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Published in:
Psychological Science

DOI:
10.1177/0956797619834876

Published: 01/05/2019

Document Version:
Peer reviewed version

Licence:
Other

Link to publication in Bond University research repository.

Recommended citation(APA):
Sexual Selection, Agonistic Signaling, and the Effect of Beards on Men’s Anger Displays

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Word count: 1999 (excluding methods and results)

Running head: Beards influence recognition of anger displays

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Acknowledgments: This study was supported by a University of Queensland Postdoctoral Research Fellowship awarded to B.J.W.D.
Abstract

The beard is arguably one of the most obvious signals of masculinity in humans. Darwin suggested almost 150 years ago that beards evolved to communicate formidability to other males, but no studies have investigated whether beards enhance recognition of threatening expressions like anger. Here, we show that the presence of a beard increased the speed and accuracy of recognizing anger but not happiness (Experiment 1, N=219). This effect was not due to shared evaluative or stereotypic associations between beardedness and negativity, as beards did not facilitate recognition of another negative expression, sadness (Experiment 2, N=90), and beards increased rated prosociality of happy faces but also masculinity and aggressiveness of angry faces (Experiment 3, N=445). A computer-based emotion classifier reproduced the influence of beards on emotion recognition (Experiment 4). Results suggest that beards may alter perceived facial structure facilitating rapid judgments of anger in ways that conform to evolutionary theory.

Key Words: Facial hair, Emotion recognition, Face processing, Intra-sexual selection.
Sexual Selection, Agonistic Signaling, and the Effect of Beards on Men’s Anger Displays

Agonistic interactions between males during competition over resources, status and mating opportunities occur across mammals and have shaped the evolution of weaponry and threat displays (Darwin, 1871; Emlen, 2008; Kokko, Jennions, & Brooks, 2006). In humans, these displays manifest in a variety of bodily and facial dimorphisms of which beardedness is one of the most visually salient (Dixson, Lee, Sherlock, & Talamas, 2017; Dixson & Vasey, 2012). Beards provide an accurate indication of male sexual maturity and bearded faces are rated as more masculine, dominant, and aggressive than clean-shaven faces (Dixson & Brooks, 2013; Muscarella & Cunningham, 1996; Neave & Shields, 2008). These effects stem from the development of beards around the jaw and mouth, which emphasize jaw size and masculine facial structure (Dixson et al., 2017; Dixson, Sulikowski, Gouda-Vossos, Rantala, & Brooks, 2016; Sherlock, Tegg, Sulikowski, & Dixson, 2017). Beardedness has a greater influence on ratings of masculinity and dominance than craniofacial shape or jaw size (Dixson et al., 2017; Sherlock et al., 2017).

The enhancing effects of facial hair on judgments of men’s facial masculinity, dominance, and aggressiveness through framing components of masculine facial shape have been measured using stimuli depicting neutral facial expressions. However, faces carry multiple sources of social information including emotional facial expressions that can convey internal states and intentions. Facial expressions like anger can be enacted in agonistic interactions to signal interpersonal threat (Blair, 2003; Schmidt & Cohn, 2001; Sell, Cosmides, & Tooby, 2014; Tay, 2015). Beardedness has been hypothesized to facilitate recognition of threatening displays like anger through enhancing masculine facial features related to dominance (particularly jaw size; Blanchard, 2009; Goodhart, 1960; Guthrie, 1970), but to date, there are no behavioral studies detailing whether beards influence recognition of angry expressions.

While the influence of facial hair on recognition of anger expressions has not been directly tested, previous findings suggest it is plausible that beards facilitate anger recognition. Cues of
masculinity facilitate anger recognition. Previous research demonstrates that people are faster to recognize anger on male than female faces (Becker, Kenrick, Neuberg, Blackwell, & Smith, 2007). This influence of masculinity on anger recognition has been partly attributed to overlap between structural cues of anger and masculinity. It has been suggested that angry facial expressions emphasize masculine facial structures, such as the prominence of the jaw (Becker et al., 2007; Hess, Adams, Grammer, & Kleck, 2009; Sacco & Hugenberg, 2009). Facial hair grows around the areas involved in expressing a range of emotions including anger and also enhances masculine craniofacial structure and the prominence of the jaw (Dixson et al., 2017; Sherlock et al., 2017), suggesting that the presence of a beard may facilitate recognition of angry expressions.

