Angry men and happy women – A pre-registered replication using psychophysics

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Data availability statement:

The data that support the findings of this study are openly available in Open Science
Framework (OSF) at <https://bit.ly/2Uzh6bw>

Abstract

Judgments about the emotional expression of a face are influenced by its sexual features, and vice versa. The cause of this interaction remains unclear. Most previous research has used standard analyses of categorisation responses to full-blown emotional expressions. A better understanding of the phenomenon may however require the adoption of nuanced stimuli and sophisticated analyses methods. For example, Harris et al. (2016), used psychophysics methods to compare responses to faces displaying emotions at several intensity levels. The point of subjective equality (PSE), at which happy and angry categories are equally likely, was found to be closer to the happiness pole for male compared to female faces. Because these methods seem promising for the quest of advancing the field to a better understanding of how emotional and social judgments of faces are formed, we attempted a replication of Harris et al.'s study, after pre-registration in an independent public registry (<https://bit.ly/2v8BW7Q>). A large sample ($N = 108$) from a comparable population was tested with the same stimuli and task as in the original publication. We successfully replicated the main and some secondary findings, which we discuss in the context of the literature, and we indicate promising avenues of research in this domain.

Keywords

Face processing; social judgments; categorisation; emotion; sex

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Introduction

Human faces reveal many things, such as a person's age, sex, focus of attention, and emotional state, which perceivers extract and categorise automatically at first sight (Willis & Todorov, 2006). Face perception also relies heavily on top-down effects of categorisation, such as situational context and perceiver biases (Wieser & Brosch, 2012). Importantly, the sight of a face can elicits the activation of multiple competing, and possibly interacting, social categories in the mind (and brain) of the perceiver (Freeman & Johnson, 2016). In line with this, previous work has suggested that a face's biological sex influences perceptual judgments of its emotional expression, and vice-versa. In general, maleness is associated with anger or aggression, while femaleness is associated with happiness, fear, or sadness. For example, emotionally ambiguous infant faces are rated as angry when the infant is labelled as a boy, and as fearful when it is labelled as a girl (Condry & Condry, 1976). Emotionally and sexually ambiguous adult faces are rated as angry if shown with typically male clothing and hairstyle, and as sad when shown with typically female clothing and hair (Plant et al., 2004).

The mechanisms underlying the reported mutual effects of emotional expression and sex during face perception remain debated. They may include top-down effects of gender evaluation and gender stereotyping (Amodio & Devine, 2006; Plant et al., 2000), and objective morphological similarities between certain sexual and emotional features (Said et al., 2009; Zebrowitz et al., 2010). Because of this complexity, the field is best advised to start adopting rigorous research methods, such as the use of standardized tasks, fine-grained and controlled facial stimuli, advanced data analysis, and registered replications.

The perhaps most common method to experimentally investigate the mutual influence of facial emotion and sex cues, is the categorisation of male and female faces that display a strong and therefore clear emotional expression. Using this method, several studies have found that the categorisation of both the emotional expression and the sex of faces is faster and more

accurate for angry male and happy female faces, compared to happy male and angry female faces (Becker et al., 2007; Hess et al., 2009).

A recent categorisation study however stands out for having used male and female faces that gradually change between happiness and anger. Harris et al. (2016) fitted psychophysics curves to happy/angry categorisation choices in response to nine emotion levels (including neutral), and established that the point of subjective equality (PSE), at which happy and angry categories are equally likely to be selected, was further towards the happiness pole for male than for female faces. The effect size was small to medium (Cohen's $d = 0.28$). This approach, which focuses on ambiguous rather than full-blown expressions, appears promising for a more in-depth exploration of the phenomenon of emotion-sex interaction effect on face processing.

To test its robustness, we carried out a pre-registered (<https://bit.ly/2v8BW7Q>) direct replication attempt of the main finding of Harris et al. (2016), by testing 108 participants with the same task and identical face stimuli.

Methods

Participants

Participants were 108 psychology students (75 females, age range 18 to 33 years, mean age = 21.51, SD = 2.9) who received study credits for their participation. To determine sample size we estimated the original effect size based on the means and standard errors of the mean (SEMs) shown in Figure 4A of the original study (Harris et al., 2016). In the original study, the average PSEs (SEM) were 4.3 (1) for male and 1.2 (1) for female faces. From that, we estimated a standard deviation (SD) of 12 for both groups, by multiplying the SEM by the square root of the sample (126). Using these values, and assuming a 0.6 correlation between groups, Cohen's d was estimated to be 0.28 with the program G*Power (Faul et al., 2007). A total sample size of 103 participants was estimated to be necessary to replicate the finding with a power of 0.8,

with alpha set at 0.05. We aimed to test up to 110 participants, but stopped at $N = 108$ due to organizational reasons. The study was approved by the ethics committee of the University of Vienna.

