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Association between Facial Metrics and Mate Rejection for Long-Term Relationship by Heterosexual Men

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Abstract: Investigations on mate choice in humans frequently report preferences, but there is little knowledge about what is important for rejection by a potential mate. The present study aims to verify if facial asymmetry and facial disharmony have an influence on mate rejection by men. We hypothesized that more asymmetric and disharmonious faces would be more rejected. For this purpose, photographs of women's faces were presented in pairs by self-declared heterosexual men. It was requested they reject one of the faces as a potential mate for a long-term relationship. Women's faces were also analyzed to measure facial asymmetry and facial disharmony. We used a linear mixed model to evaluate the effect of the cited metrics on each face's number of rejections. We found that the female metrics influenced mate rejection only if associated with male age and income. The older participants rejected female partners with asymmetric faces. We suggest that aging makes men more demanding in mate choices, at least considering facial asymmetry. We concluded that rejection could be a key variable in mate choice studies, but further research is needed to clarify its effects.

Keywords: rejection; mate choice; asymmetry; facial metrics; facial disharmony; facial asymmetry

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1. Introduction

Mate choice investigations in humans usually report traits and behavior preferences [1–3]. However, the rejection of negative physical traits was possibly a relevant decision for our ancestors: for example, rejecting traits that indicate compromising health aspects, poor hygiene, or low reproductive potential [4]. We hypothesized that mate rejection was selected in human ancestors because they lived in groups with few members, with few people in reproductive age and there were not enough options (individuals) to search for attractive traits in a mate choice context. In addition, identifying bad traits in potential mates and excluding these mates from mating possibilities could be decisive t healthy and survival offspring.

Member exclusion from a social group is an adaptive behavior adopted by many species [5–7]. Member rejection from a group aims to remove those who bring more prejudice than benefits to the group, and those who have scarce interactions with other individuals in a community. The behavior of the excluded member would not favor the group's survival [8]. The same reasoning could be applied to mate selection in humans, in which subjects with a low supply of resources to raise their offspring are excluded, either men or women. They need to overcome rejection in addition to adapting, so they can get the attention of another potential mate [9,10].

Despite the importance of the discussion on mate rejection, reports on this topic are still scarce. A few studies list physical and behavioral traits relevant to potential mate rejection [11–13]. Some studies discuss what happens in the rejected mate or the mating behavior in the face of rejection [9,10,14–17]. On the other hand, there are a lot of papers about favorite mate traits. The facial components (e.g., eyes, nose, mouth) are recurrent because these features are fundamental to facial recognition and to identify a friendly or attractive face [18–20].

Some facial measurements, e.g., the distance between the eyes, the distance between the end of the nose and the high lip, and the size of facial components seems to influence facial attractiveness because they change its proportions and its harmony (i.e., the balance of the measurements) [21–25]. Facial features should not be analyzed separately because the relationship between facial components create the perception of what is considered as normal (or harmonious) in the face, and this relationship is related to facial attractiveness [26,27]. One of the methods to measure facial harmony highlighted here is the rule of thirds, in which a face could be divided into portions guided by the facial components: between the hairline and the eyebrow line (upper part of the face); between the eyebrow line and the end of nose (middle part of the face); between the end of the nose and the end of the chin (lower part of the face). In a perfectly harmonious face, these vertical and horizontal portions would be similar [28,29].

Another characteristic that could influence facial attractiveness is facial symmetry (i.e., the equality between the left and right halves of the face). Small differences in position or size of the eyes, eyebrows, nose, and mouth in each half of the face are considered normal. This condition is called fluctuating asymmetry [30]. Grammer and Thornhill (1994) used computer-generated faces and varied a set of measurements for symmetry, averageness (the facial measure of all faces mixed as an average), and facial feature size. The authors presented the created faces to 96 participants and found that men and women preferred symmetrical faces for potential partners [31]. There are several studies that indicate facial symmetry is associated to personal advantages to the person who has it, such as genetic quality and organism homeostasis in face of environmental adversities and stress [32–35]. An individual exposed to low nutrient diet, toxins, parasitism, or other sources of stress could develop facial asymmetries, and the face symmetry would provide a biological indicator for resistance to pathogens and other environmental distress. In addition, studies show that symmetrical faces are related to a healthy appearance to raters [36–38].