To test whether beards amplify anger displays, we presented participants with photographs of the same men bearded and clean-shaven posing standardized expressions of emotion (Figure 1). Initially, participants categorized expressions of anger and happiness to test how facial hair impacts the speed and accuracy of recognizing expressions that can communicate threat, but also affiliation. This allowed us to determine whether the influence of beardedness on emotion recognition was specific to a threatening expression like anger or to emotional expressions more generally. If beards amplify aggressive displays, it was predicted that participants would be faster to recognize anger but not happiness on bearded than clean-shaven faces.

Figure 1. Examples of the stimuli used in studies 1-4. The faces are the same man posing happy, sad and angry expressions when bearded (upper row) and clean-shaven (lower row).
Experiment 1

Methods

Protocols were approved by the human ethics board at Curtin University and The University of Queensland. All participants gave informed consent and were free to withdraw from the study without prejudice at any point. For each study, we report all measures, manipulations, and exclusions. No further data were collected for any of the experiments after analyses had been conducted.

Participants. A total of 227 participants (97 Males, 129 Females, 1 did not respond, $M_{age}=30.88$, $SD_{age}=10.22$) provided some data for Experiment 1. Participants were 78 undergraduate students at Curtin University (8 males, 69 females, 1 did not respond, $M_{age}=24.85$, $SD_{age}=9.68$) who participated in the study in the laboratory in return for partial course credit and 149 online based participants who were Amazon Mechanical Turk (mTurk) workers (89 males, 60 females, $M_{age}=34.10$, $SD_{age}=8.99$). In all studies reported, mTurk participants received monetary compensation in return for taking part.\footnote{As no previous studies have looked at the influence of beardedness on emotion recognition, we looked at effect sizes observed in previous studies investigating the moderating influence of sex and race on emotion recognition in comparable tasks when estimating the required sample size (e.g., Becker et al., 2007; Hugenberg, 2005 & Hugenberg & Sczesny, 2006; $d_i$ between 0.36 and 1.22). Power analyses conducted using G*Power 3.1 (Faul, Erdfelder, Lang, & Buchner, 2007) based on these effect sizes suggest that between 8 and 63 participants would be needed to have an 80\% chance of detecting an effect of these sizes. We assumed that the influence of beards on emotion recognition may be smaller than the influence of social category cues on emotion recognition and thus aimed to sample more than this number for the laboratory based experiment (approximately 76-80 participants). For the online experiment, we aimed to test approximately double that sample size to have sufficient male and female participants to investigate participant sex effects.}

Stimuli. Photographs of 10 young adult Caucasian males ($M_{age}=23.50$, $SD_{age}=3.57$, range 20–30 years) were taken from a stimulus set developed and used in previous research (Dixson & Vasey, 2012). Men were photographed with happy and angry expressions when clean-shaven and again with a full beard (at least 8 weeks of untrimmed facial hair growth). Emotional expressions were generated using instructions based on the Facial Action Coding System (Ekman, Friesen, & Hager, 2002). This resulted in 40 photographs (10 bearded angry, 10 bearded happy, 10 clean-shaven angry and 10 clean-shaven happy images). The use of this stimulus set is a particular strength of the study as the same
individuals are presented posing the same expressions with and without facial hair. This eliminates the influence of possible systematic differences in facial structure or the way emotions are expressed between those who choose to be bearded or clean-shaven and represents an advancement over previous work using different individuals to represent the bearded and clean-shaven conditions. These images were edited to remove clothing and backgrounds and faces were placed on a uniform gray background 485 × 709 pixels in size (Figure 1).

**Procedures.**

*Laboratory experiment.* Participants were seated in front of a 24in LED monitor with a screen resolution of 1920 × 1080 pixels and a refresh rate of 120Hz in a small group computer laboratory with four testing terminals. The laboratory based task was executed using DMDX (Forster & Forster, 2003). Participants were instructed that faces would appear on the screen one at a time. They were asked to categorize each face as either ‘happy’ or ‘angry’ as quickly and accurately as possible by pressing the right and left shift keys. Response mapping was counterbalanced across participants. On each trial, a fixation cross was presented for 1000ms on a gray background followed by one of the 40 photographs which remained on the screen until a response was made or for 3000ms. A blank screen was presented for 500ms between each trial. Each of the 10 posers was presented expressing happiness and anger, bearded and clean-shaven three times resulting in 120 trials. Participants provided their age, sex, and ethnicity at the end of the testing session.