Stimuli

The identical stimulus set was used as in the original publication (Harris et al., 2016). It included 72 pictures of faces selected from the NimStim database (Tottenham et al., 2009), displaying a neutral face, as well as morphs with 10, 20, 40, and 80% of both happiness and anger, for eight facial identities (four male, four female).

Procedure

The task was programmed with PsychoPy3 (Peirce et al., 2019) and consisted in categorising each face as either happy or angry, by pushing, with the index and middle/ring fingers of the right hand, the right or left arrow button on a computer keyboard (assignment of buttons to emotions was counterbalanced across participants). In each trial, a fixation cross was shown for one second, followed by a face for one second, and a question mark for 1.5 seconds. Participants were instructed to indicate their categorisation choice when the question mark was on the screen. The task was preceded by four practice trials, in which emojis were shown instead of faces. Up to 10 participants were tested simultaneously, each sitting in front of a computer screen and separated by cubicles.

The replication attempt was part of a preregistered study (<https://bit.ly/2v8BW7Q>). It was followed by other categorisation tasks with different stimuli (not reported here), and by a series of questionnaires. We focus here on the PANAS questionnaire (Watson et al., 1988), as it was also reported in Harris et al (2016).

Analyses

The data and the analysis scripts are available online (<https://bit.ly/2Uzh6bw>). After removal of trials without response (2.4% of all trials), participants' categorisation choices were analysed in a generalized linear mixed-effects binomial model (GLMM), using the *glmer* function of the *lme4* package in R¹. A probit (cumulative gaussian) function was specified, as in Harris et al. (2016). By including random effects, GLMMs reduce Type-I errors and allow for better generalization of findings (Judd et al., 2017). Categorisation choice (happy/angry) was the dependent variable, stimulus emotion (nine levels, cantered) and stimulus sex (two levels, dummy-coded) were the fixed effects, and by-subject random intercepts and random slopes for stimulus' emotion and sex and their interaction were included. Based on the fitted GLMM, the PSE and the slope of the model fits were calculated for each subject and sex. To compare the PSEs for male and female faces (main finding in Harris et al., 2016), we used linear regression implemented with the function *lm* in R. Type III ANOVA output was obtained with the *Anova* function of the *car* package. Similarly, model slopes and percentages of categorisation choices for the standard neutral faces (those labelled as neutral in the original face database) were regressed on the predictor stimulus' sex. Participants' sex and scores on the positive and negative PANAS scales were added as covariates, to control for individual differences. PSEs were also compared against zero using two-tailed *t*-tests.

Results

The analysis of categorisation choices resulted in significant main effects of Emotion ($b = .48, SE = .02, z = 30.32, p < .001$) and Sex ($b = -.84, SE = .09, z = -9.59, p < .001$), as well as a significant Emotion X Sex interaction ($b = .13, SE = .03, z = 3.70, p < .001$). The main effect of Emotion reflects that happier faces were categorised more often as happy, and thus

¹ `glmer(choice ~ emotion * sex + (emotion * sex | sub), family=binomial (link="probit"))`

that participants followed instructions and could recognize the facial expressions. The main effect of Sex confirms the hypothesis that female faces are perceived as happier than male faces. Finally, the interaction is explained by a greater difference between female and male faces at the centre of the emotion continuum (where expressions are more ambiguous), compared to the extreme facial expressions (see Figure 1A and 1B).

Fig1: (A) Lines represent the average (SD) percentage of trials categorised as happy, by emotional expression and sex. Raw data (jittered to improve visibility) is shown with blue triangles (male faces) and red circles (female faces). (B) Marginal means and confidence intervals of the GLMM fitted to the data, with indicated points of subjective equality (PSE, for which there is a 50% chance to be categorised as happy or angry). Stimuli at the PSE for male faces contained significantly more happiness than stimuli at the PSE for female faces.