In the present investigation, our interest is to evaluate, in the perspective of mate rejection, the influence of facial asymmetry and facial disharmony on mate choice by heterosexual men. We hypothesize that the more asymmetrical and disharmonious the face is, the more it will be rejected.

2. Materials and Methods

2.1. Ethical Considerations

This study is in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of the Federal University of Pará (report #13854319.1.0000.5172). All the participants accepted the participation for free and provided a written consent term.

2.2. Participants

Two groups of participants were included in the present study. A group (group 1) with sixty-three Brazilian men, self-declared heterosexual, in an age range from 20 to 57 years old (mean $\pm$ SD = 27.63 $\pm$ 6.96) participated of a mate rejection experiment, and another group (group 2) with fifty-one participants (mean $\pm$ SD = 25.05 $\pm$ 2.12 years) participated in an additional experiment to score the attractiveness of the female faces. Participants from both groups have declared no neurological or systemic illness that could compromise their answers during the experiment. They were contacted by phone through advertisements disclosed in the Federal University of Pará and University of São Paulo.

They were invited to attend in-person in one of these two universities, in the offices where the experiment happened.

2.3. Stimuli

Eight female face photographs were chosen from Chicago Face Database (CFD), available on chicagofaces.org [39]. Face stimuli included photographs of young (aged between 20 to 25 years) female individuals with neutral facial expressions. All faces had similar skin, eyes, and hair color. The photograph spatial resolutions were 2444 × 1718 pixels and stimulus identification numbers in CFD are: LF-210-220; LF-213-079; LF-218-072; LF-227-054; LF-228-125; LF-229-164; WF-006-002; WF-007-001.

2.4. Procedure

2.4.1. Measure of Facial Asymmetry and Facial Disharmony

The facial asymmetry of the photographed faces was quantified based on Grammer and Thornhill's calculation [31]. This metric consists of the sum of all possible non redundant differences between the midpoints of horizontal lines between pairs of specific points on the face: the inner corner of the eyes; the outer corner of the eyes; more salient cheeks; more prominence of jaws; and the corners of the mouth. Therefore, five horizontal lines were traced between the points, which were defined according to the last pixel of each cited anatomic area with the software ImageJ (National Institutes of Health, Bethesda, MD, USA). Results with a value of zero would represent a perfect symmetrical face, while an asymmetrical face would result in a value higher than zero.

Facial disharmony was calculated using the method suggested by Suguino et al. [29], in which facial components from photos of female faces were measured. Distances between the hairline and eyebrows; the eyebrows and the lower part of the nose; the lower part of the nose and the lower part of the chin (Figure 1, A, B, C on the left); the sum of the differences between these distances we called vertical facial disharmony. We also measured the distance between the inner and outer corners (Figure 1, A and C on the right), and the distance between the inner corners of the eyes (the distance between eyes, Figure 1, B on the right). The sum of the differences between these distances are called horizontal facial disharmony. For both facial disharmony metrics, the larger the value, the more disharmonious the face would be. There are some discussions about the use of hairline in this type of calculation, because age can change its position. Here, we minimize this bias by selecting only women of similar age [28].

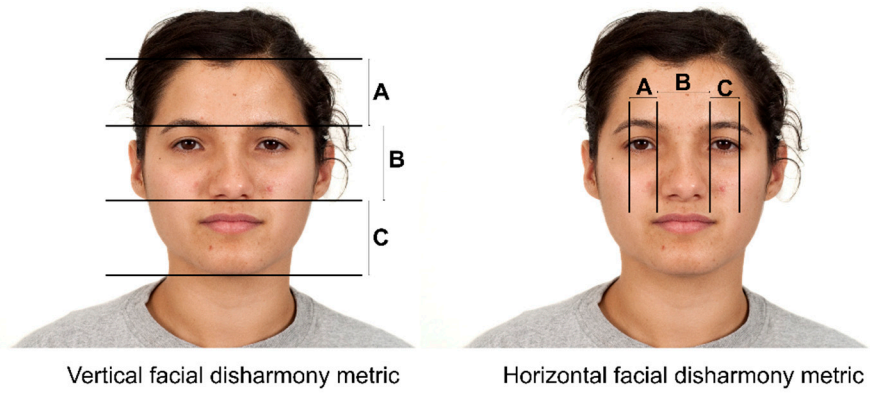

Figure 1. Example of distances used in vertical and horizontal facial disharmony metrics.