*Online experiment.* The laboratory based and online experiments proceeded in a similar manner with a few differences in order to adapt the procedures to an online testing environment. Participants completed the task on their personal desktop or laptop computer in a location of their choice using Inquisit 4 Web software to run the experiment. Participants made their responses using the

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2 Due to a coding error, half of the participants completed one additional block of trials and saw each of the 40 photographs one more time (a total of 160 trials). This additional presentation did not influence the pattern of response time means, $F_s<0.61$, $ps>0.440$, $\eta_p^2<0.01$, 90% CIs $[0.00-0.07]$, so results from the first 120 trials for all participants are reported.
‘A’ and ‘L’ keys rather than the shift keys. Throughout the task, written reminders of the response mapping were presented in the bottom left and right of the screen (e.g., ‘Press ‘A’ for angry’, ‘Press ‘L’ for happy’). Participants completed a short (10 trial) practice task prior to the main task. Feedback was provided after an incorrect response only during the practice task and at the end of the practice task participants were given their mean response time and accuracy. As the screen size and resolution varied across participants, the image was set to take up 35% of the height of the screen without altering the aspect ratio of the image. In the online experiment, a black background (rather than a gray background) was used. All participants completed 120 trials. After completing the response time task, participants completed a demographic survey indicating their age, sex, ethnicity, and whether they had a beard. They were also asked to describe their environment and were given the chance to provide any final comments.

Data processing and analysis. Incorrect responses and response times faster than 100ms or more than three standard deviations faster or slower than each participant’s mean response time were removed as invalid responses. Participant sex has been found to moderate the influence of beardedness on person perception in some previous studies (Dixson & Vasey, 2012). In the current study, we considered it plausible that male and female observers may differ in their responses. For example, anger cues may be seen as more threatening to women owing to sex differences in physical strength (Puts, 2010). On the other hand, male-male competition has played an important role in the evolution of men’s secondary sexual traits (Puts, 2010) and therefore men might be more sensitive to displays of anger and beardedness than women. Participant sex did not consistently influence performance in the current investigation. As such, results are reported collapsed across participant sex, but analyses including participant sex as an additional factor are reported in the online supplement for completeness. Response times and error rates were averaged and these condition means were submitted to separate 2 (Facial hair: bearded, clean-shaven) × 2 (Emotional expression: happy, angry) repeated measures
ANOVAs. For all behavioral experiments, follow up comparisons were conducted using two-tailed paired samples t-tests with Cohen’s $d_z$ (standardized mean difference scores) reported as effect sizes.

Additionally, to examine whether a systematic tendency towards making angry or happy responses for a particular face type could account for any response time differences observed, we calculated a measure of response bias ($c$) separately for bearded and clean-shaven faces using a signal detection theory calculator created by Gaetano (2017). Response bias takes into account hits (here conceptualized as the proportion of correct angry responses) as well as false alarms (conceptualized as the proportion of incorrect angry responses to happy faces). $c$ provides an index of whether the participants have a bias towards making more angry responses (negative values), no bias ($c$ values around zero) or a bias towards making more happy responses (positive values). Corrections for hit/false alarm rates of 0 or 1 were made in line with the recommendations of Stanislaw and Todorov (1999). With this correction, 0 is replaced with the value of $0.5/n$ and 1 is replaced with the value $(n-0.5)/n$ where $n$ is the number of signal (angry) or noise (happy) trials. A correction is made as hit/false alarm rates of 0 and 1 correspond to z-scores of $-\infty$ and $\infty$ preventing finite outputs when the response bias is calculated.

Two participants who completed the laboratory based task could not be included in analyses as they made no valid responses in at least one condition. Five participants in the online based task were not included in the analyses as they had error rates approaching chance (> 40% of responses incorrect or invalid). The participant who did not identify as male or female was not included in analyses to maintain a consistent dataset for the main and supplementary analyses, but this exclusion did not change the significance or direction of results. Raw data for all experiments are available on the Open Science Framework (https://osf.io/zuwxt/).
Results

**Response times.** The main effects of facial hair, $F(1,218)=0.40, p=.529$, $\eta_p^2<.01$, 90% CI[.00-.02], and emotional expression, $F(1, 218)=0.71, p=.402$, $\eta_p^2<.01$, 90% CI[.00-.03], were not significant, but facial hair and facial expression interacted to influence response speed, $F(1,218)=41.42, p<.001$, $\eta_p^2=.16$, 90% CI[.09-.23]. Participants were significantly faster to categorize anger on bearded than on clean-shaven faces, $t(218)=5.06, p<.001$, $d_z=0.34$, 95% CI[0.20-0.48], but significantly faster to categorize happiness on clean-shaven than on bearded faces, $t(218)=4.73, p<.001$, $d_z=0.32$, 95% CI[0.18-0.45], (See Figure 2).

