than non-mothers who were not using contraceptives ($p < 0.001$; $d = 0.30$). There was also a main effect of reproductive status on judgments of age, $F(4,2097) = 4.63$, $p < .001$, eta = .009, which received strong support in Bayesian analyses ($BF_{10} = 1719.105$). Mothers gave higher ratings than non-mothers who were not using contraceptives ($p = .003$; $d = 0.22$). There was a significant effect of reproductive status on judgments of masculinity, $F(4,2097) = 4.87$, $p < .001$, $\eta^2 = .009$, which received weak support in Bayesian analyses ($BF_{10} = 0.971$). Pregnant women gave higher ratings for beards than non-mothers who were not using contraceptives ($p = .021$; $d = 0.26$), mothers gave higher ratings than non-mothers who were not using contraceptives ($p = .032$; $d = 0.17$) and mothers who were not using contraceptives gave higher ratings than non-mothers who were not using contraceptives ($p = .033$; $d = 0.19$). The effect of reproductive status was significant for judgments of attractiveness, $F(4,2093) = 3.00$, $p = .018$, $\eta^2 = .006$, although the main effect received weak support in Bayesian analyses ($BF_{10} = 0.142$). While preferences were highest among women using hormonal contraceptives, no Bonferroni tests were significant. The effect of reproductive status was not significant for judgments of attractiveness dominance, $F(4,2097) = 1.73$, $p = .141$, $\eta^2 = .003$. For results relating to participant's age and Bayesian models see the Electronic Supplementary Materials (ESM).

Analysis 2. **Women's parity and judgments of facial hair**. There was a significant effect of parity on judgments of beardedness when judging age, masculinity, fathering, while attractiveness judgments were approaching significance at the 5% levels and dominance judgments were not statistically significant (Table 2). Parous women had higher preferences for facial hair than nulliparous women when judging age, $p = .012$, $d = 0.21$, $BF_{10} = 396.739$, masculinity, $p < .001$, $d = 0.15$, $BF_{10} = 5.272$, and fathering, $p = .002$, $d = 0.15$, $BF_{10} = 6.226$. Nulliparous women judged facial hair as more attractive than mothers, $p = .059$, $d = 0.14$, $BF_{10} = 3.800$. Judgments of dominance did not differ significantly with parity, $p = .169$, $d = 0.004$, $BF_{10} = 0.055$ (Figure 4).

There were significant associations between participant's age and judgments of age, masculinity, dominance and attractiveness, but not parenting skills, for men's facial hair (Table 2). Thus, age was positively associated with preferences for beards when judging age ($r = .117$, $p < .001$), while associations were negative for judgments of dominance ($r = -.082$, $p < .001$) and attractiveness ($r = -.073$, $p = .002$). Masculinity judgements were negatively associated with age but were not statistically significant ($r = -.023$, $p = .334$). The age x reproductive status interaction was not statistically significant for judgments of age, masculinity, attractiveness and dominance, but was significant for fathering skills (Table 2). Judgments of parenting skills for bearded men were significantly positively associated with age among nulliparous women (n = 1088, $r = 0.088$, $p = 0.004$), but not among mothers (n = 668, $r = -0.037$, $p = 0.341$).

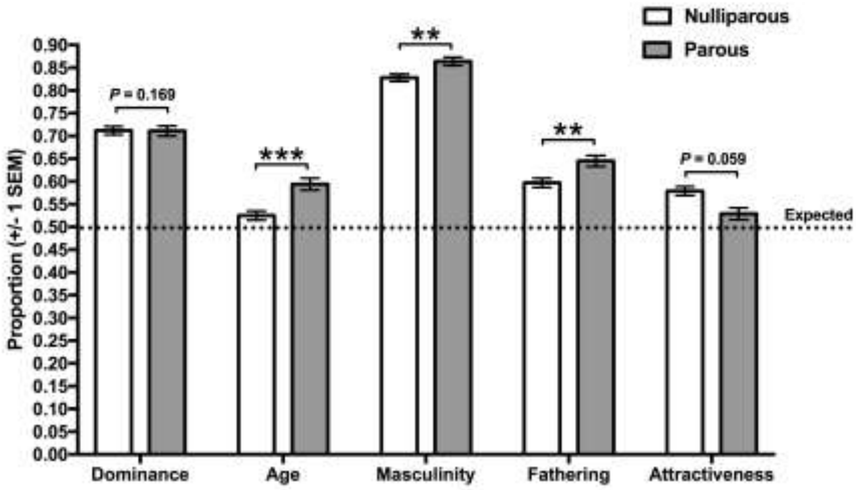

Figure 4. Mean proportion of bearded images (± 1 SEM) selected when making judgments of dominance, age, masculinity, fathering, and attractiveness among nulliparous (open bars) and parous (dark grey bars) women who were not using contraceptives. ** = p <.01; *** = p <.001.