2.4.2. Sociodemographic Questionnaire

Before the experiment, participants filled out a form with sociodemographic questions: age, educational level, current marital status, and monthly income in Brazilian minimum wages (from 0 to 2; from 2 to 4; from 4 to 10; from 10 to 20; over 20), according to the social class Instituto Brasileiro de Geografia e Estatística [Brazilian Institute of Geography and

Statistics] (IBGE) classification. Lastly, the questionnaire requires a self-rated facial beauty grade and a self-rated general beauty grade, both with a score from 1 to 9.

2.4.3. Mate Rejection Experiment

The photographs chosen as stimuli were presented in pairs (Figure 2) only to participants from group 1 on a computer monitor using Matlab R2017b (MathWorks, Natick, MA, USA) software. The pairs included all possible combinations between the eight photos, and each pair was presented twice, totaling 56 pairs—in the second presentation, the photograph order (left or right side) was inverted.

Figure 2. Example of faces shown in pairs in the mate rejection experiment. Participants should reject one of the faces by pressing keyboard arrows.

Each participant was guided to indicate which face would be rejected for a long-term relationship. To reject one of the faces, the participant should press the keyboard left and right arrows, which indicated the face on the respective side of the screen. Participants were blinded to the facial asymmetry and disharmony measures. Images remained on screen, there was no limit of time to fulfill the task, nor any interventions from the researchers regarding the participants' judgment. For each photograph, the number of rejections given by participants was recorded.

We performed an additional experiment to score the attractiveness of the female faces with participants from group 2. They scored the attractiveness of the female faces in the same photographs of the experiment about rejection. For this, the participant observed one face on the left of the screen, which was arbitrarily scored at 45. Based on the reference face and its score, the participant was asked to attribute an attractiveness score to the face on the right of the screen. The score could be decimal and had no limit. The reference face and its score were kept the same for all trials (Figure 3).

Figure 3. Example of faces shown in pairs in the attractiveness experiment. Participants should score the right face on the screen aware that the left one had a 45 score.

2.5. Data Analysis

A Linear Mixed Model (LMM) was applied to assess the effect of all variables of interest with the number of rejections (and attractiveness score) to the presented faces. The LMM included the following fixed effects of male participants: age, marital status, income, self-rated general beauty, self-rated facial beauty, vertical and horizontal facial disharmony scores, and facial asymmetry score. Simple interactions between the effects related to the subjects and the effects related to the faces were included (e.g., age of the participant × facial asymmetry). Simple interactions between facial asymmetry and (vertical and horizontal) facial disharmony were also included. Subject and face IDs were included as random effects. All continuous fixed effects were previously centered and scaled (subtracting the mean and dividing by the standard deviation of the sample). Categorical variables relative to the male observers were recoded into numeric form: marital status: single = –0.5 and married = 0.5; and income: 0 to 2 minimum wages = –0.5; 2 to 4 minimum wages = 0; 4 to 10 minimum wages = 0.5. Age was grouped only for visualization purposes.

A stepwise procedure was used to remove, sequentially, non-significant interactions from the initial model, keeping all the simple effects. The initial model is presented in the supplementary material (Table S1). The visual inspection of the residuals was used to verify the reliability of the model. The analysis and visualizations were conducted in the software R 4.04 [40] and the following packages: lme4 [41] for the construction of LMM; lmertest [42] to estimate the *p*-value based on the Satterthwaite approximation; performance [43] to visual inspection and residual statistics of LMM; and ggeffects [44] e ggplot2 [45] for data visualization. The significance level was $\alpha = 0.05$.

3. Results

3.1. Rejection of Facial Asymmetry and Facial Disharmony on Female Faces

A significant effect was found in the interactions between participant age and facial asymmetry score ($\beta = 0.66$, SE = 0.19, $p < 0.001$), participant age and vertical facial disharmony score ($\beta = –0.53$, SE = 0.17, $p = 0.002$), and between participant age and horizontal facial disharmony ($\beta = –0.54$, SE = 0.18, $p = 0.002$) on the rejection of the presented faces (Table 1, Figure 4). These results suggest that older participants tended to reject more asymmetrical faces compared to younger participants (Figure 4a). On the other hand, it indicates that the older participants tended to reject vertically and horizontally, harmonious faces, the reverse of the observed for younger participants (Figure 4b).