**Accuracy.** A similar pattern was observed in error rates. Participants were no more accurate to categorize expressions on bearded or clean-shaven faces, $F(1,218)=1.55, p=.214$, $\eta_p^2=.01$, 90% CI[.00-.04], but they were significantly more accurate to categorize happy than angry expressions, $F(1,218)=3.99, p=.047$, $\eta_p^2=.02$, 90% CI[.00-.06]. This effect was moderated by a significant Facial hair × Emotional Expression interaction, $F(1,218)=30.66, p<.001$, $\eta_p^2=.12$, 90% CI[.06-.19]. Participants were more accurate to categorize anger on bearded than on clean-shaven faces, $t(218)=5.12, p<.001$, $d_z=0.35$, 95% CI[0.21-0.48], but more accurate to categorize happiness on clean-shaven than on bearded faces, $t(218)=3.45, p=.001$, $d_z=0.23$, 95% CI[0.10-0.37].

**Response bias.** There was a significant difference between the response bias on bearded trials ($M=-0.03, SD=0.25$) and clean-shaven trials ($M=0.08, SD=0.24$, $t(218)=4.84, p<.001$, $d_z=0.33$, 95% CI[0.19-0.46]); however, comparing these response biases to zero (no bias), this difference emerged as there was a significant happy response bias for clean-shaven faces, $t(218)=4.90, p<.001$, $d_z=0.33$, 95% CI[0.19-0.47], but the response bias for bearded faces did not differ significantly from zero, $t(218)=1.53, p=.127$, $d_z=0.10$, 95% CI[-0.03-0.24].
Discussion

In Experiment 1 facial hair facilitated anger recognition. This speed advantage could not be attributed to a shift towards angry responding. Recognition of happiness, a positive and non-threatening expression, was slowed by the presence of a beard in this task. This happy advantage may have been partly due to a small happy response bias on clean-shaven face trials. The angry advantage for bearded faces could be due to beards enhancing visual cues of anger, but it could also be due to the activation of implicit negative evaluations of beardedness priming categorization of negative expressions. This mechanism explains the influence of race and age cues on emotion classification in similar tasks.
(Craig, Koch, & Lipp, 2017; Craig & Lipp, 2018; Hugenberg, 2005). To test this possibility, participants categorized expressions on the same bearded and clean-shaven faces, but expressions of anger were replaced with sadness. Like anger, sadness is negatively valenced but is non-threatening and not structurally related to beardedness or masculinity (Hess et al., 2009; Hugenberg & Sczesny, 2006). If congruence between negative evaluations of beardedness and negative facial expressions explains the results of Experiment 1, as has been observed in related research (Craig & Lipp, 2018; Hugenberg, 2005), then participants should be faster to recognize sadness on bearded than clean-shaven faces. If facial hair specifically enhances recognition of threat, beards should not facilitate recognition of sadness.

Experiment 2

Methods

Participants. We requested 90 participants on the mTurk platform. After the study was complete there was data available from 92 people (45 Males, 46 Females, 1 did not respond, $M_{age}=35.51$, $SD_{age}=9.96$).³

Stimuli, procedures and data analysis. The same happy faces used in Experiment 1 were presented in Experiment 2 but the angry faces were replaced with photographs of the same individuals expressing sadness. The photographs were taken under the same conditions and were edited in the same manner described above (see Figure 1). Experiment 2 proceeded as described in the online study of Experiment 1; however, the angry bearded and clean-shaven faces were replaced with sad expressions. Data were processed and analyzed as described above. Response time and accuracy data were submitted to separate 2 (Facial hair: bearded, clean-shaven) × 2 (Emotional expression: happy, angry) repeated measures ANOVAs. Response bias was again calculated and analyzed. Data from one

³ As participant sex did not have a consistent influence on emotion recognition speed and accuracy in Experiment 1 we aimed for a sample of around 80 participants in Experiment 2, collapsed across sex. We oversampled slightly in case of data loss due to recruiting online.
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participant were not included in analyses as 85% of their responses were missing or invalid. One person who did not identify their sex was also excluded to maintain a consistent dataset for the main and supplementary analyses, but this exclusion did not influence the pattern of results.