Analysis 3. Women's judgments of facial hair during pregnancy. Hormones change over pregnancy potentially influencing preferences for masculine facial traits. Of the 152 pregnant women, 149 provided information on the stage of the pregnancy from which we calculated how far along in weeks they were into their pregnancy (Mean = 23, SD = 9.88, range 3-40). When entered as a co-variate, there were no significant associations between stage of pregnancy (in weeks) and any judgments of men's beards, all $F(1,147) \leq 2.63$, all $p \geq .107$(ESM).

Analysis 4. Breastfeeding and women's judgments of facial hair. Effects of motherhood on hormones and mate preferences extend beyond pregnancy into early motherhood and are influenced by breastfeeding. Of the 387 women (mean age = 29.41, SD = 4.99) who completed surveys when in early motherhood, 359 (93%, mean age = 29.54, SD = 4.99) were breastfeeding and 28 (7%, mean age 27.75, SD = 4.75) were not breastfeeding. Differences in age between women currently breastfeeding and not breast feeding were not statistically significant, $t(385) = 1.83$, $p = .068$. The GLMS revealed breastfeeding was not associated with any judgments, all $F(1,385) \leq 1.56$, all $p \geq .213$ (ESM).

Analysis 5. The age of women's offspring and their judgments of facial hair. As women's testosterone is lower in the first years of motherhood, we compared mother's judgments for beards in GLMs and Bayesian ANCOVAs where the age of their youngest child (in months) was a covariate. Mothers' age and the age of their youngest child were significantly positively correlated ($r = .864$, $p < .001$), therefore mothers' age was also included as a covariate. A total of 839 women (mean age 35.21 years, SD = 10.58) provided the ages of their last-born child (mean = 69.98 months, SD = 113.7). When judging attractiveness, there was a significant effect of infant's age, $F(1, 836) = 11.61$, $p < .001$, and mother's age, $F(1, 836) = 18.12$, $p < .001$, but there was no infant age x mother's age interaction, $F(1, 835) = 0.09$, $p = .768$. To test whether women's preferences for beards were associated with age of their youngest infants when controlling for their age, we ran a partial correlation comparing attractiveness judgments with age of infants while controlling for mother's age. This correlation was positive and significant, N = 836, $r = .117$, $p < .001$, which reflects that when controlling for mother's age attractiveness judgments increase as the age of mother's youngest infants increase. There were no significant associations between age of youngest infant and women's judgments of age, masculinity, dominance and parenting skills, all $F(1, 836) \leq 1.16$, all $p \geq .281$ (ESM).

We also examined whether the age of the infants (n = 349, mean age 6.14 months, SD = 3.45) among women in the first year of motherhood influenced judgments of facial hair. Age of mothers (N = 349, mean age 29.41, years SD = 4.99) was not correlated with the age of their youngest infant ($r = .016$, $p = .767$) None of the correlations between age of infants and women's judgments of beards were statistically significant, all *r*s ≤ .07, all $p \geq .194$. When entered as a co-variate, there were no significant associations with any trait judgments, all $F(1,347) \leq 1.69$, all $p \geq .194$ (ESM).

3.2. Study 2: Women's preferences for men's beards during pregnancy and post-partum

The GLM showed no change in selections for bearded faces from pregnancy to the early post-partum period on judgments of any traits (ESM). We repeated these analyses including parity as a between-subjects factor comparing women having their first child (n = 12, mean age 29.50, SD = 5.21) and women who already had children (n = 41, mean age 31.24, SD = 4.2). There was a significant pregnancy × parity interaction when judging for fathering, $F(1,51) = 6.25$, $p = .016$, $\eta^2 = .108$, which received no support from Bayesian analyses $BF_{10} = 0.316$ (ESM). This reflects that during pregnancy, women carrying their first child judged beardedness higher for parenting skills than pregnant women who had children already (i.e. parous). However, post-partum women nursing their first child judged beards lower for parenting skills than women with multiple children (Figure 5). None of the other main effects or interactions were statistically significant, all $F(1,51) \leq 2.61$, all $p \geq .112$ (ESM).