Table 1. Estimate (β), Standard Error (SE) and *p*-value to each fixed effect in the final LMM for rejection.

	β	SE	*p*
Intercept	7.01	1.01	0.002
Age	0.01	0.19	0.969
Income	−0.04	0.56	0.950
Marital status	0.08	0.57	0.887
Self-rated facial beauty	0.01	0.23	0.951
Self-rated general beauty	0.01	0.23	0.989
Facial asymmetry	−0.02	1.02	0.988
Vertical facial disharmony	−0.03	1.04	0.980
Horizontal facial disharmony	−0.26	1.06	0.820
Age: Facial asymmetry	0.66	0.19	<0.001
Age: Vertical facial disharmony	−0.53	0.17	0.002
Age: Horizontal facial disharmony	−0.54	0.18	0.002
Income:- Facial asymmetry	−1.66	0.54	0.002

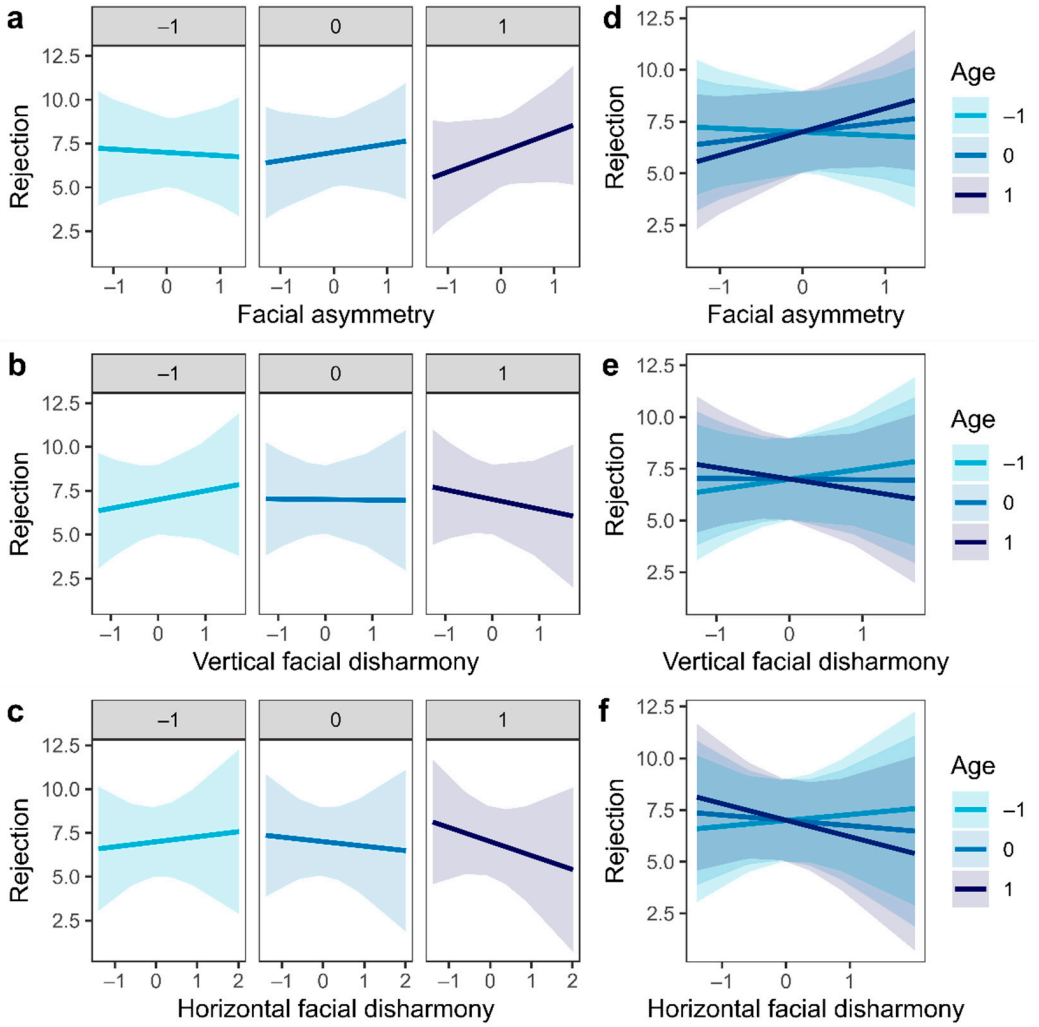

Figure 4. Effect of age on the rejection of facial asymmetry and facial disharmony on female faces. In (**a**–**c**) partial effects are shown of facial asymmetry (**a**), vertical facial disharmony (**b**), and horizontal facial disharmony (**c**) on facial rejection in different ages. In (**d**–**f**) the overlapping slopes are shown for all participant ages. Fixed effects (age, facial asymmetry, and facial disharmony) were previously standardized (centered and scaled). Age was grouped only for better visualization. Shaded areas show a 95% confidence interval.

We also found a significant effect on the interaction between the participant's monthly income and facial asymmetry (β = −1.66, SE = 0.54, p = 0.002) on the rejection of the presented faces (Table 1, Figure 5). It indicates that participants with higher monthly income tended to reject less the asymmetrical faces as compared to participants with lower monthly income (Figure 5a).