Results

Response times. As in Experiment 1, the main effects of facial hair, \( F(1,89)=1.57, p=.213, \eta^2_p=.02, 90\% \text{ CI}[.00-.09], \) and emotional expression, \( F(1,89)=2.76, p=.100, \eta^2_p=.03, 90\% \text{ CI}[.00-.11], \) were not significant but there was a significant Facial hair × Emotional expression interaction in response times, \( F(1,89)=6.34, p=.014, \eta^2_p=.07, 90\% \text{ CI}[.01-.16]. \) Contrary to Experiment 1, however, participants were slower to categorize sadness on bearded than clean-shaven faces, \( t(89)=3.16, p=.002, d_z=0.33, 95\% \text{ CI}[0.12-0.54], \) but no faster or slower to categorize happiness on clean-shaven or bearded faces, \( t(89)=0.68, p=.496, d_z=0.07, 95\% \text{ CI}[-0.14-0.28], \) (see Figure 2).

Accuracy. Looking at error rates, overall, accuracy did not differ for happy and sad expressions, \( F(1,89)=0.05, p=.826, \eta^2_p<.01, 90\% \text{ CI}[.00-.02], \) but participants were significantly more accurate to categorize expressions on clean-shaven than bearded faces, \( F(1,89)=4.60, p=.035, \eta^2_p=.05, 90\% \text{ CI}[.00-.14]. \) This effect was moderated by a significant Facial hair × Emotional expression interaction, \( F(1,89)=4.82, p=.031, \eta^2_p=.05, 90\% \text{ CI}[.00-.14], \) (see Figure 2). Participants were less accurate categorizing sadness, \( t(89)=3.04, p=.003, d_z=0.32, 95\% \text{ CI}[0.11-0.52], \) but not happiness, \( t(89)=0.06, p=.951, d_z=0.01, 95\% \text{ CI}[-0.20-0.21], \) on bearded than clean-shaven faces.

Response bias. There was a significant difference between the response bias on bearded trials (\( M=0.05, SD=0.23 \)) and clean-shaven trials (\( M=-0.04, SD=0.20, t(89)=2.54, p=.013, d_z=0.27, 95\% \text{ CI}[0.05-0.48] \)). In contrast to Experiment 1, this difference emerged as the response bias on bearded face trials was directionally towards happy responding; however, when comparing these response biases to zero, neither the response bias for bearded faces, \( t(89)=1.95, p=.054, d_z=0.21, 95\% \text{ CI}[0.00-
0.41], nor clean-shaven faces, \( t(89)=1.68, p=.096, d_z=0.18, 95\% \text{ CI}[-0.03-0.38] \), differed significantly from zero.

**Discussion**

In contrast to Experiment 1, participants were slower to recognize sad expressions on bearded than clean-shaven faces indicating that the recognition advantage for bearded faces does not generalize to all negative expressions. A response bias is unlikely to explain response time differences as there was no significant response bias in either direction for bearded or clean-shaven faces. The results of Experiment 2 suggest that the recognition advantage for angry expressions on bearded faces in Experiment 1 was not driven by congruence between negative evaluations of beardedness and anger.

Another possible explanation for the recognition advantage for anger on bearded faces observed in Experiment 1 is that implicit stereotypes (information based associations) about bearded men were activated and influenced emotion recognition. For example, bearded men may be seen as more aggressive and less sociable facilitating recognition of anger but not happiness or sadness (Guthrie, 1970). This is possible as racial and gender stereotypes influence emotion recognition under some circumstances (Bijlstra, Holland, & Wigboldus, 2010).

To investigate explicit associations held about bearded vs. clean-shaven men, we measured how beards influence explicit ratings of aggressiveness, prosociality, and masculinity. If congruence between stereotypes about bearded men and emotional expressions can account for the results of Experiment 1, it was predicted that emotionally expressive bearded men would be perceived as more aggressive and masculine but less prosocial than their clean-shaven counterparts.
Experiment 3

Methods

Participants. We requested 450 participants on mTurk. After the study was complete, there was some data available from 455 mTurk workers (231 Males, 214 Females, 3 Other, 7 did not respond, $M_{age}=35.67$, $SD_{age}=10.91$).

Measures and procedure. Participants were randomly allocated to complete one of three rating tasks on the Qualtrics platform. In each task, participants saw each of the 40 images (happy and angry bearded and clean-shaven faces) used in Experiment 1 once. They rated either the perceived aggressiveness, masculinity, or prosociality of each face from 0 – not at all to 100 – Extremely by clicking and dragging a slider. As participants may not have been as familiar with the concept of prosociality we defined a prosocial person as someone who appears “positive, helpful, and friendly, or someone who would act in a way that benefits others”. After rating each of the 40 faces, participants completed a brief demographic questionnaire, indicating their age, sex, ethnicity, and sexual orientation on the Kinsey scale from 0 – Exclusively heterosexual to 6 – Exclusively homosexual (or 7 – Asexual). They also provided a description of their environment while completing the survey and could leave additional comments.