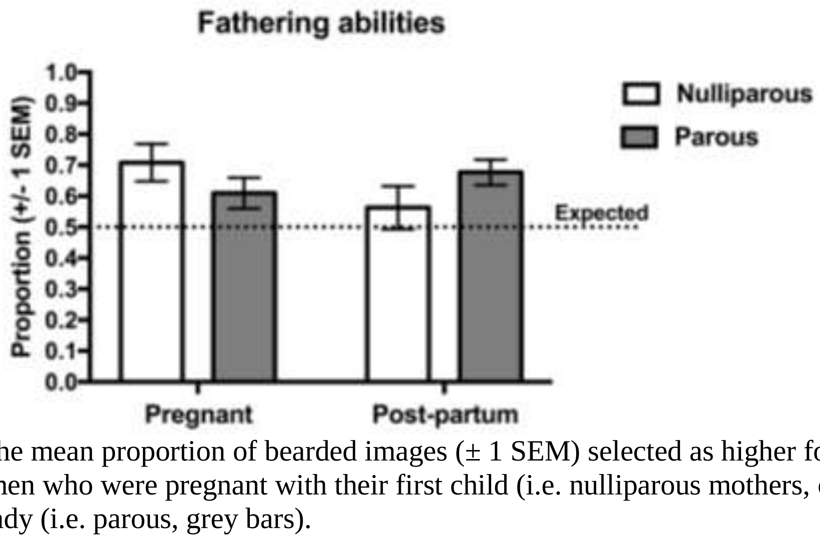

Figure 5. Data are the mean proportion of bearded images (± 1 SEM) selected as higher for fathering abilities among women who were pregnant with their first child (i.e. nulliparous mothers, open bars) or had children already (i.e. parous, grey bars).

DISCUSSION

Mating strategies theory asserts that women bypass the social costs of reduced paternal investment in favour of mates who provide indirect genetic benefits that improve offspring survivability (Gangestad & Simpson, 2000). Comparatively less attention has been given to how preferences for cues of direct benefits (e.g. resources) vary as a function of mating strategies (Scott et al., 2013). The current research tested whether women's preferences for men's beards follow those of past research reporting women's preferences for masculine traits are relaxed following childbirth leading into early motherhood compared to women not using contraceptives and pregnant women (Escasa-dorne et al., 2017; Limoncin et al., 2015). In Study 1, we found mothers with children under one year of age had higher preferences for beards when judging fathering abilities than women who were pregnant, not using contraceptives, and using hormonal contraceptives. These preferences were significant for comparison between mothers and women not using contraceptives and the model received strong support from Bayesian analyses (van Doorn et al., 2019). Pregnant women and mothers also judged bearded faces as more masculine and older, but less attractive than women who were not using contraceptives, which is similar to past research reporting women's preferences for facial masculinity are stronger among young reproductively capable non-pregnant women than pregnant women (Limoncin et al., 2015). We also found that parous women gave significantly higher selections for beards when judging masculinity, age, and fathering abilities, but lower sexual attractiveness judgments compared to nulliparous women, which differs from research on craniofacial masculinity (Escasa-dorne et al., 2017) and highlights a potential role of beardedness in communicating direct benefits.

In addition to pronounced hormonal changes between pregnant and cycling women, endocrine changes occurring during pregnancy may underpin variation in women's preferences for masculine traits (Cobey et al., 2015). Thus, estradiol, progesterone and testosterone may be positively associated with women's facial masculinity preferences over the menstrual cycle (Roney et al., 2011; Welling et al., 2008; Marcinkowska et al., 2018b). Hormonal changes due to pregnancy are far more pronounced than those during menstrual cycles (Motta-Mena & Puts, 2017) and may be associated with variation in preferences for masculine traits (Cobey et al., 2015). However, we found no significant relationship between how far into their pregnancy women were and their attractiveness judgments of men's beards, suggesting that judgments were not specific to hormonal variation occurring during pregnancy. Progesterone, estradiol, and testosterone rise from the 1st to the 3rd trimester and decline dramatically postpartum (Schock et al., 2016; Buckwalter et al., 1999). Women's preferences for facial masculinity were more pronounced during the 3rd trimester of pregnancy than the first three months postpartum (Cobey et al., 2015). In Study 2, we measured judgments of men's beards in a subset of the participants from Study 1, first during the 3rd trimester of pregnancy and again three months post-partum. We found no significant differences in women's judgments of beards for any perceptual traits post-partum compared to pregnancy. However, when judging fathering abilities, first-time mothers reported higher preferences for beards than parous women during pregnancy, whereas multiparous women had higher preferences for beards than first-time mothers postpartum. While these analyses were exploratory, support from Bayesian analyses was weak, and further replication is required, our findings provide preliminary evidence that variation in women's judgments of men's beards may vary with the transition to motherhood and parity rather than variation in reproductive hormones during pregnancy.