We found a non-significant effect of marital status (β = 0.08, SE = 0.57, p = 0.887), or participants' self-rated facial beauty (β = 0.01, SE = 0.23, p = 0.951) and self-rated general beauty (β = 0.01, SE = 0.23, p = 0.989) on the rejection of presented faces (Table 1).The simple effect of participant age (β = 0.01, SE = 0.19, p = 0.969), participant monthly income (β = −0.04, SE = 0.56, p = 0.950), facial asymmetry score (β = −0.02, SE = 1.02, p = 0.988) and vertical (β = −0.03, SE = 1.04, p = 0.980), and horizontal facial disharmony (β = −0.26, SE = 1.06, p = 0.820) were also non-significant.

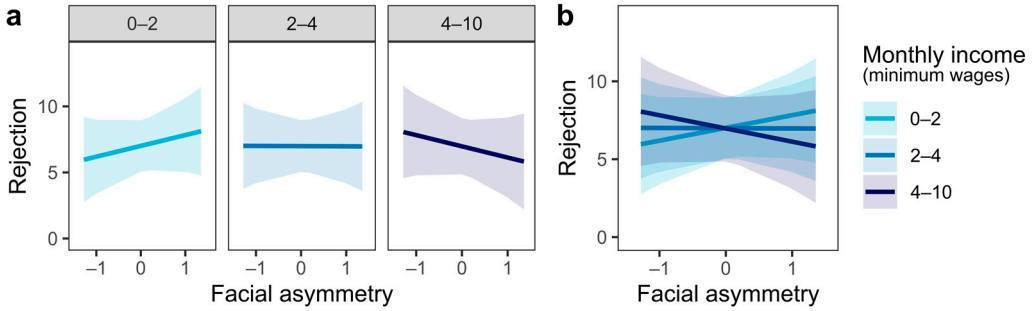

Figure 5. Effect of monthly income on asymmetry rejection on female faces. In (**a**) partial effects are shown of facial asymmetry on facial rejection for participants with different monthly incomes (in Brazilian minimum wages). In (**b**) overlapping slopes are shown for each monthly income range. Fixed effect (monthly income and facial asymmetry) data were previously standardized (centered and scaled). Shaded areas show a 95% confidence interval.

3.2. Attractiveness of Facial Asymmetry and Facial Disharmony on Female Faces

No significant effect was found in the variables related to the participants (age, income, marital status, self-rated facial beauty, self-rated general beauty) or related to the stimuli (facial asymmetry, vertical and horizontal facial disharmony) on the attractiveness ratings (Table 2). Although the interaction between marital status and vertical facial disharmony was marginally significant in the initial model (Table S2), a stepwise procedure excluded that interaction in the final model.

Table 2. Estimate (β), Standard Error (SE) and p-value to each fixed effect in the final LMM for attractiveness.