As expected, the PSE contained more happiness in male than female faces. On average, male faces required 17.5% of happiness, to be categorised as happy 50% of the time, while female faces only required 4.1 % (Figure 1B). This difference was statistically significant, as shown by linear regression ($F(1, 214) = 75.75, p < .001$), and stayed significant when controlling for participants' sex, and mood (positive and negative subscales of the PANAS, see Figure 2A and 2B). The effect size of the difference in PSEs was Cohen's $d = 2.0$ (SDs were 8.7 for male, and 10.2 for female faces, correlation of 0.76 between conditions). Thus, although the difference between male and female PSEs in the current replication (1.34 in units of

morphs) was less than half of that (3.1) found by Harris et al., the corresponding effect size was more than seven-fold bigger, thanks to smaller SDs. The PSEs were also significantly different from zero for both male faces ($t(107) = 16.64, p < .001$) and female faces ($t(107) = 2.15, p = .04$).

Furthermore, we carried out the other analyses reported in the original study. The slope of the fitted statistical model was steeper ($F(1, 214) = 33.10, p < .001$) for male faces ($b = .59$) than for female faces ($b = .48$), suggesting that emotion was perceived more categorically for male than female faces. Standard neutral faces (those at the centre of the continuum, which were labelled as neutral in the original database), were categorised significantly ($F(1, 214) = 71.99, p < .001$) more often as happy if they were female (45.14%), than male (14.51%), confirming that neutral male faces are perceived as angrier compared to neutral female faces. This result remained when controlling for participant's sex and mood (Figure 2C and 2D). Reaction times for faces with 80% intensity were neither predicted by the emotion (happy, angry), nor by the gender (male, female) of the face, nor by their interaction (all $F < .5$, all $p > .5$).

Fig2: Top row: scatterplots between PSE and (A) positive mood, (B) negative mood. Bottom row: scatterplots between the percentage of happy categorisations at the standard neutral faces and (C) positive mood, and (D) negative mood. None of the correlations was statistically significant (all $p > .5$).

Discussion

Harris et al.'s (2016) finding, that stimuli at the PSE for male faces contain significantly more happiness compared to the stimuli at the PSE for female faces, was successfully replicated. The corresponding standardized effect size ($d = 2.0$) was about seven times larger than in the original study ($d = .28$). We also replicated the finding that male neutral faces were judged angrier than female neutral faces. Our results confirm that male faces are perceived as angrier (less happy) than female faces, and are in line with the literature (Becker et al., 2007; Hess et al., 2009).

Other results differed from those reported by Harris et al. (2016). First, the fitted probit function had a steeper slope for male compared to female faces, suggesting more categorical emotion perception for male faces. In contrast, Harris et al. found no difference in slopes. Second, we did not replicate the correlations between PSEs and participants' positive affect, nor between categorisation of standard neutral faces and positive affect. Third, we did not replicate the finding of faster responses to female than male faces with 80% anger. These effects were however not the focus of the replication, and their replication may have required a larger sample size.

Successful replication of the difference in PSEs for male and female faces may partly be attributable to the fact that comparable groups of participants were tested in both studies (all students, similar average age and gender ratio). However, focusing on student populations bears its problems (Henrich et al., 2010), and it therefore should be tested if the results hold also in other groups.

Neither the results by Harris et al. (2016), nor this replication, can by themselves clarify what causes men to be perceived as angrier, and women as happier. Several factors have been proposed to underlie these effects, ranging from low-level visual similarities between male faces and angry faces, to top-down modulation by higher-order cognition like stereotypes

(Plant et al., 2004; Said et al., 2009; Zebrowitz et al., 2010). Clearly, laboratory experiments using controlled stimuli with gradual emotion changes, and psychophysical analyses of participants' responses seem an appropriate first step to better understand the phenomenon at hand. Registered replication efforts provide the important validation of reported findings.

The phenomenon should however also be investigated from different angles, e.g. by investigating if the sex-induced emotion bias can be erased through priming, which would suggest that it is easily modifiable and thus unlikely to be hardwired (Kurzban et al., 2001), or by investigating if it occurs when face awareness is suppressed by binocular rivalry (Korb et al., 2017). In addition, it might be worthwhile to explore the bidirectionality of the emotion by sex interaction, and to compare the strength of these effects at the explicit and implicit level. To that purpose, we have recently developed a new stimulus set comprising avatar faces with 11 levels of emotion and sex, and found that ratings and categorisations of faces are influenced equally by the face's emotion and sex, when these dimensions are attended to, but that the effects of emotion prevail over the effects of sex, when these stimulus dimensions are processed implicitly (in preparation).

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226