The results of our second study highlight that parity may impact on women's mate preferences. Compared to nulliparous women, parous women in our first study selected bearded faces relative to clean-shaven faces more often when judging masculinity, age and fathering abilities, but less often when judging sexual attractiveness. Beards also received higher selections for fathering abilities among mothers not using contraceptives than women not using contraceptives without children and among mothers raising young infants under 1 year of age compared to women who were not using contraceptives. Pregnancy and early motherhood are periods in which women are vulnerable and social support is beneficial to maternal and infant wellbeing (Hrdy, 2016). Human mating systems are cooperative and characterized by allomaternal investment from grandmothers, sisters, and aunts via infant care and provisioning (Hrdy, 2016). Fathers also contribute to the survival of their offspring through providing tangible resources and protection (Gettler, 2016; Muller, 2017). In many species, male secondary sexual characters are employed primarily in intra-sexual competition (Rico-Guevara & Hurme, 2019) and may be preferred by females when resources and protection could be gained (Wong and Candolini, 2005). Recent evidence suggests that men's secondary sexual traits play a more important role in male-male competition than enhancing attractiveness (Kordsmeyer et al., 2018). In the current study, women judged beards as looking significantly more dominant than clean-shaven faces irrespective of changes in reproductive status, which is consistent with past studies (Dixson et al., 2018c). However, our findings that mothers judge bearded men as having higher parenting skills differ from research on women's preferences for men's facial masculinity, which report preferences for facial masculinity continue to decrease post-partum (Cobey et al., 2015; Marcinkowska et al., 2018c) and during early motherhood (Escasa-dorne et al., 2017). Unlike facial masculinity, beardedness may not be related to fighting ability (Dixson et al., 2018c) and instead enhances perceptions of social aspects of dominance and prestige including sincerity, courageousness, self-confidence and competence (Kenny & Fletcher, 1973; Pellegrini, 1973; Guido et al., 2011; Hellström & Tekle, 1994). Interestingly, we found no associations between women's preferences for men's beards when judging fathering abilities and the age of their infants. Instead, there was a positive association between the age of the last-born child and women's attractiveness judgments of men's beards. Thus, women's preferences for beards when judging long-term partner preferences and parenting skills, particularly when young rearing infants, may reflect selection for an ornamental badge of status that communicates direct benefits like resources and protection.

There are some important limitations to our studies that are worth addressing in future research. For example, while the sample size in our second study was sufficiently powered to detect a medium effect size, our analyses were restricted to women interviewed during the third trimester and the early months post-partum. Future research should ideally use data collected prior to pregnancy, over the entire course of pregnancy and postpartum using within-subject designs in conjunction with hormone measures. It is also possible that our sampling approach, wherein women were interviewed in late pregnancy and again in the first three months post-partum, introduced sampling biases due to not counterbalancing data collection. We also found no influence of breastfeeding on women's judgments of beardedness. However, 93% of our sample of Australian mothers were breastfeeding, which is likely a reflection of the mothers being from middle-class backgrounds as breastfeeding rates decline between 3-6 months postpartum due in part to returning to the work force (Australian Institute of Health and Welfare, 2010). Unfortunately, we did not collect information regarding our participants socioeconomic status or whether breastfeeding women had resumed menstrual cycles, which will alter their hormonal status (Ellison, 2003) and potentially influence mate preferences. Further, effects of breastfeeding on gonadotropin release are most pronounced when breastfeeding is chronic and given we do not have detailed information on the frequency of breastfeeding, we speculate that the hormonal profiles of our sample may have been fairly heterogenous, which may also explain our null result. Breastfeeding impacts on mate preferences in some small-scale societies such as the Hadza hunter-gatherers of Tanzania and Manilla in the Philippines, where lactation was associated with lower preferences for masculine voices (Apicella and Feinberg 2009; Shirazi et al., 2018). Thus, future research extending our study to include cross-cultural samples from small-scale societies would be valuable. Finally, future research might use stimuli that manipulate facial masculinity and beardedness in concert to test possible trade-offs in trait preferences and potentially expose multiple preference functions during the transition to motherhood (Dixson et al., 2016). For the present, our results suggest that mothers may be sensitive to beards as a masculine secondary sexual characteristic that communicates parenting skills, rather than sexual attractiveness, providing preliminary evidence that women's mate preferences for beards reflect sexual selection for direct benefits.

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