	B	**SE**	***p***
Intercept	39.41	3.65	<0.05
Age	−1.02	1.59	0.526
Income	−2.31	4.12	0.578
Marital status	−2.10	4.55	0.646
Self-rated facial beauty	−1.76	2.57	0.526
Self-rated general beauty	2.22	2.54	0.386
Facial asymmetry	−2.02	2.80	0.511
Vertical facial disharmony	−1.88	2.88	0.550
Horizontal facial disharmony	−1.80	2.93	0.573

3.3. Multicollinearity of the Statistical Models

We tested the correlation between the main variables of the study and found only significant correlations between self-rated facial beauty and self-rated general beauty by using data from the rejection (r = 0.7) and attractiveness (r = 0.8) experiments (Figure 6). To avoid multicollinearity problems, all fixed effects were centered and scaled (see Section 2.5), and both Linear Mixed Models (rejection and attractiveness) were checked for multicollinearity by calculating the variance inflation factor (VIF) for each parameter. A VIF less than 5 indicates a low correlation between a single variable and the other variables in the model [46]. All variables had a VIF less than or equal to 2.04 (Table S3).

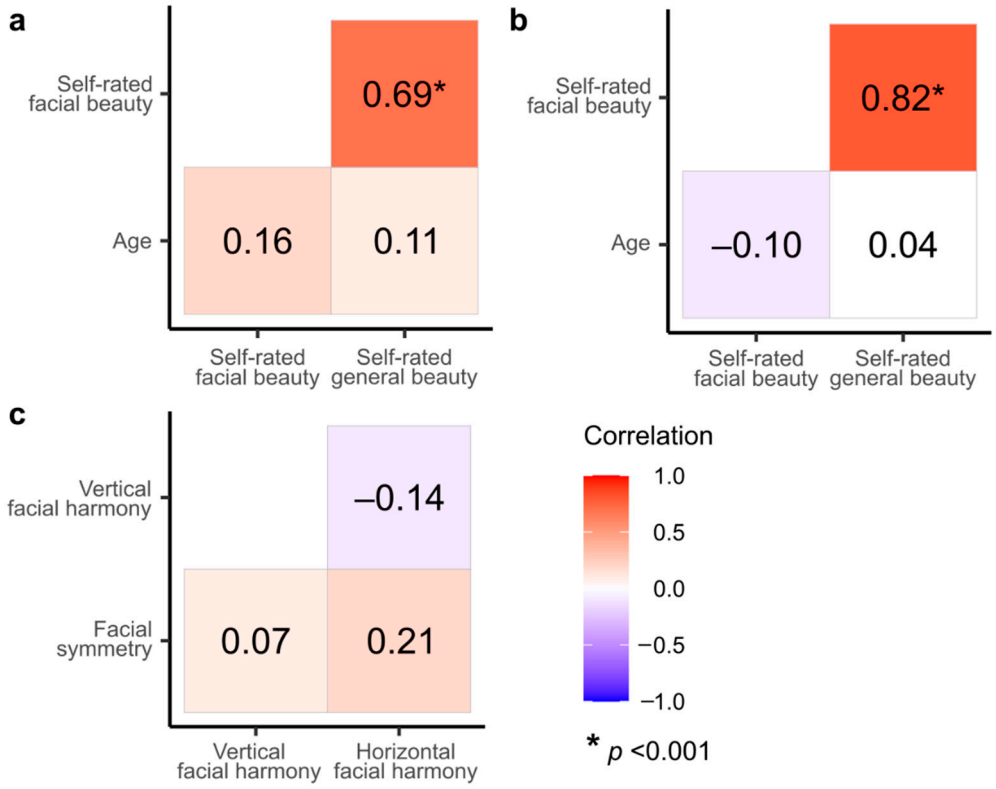

Figure 6. Correlation between the main variables of the study. In (**a**,**b**) the Pearson's correlations are shown between variables related to the participants for rejection (**a**) and attractiveness experiments (**b**). (**c**) Kendall's correlation is shown between variables related to the stimuli (the same used for both experiments). The correlation coefficients range from −1 to 1, color-coded from blue to red, respectively. * Statistical significance of $p < 0.001$.

4. Discussion

We have explored the effects of female facial metrics and male socioeconomic factors on mate rejection by heterosexual men. Our main findings demonstrate that the age and income of the observer have an impact on the way the faces were evaluated. We found that asymmetrical and non harmonic faces are both rejected by older men. In addition, men with a higher monthly income tended to reject less asymmetrical faces.