Data processing and analysis. Participant ratings were averaged to create condition means which were submitted to separate 2 (Facial hair: bearded, clean-shaven) × 2 (Emotional expression: happy, angry) repeated measures ANOVAs for the aggressiveness, masculinity, and prosociality rating tasks. Data from 10 participants could not be included in analysis as they did not identify their sex as male or female, and/or they provided ratings for fewer than 20% of the faces. These exclusions resulted in 151 participants (81 Males) in the Aggressiveness rating task, 146 (78 Males) in the Prosociality rating task, and 148 (72 Males) in the Masculinity rating task.

4 For Experiment 3 we again aimed to sample sufficient participants to detect participant sex effects in explicit ratings so aimed for around 150 participants for each ratings task.
Results

**Aggressiveness ratings.** As can be seen in Figure 3, overall, bearded faces were rated as more aggressive than clean-shaven faces, $F(1,150)=69.96$, $p<.001$, $\eta^2=.32$, 90% CI[.22-.41], and angry faces were rated as more aggressive than happy faces, $F(1,150)=519.53$, $p<.001$, $\eta^2=.78$, 90% CI[.73-.81], but facial hair and emotional expression interacted to influence aggressiveness ratings, $F(1,150)=52.65$, $p<.001$, $\eta^2=.26$, 90% CI[.16-.35]. Angry faces were rated as more aggressive when bearded than clean-shaven, $t(150)=9.43$, $p<.001$, $dz=0.77$, 95% CI[0.58-0.95], while happy faces were rated similarly irrespective of beardedness, $t(150)=1.53$, $p=.129$, $dz=0.12$, 95% CI[-0.04-0.28].

**Prosociality ratings.** Overall, bearded faces were rated as more prosocial than clean-shaven faces, $F(1,145)=7.31$, $p=.008$, $\eta^2=.05$, 90% CI[.01-.11], and happy faces were rated as more prosocial than angry faces, $F(1,145)=1443.29$, $p<.001$, $\eta^2=.91$, 90% CI[.89-.92], but facial hair and emotional expression interacted to influence prosociality ratings, $F(1,145)=38.89$, $p<.001$, $\eta^2=.21$, 90% CI[.12-.30]. Angry faces were rated as more prosocial when clean-shaven than bearded, $t(145)=2.44$, $p=.016$, $dz=0.20$, 95% CI[0.04-0.37], but happy faces were rated as more prosocial when bearded than when clean-shaven, $t(145)=5.04$, $p<.001$, $dz=0.42$, 95% CI[0.25-0.58].

**Masculinity ratings.** Overall, bearded faces were rated as more masculine than clean-shaven faces, $F(1,147)=281.67$, $p<.001$, $\eta^2=.66$, 90% CI[.58-.71], and angry faces were rated as more masculine than happy faces, $F(1,147)=71.65$, $p<.001$, $\eta^2=.33$, 90% CI[.23-.42], but facial hair and emotional expression interacted to influence masculinity ratings, $F(1,147)=4.17$, $p=.043$, $\eta^2=.03$, 90% CI[.00-.08]. Bearded faces were rated as more masculine than clean-shaven faces when expressing happiness and anger, $t>14.88$, $ps<.001$, $dz>1.22$, 95% CI[1.00-1.62], but this difference was smaller for angry expressions. Interestingly, bearded happy faces were judged as more masculine than clean-shaven angry faces, $t(147)=6.74$, $p<.001$, $dz=0.53$, 95% CI[0.38-0.72], suggesting that beardedness influences masculinity judgments more than emotional expressions do (see Figure 3).
Discussion

Beardedness increased ratings of aggressiveness for angry faces, but also increased ratings of prosociality for happy faces. These ratings suggest that bearded men are not uniformly stereotyped as negative (aggressive and anti-social). If stereotypes influenced emotion recognition in Experiment 1, based on the stereotypes uncovered here, the presence of a beard should facilitate the recognition of both happy and angry expressions as beards increased perceived aggression and perceived prosociality. Experiment 4 aimed to further investigate structural overlap between beardedness and anger cues as an explanation for the angry advantage for bearded faces. To examine this account, stimuli were entered into a computer-based emotion classifier. Computer classifiers are an extra step removed from the stereotypes and attitudes held by human observers. It was predicted that the image classifier would produce higher confidence ratings for anger expressions on bearded than clean-shaven faces, but higher confidence ratings for sadness on clean-shaven than bearded faces.
Experiment 4