Although the results of the impact of facial symmetry on mate choice are mixed [36,47–49], this research supports that facial asymmetry could be an important trait to in rejection. As far as we know, no previous investigation reported results about rejection and facial asymmetry. The studies about facial symmetry and male mate choices were focused on decision behaviors tuned to preferences for relationships [50]. The main effects of facial disharmony/asymmetry of females in the rejection decision of males were non-significant and weakly negative. As we added interactions in the model, and these interactions were significant, it is more conservative not to interpret the separated main effects.

Our unprecedented findings could indicate that the mating behavior of people of different ages is distinct in physical traits rejection, and there are distinct mating strategies depending on the age. We suggest that the perception of fluctuating asymmetry, or that the asymmetry we can find in faces daily could be improved over the years. To clarify those findings, more studies should be done on the mating behavior of older people compared to mating behavior of younger individuals, related to their perception of facial asymmetry.

Previous research found differences in mating behavior over the age. Older men prefer intelligence in partners [51], and domestic and creative mates [52]. In general, older men tend to be more selective in their choices, mainly over 40 years old, because they have accumulated experience and resources to offer, aspects sought by women in a partner [53].

However, aging is not the only factor that influences how demanding the person (man or woman) would be in looking for a mate. This behavior is attached to other social, economic, and psychological attributes and their combination [46,54,55]. Another point here is the age of the women in facial photographs, 20 to 25 years old. Men tend to aim their search for a female partner on youth and usually prefer younger mates [46,55–57].

Men with higher socioeconomic status tend to be more selective in their mate choice and the evaluation of facial attractiveness [58–61]. However, in the present study, we found a negative influence of monthly income on the relation between mate rejection and facial asymmetry. Different from the expected, in the present study men with a higher income tended to reject women with less asymmetrical faces. It is unclear the reason for our findings. The range of the monthly income of our sample was limited between 0 to 10 minimum wages (low and intermediate incomes), and maybe the inclusion of participants with higher incomes could positively influence mate rejection.

The facial measures were associated to facial beauty, but beauty is supposed to be a volatile concept that can dramatically change between generations and different cultures [25,29]. The present study found that faces with values of disharmony close to zero (i.e., harmonious faces) are significantly more rejected by older men. We consider that this evidence indicates that the method of measuring facial disharmony could not be related to beauty in a mating context.

On the other hand, Valentine et al. [62] used a calculation in which the higher the ratio between the width and the length of men's faces, the higher the women's preference for a long-term relationship. This finding suggested that facial measures, such as facial harmony, could signal preferences in the mating context and a good proportion of facial measures means some advantage in mating choice, although we did not find which proportion of female faces would mean an important factor in mate rejection by heterosexual men. To clarify this question, further studies are necessary, using different calculations about other facial measures that could mean harmony or disharmony on female faces.

Income grouped as a categorical variable is a limitation that we assumed due to the relatively small number of participants. An increase of participants will allow future studies to be more robust, and quantitative models of judgments will be able to reveal information about choices with greater refinement which is not available at this moment.

Finally, the present study suggests that male mate rejection is related to facial metrics when associated with other demographic (such as age) or economic (income) factors. This evidence has a clear potential contribution for the usage of faces as stimulus as the use of facial images is further spread, used for marketing to psychological clinics' approaches.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/sym15010133/s1, Table S1: Estimate (β), Standard Error (SE) and p-values for each fixed effects of the initial LMM for rejection; Table S2: Estimate (β), Standard Error (SE) and p-values for each fixed effects of the initial LMM for attractiveness; Table S3: Variance Inflation Factor (VIF) for each parameter in the final LMM for rejection and attractiveness.

Author Contributions: Conceptualization, L.P.P., L.C.P.M., G.S.S. and A.L.H.; methodology, L.P.P., L.D.H., G.S.S., M.F.C. and A.L.H.; software, G.S.S.; formal analysis, L.C.P.M. and A.C.M.; investigation, L.P.P. and L.D.H.; writing—original draft preparation, L.P.P. and G.S.S.; writing—review and editing, L.P.P., L.C.P.M., L.D.H., G.S.S., A.C.M., M.F.C. and A.L.H.; visualization, L.P.P., L.C.P.M. and G.S.S.; supervision, G.S.S., M.F.C. and A.L.H. All authors have read and agreed to the published version of the manuscript.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available in Supplementary Material S1.

Conflicts of Interest: The authors declare no conflict of interest.

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