Methods

Procedure. All photographs of the men bearded and clean-shaven expressing happy, angry, and sad expressions were entered into the Microsoft Emotion API image classifier (ME-API) (https://azure.microsoft.com/en-au/services/cognitive-services/emotion/) in the same format that they were presented to participants. The expression recognition algorithms in the ME-API were developed via a deep learning neural network trained on large sets of images. The system does not recognize facial expressions based on predefined features or action units, but instead learns through training and testing with large sets of images representing the different emotion categories. The ME-API and human raters have shown comparable identification accuracy (Goeleven, De Raed, Leyman & Verschuere, 2008; Takáč, Mach, & Sinčák, 2016). For each image, the classifier provided a confidence rating between 0 (very unlikely) and 1 (very likely) for each of eight emotional expressions (anger, contempt, disgust, fear, happiness, neutral, sadness, and surprise) which were recorded. To determine whether the presence of a beard resulted in the image classifier systematically (but incorrectly) identifying a particular emotion on emotionless faces, photographs of the same men used in Experiments 1-3 posing a neutral expression with and without a beard were also entered into the ME-API. Analysis of confidence estimates revealed that emotion identification of neutral faces was not influenced by the presence or absence of a facial hair (a full analysis is provided in the online supplement).

Data analysis. The confidence rating for the intended emotion for each face was taken (i.e., the confidence estimate from the ME-API for happiness was taken for happy expressions, the anger estimate for angry expressions and so on). These confidence estimates were submitted to a 2 (Facial hair: bearded, clean-shaven) × 3 (Emotional expression: anger, happy, sad) repeated measures ANOVA with Greenhouse-Geisser adjustments for violations of sphericity. Each of the 10 posers acted as a single case in the analysis. Follow-up analyses were conducted using two-tailed paired samples t-tests and Cohen’s $d_z$ effect sizes are reported. Confidence estimates are only presented here for the intended
expression. This does not provide information about the image classifier’s estimates for non-intended expressions, so for completeness, an analysis including ratings for non-intended expressions is provided in the online supplement.

Results

Confidence estimates varied by emotional expression, $F(2,18)=19.70$, $p=.001$, $\eta^2_{p}=.69$, 90% CI[.40-.78], (see Figure 4). Confidence estimates for the intended expression were higher for happy faces than angry faces, $t(9)=4.72$, $p=.001$, $d_z=1.49$, 95% CI[0.63-2.35], and higher for angry faces than for sad faces, $t(9)=3.35$, $p=.009$, $d_z=1.06$, 95% CI[0.31-1.81]. This effect was moderated by a significant Facial hair × Emotional expression interaction, $F(2,18)=7.58$, $p=.008$, $\eta^2_{p}=.46$, 90% CI[.12-.61]. Confidence estimates were higher on bearded than on clean-shaven faces for angry expressions, $t(9)=2.00$, $p=.077$, $d_z=0.63$, 95% CI[-0.03-1.30], but lower on bearded than clean-shaven sad faces, $t(9)=2.43$, $p=.038$, $d_z=0.77$, 95% CI[0.08-1.46]. Estimates for bearded and clean-shaven happy faces

![Figure 4](https://example.com/figure4.png)

**Figure 4.** Mean image classifier confidence ratings for the intended emotional expression for angry, happy, and sad faces when bearded (dark bars) and clean-shaven (open bars). Error bars represent 1 standard error of each mean. For a figure displaying distributions of image classifier confidence ratings see the online supplement.
were almost at ceiling (> .99 out of 1) and did not differ, \( t(9)=1.27, p=.236, d_z=0.40, 95\% \text{ CI}[-0.24-1.04]. 

**General Discussion**

Evolution by sexual selection has shaped secondary sexual characteristics employed during male-male agonistic signaling (Darwin, 1871; Emlen, 2008) and may have acted on sexually dimorphic traits in men (Dixson, Dixson, & Anderson, 2005). Here we show that beardedness, a highly sexually dimorphic and visually salient masculine characteristic, enhances recognition of angry facial expressions (Experiment 1). Participants were faster and more accurate to categorize anger than happiness on bearded but not on clean-shaven faces. Experiment 2 ruled out the possibility that beards facilitated recognition of anger displays because of congruence between negative evaluations of beardedness and anger, as beards slowed recognition of the negative expression, sadness. Explicit ratings of the faces in Experiment 3 demonstrated that beardedness enhanced perceived aggressiveness of angry faces but also enhanced perceived prosociality of happy faces. These ratings are inconsistent with a stereotype based explanation for the angry advantage for bearded faces. Finally, in Experiment 4, a computer-based image classifier was more accurate classifying anger on bearded faces but sadness on clean-shaven faces.

Considering these results together with previous research, the angry advantage for bearded faces may have emerged as beards increase perceived masculinity via enhancing the prominence of the jaw (Dixson et al., 2017). The mouth and jaw are important in anger recognition and masculine jaw lines are associated with faster recognition of anger (Becker et al., 2007). Enhanced prominence and angularity of the jawline from the presence of facial hair potentially facilitated anger classification in our study. This visual structural explanation is also consistent with the results of Experiment 2 where sad expressions were employed. Sadness is partly conveyed through drooping the lip corners (Reed & DeScioli, 2017). Facial hair masks areas of the lips and chin that convey sadness while augmenting the size of the lower face and jaw which may have reduced the visibility of sadness cues. Experiment 4
suggests that the anger advantage for bearded faces may be carried in visual information to some extent as a computer-based image classifier produced the same biases as human observers even though computers do not directly hold the attitudes and stereotypes held by human observers. However, we note that human involvement in training the image classifier can also lead to the bias observed if, for example, more bearded faces were selected as training images for anger. We did not develop the image classifier so cannot rule out this possibility. Further research into the structural overlap between facial hair and emotional expression would be beneficial.

The finding that beards facilitate recognition of anger has wide-reaching implications that intersect with theory and practice. Our data suggest that beards may be an evolved signal of masculinity and formidability, which is consistent with studies reporting that facial hair is not functionally protective (Dixson, Sherlock, Cornwell, & Kasumovic, 2018). Beards may have evolved via intra-sexual selection, where facial hair increased the perceived formidability of opponents, curtailing conflicts and leading to increased social status and access to mates (Darwin, 1871). Alternatively, beards may serve no function for survival or reproduction. They may simply mask the lower part of the face and draw more attention to the eyes, an area important for recognizing anger relative to happiness (Calvo & Fernandez-Martin, 2012). Regardless of the mechanism or the origin of beards, understanding how facial hair influences recognition of emotions represents an important development for person perception research.

In the current study, we only used emotionally expressive faces in the experiments with human observers. Although the presence or absence of facial hair did not influence the image classifiers emotion estimates, future research may investigate whether beards influence human observers to perceive emotion in neutral faces. Future research may also investigate whether the influence of beards on emotion perception is due to beards altering the contrast between teeth and the rest of the face. Teeth were visible in all happy and angry expressions used in our study so the presence of teeth in only some images cannot explain our results. As teeth are important for emotion perception (Becker &
Srinivasan, 2014), it could be valuable to investigate whether beards influence emotion recognition differently depending on whether expressions are displayed with teeth exposed or covered. More generally, our results demonstrate the importance of considering the influence of social information including facial hair in emotion perception research as these influences are often overlooked (Schmidt & Cohn, 2001).

We have demonstrated that emotional expressions are not processed in isolation from beards. These initial biases could impact how bearded men are perceived, suggesting that a man might be treated differently when bearded than when clean-shaven. In the current study beards facilitated anger recognition suggesting that professionals responsible for detecting and responding to threat (e.g., police officers) could more readily perceive bearded men as threatening. This is consistent with previous research showing that beards influence perceivers’ behavior including voting decisions (Herrick, Mendez, & Pryor, 2015), or judgments of criminality (Conti & Conti, 2004). Together, this research demonstrates that beardedness impacts nonverbal communication with potential to open new lines of inquiry into how masculine characteristics influence social interactions beyond the lab and into men’s daily lives.
Author Contributions. B.M.C. and B.J.W.D. conceptualized the initial idea. B.J.W.D. and N.L.N. acquired funding to support the project. All authors contributed to the development of the methods. B.J.W.D. developed the stimuli and B.M.C. prepared the protocols. B.M.C. and N.L.N. contributed to data acquisition. B.M.C analyzed the data. All authors contributed to the original draft and reviewed and proofread the manuscript.

Open Practices Statement. None of the experiments reported in this article were formally preregistered. The data have been made available on a permanent third-party archive (https://osf.io/zuwxt/). Stimuli are not available as the individuals depicted in the stimuli did not agree for their likeness to be shared in this manner. Requests for the materials can be sent via email to the lead author at [bcraig7@une.edu.au].
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doi:10.1080/02699931.2017.1310087


doi:10.1093/beheco/arr214


doi:10.1111/jeb.12958


