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OBM Neurobiology
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Original Research

Faster and More Accurate Identification of Male Faces in Female Care Home Residents

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Academic Editor: Bart Ellenbroek

OBM Neurobiology
2020, volume 4, issue 1
doi:10.21926/obm.neurobiol.2001050

Received: August 21, 2019
Accepted: February 18, 2020
Published: February 26, 2020

Abstract

We investigated whether healthy older adults who live in female-dominated old age care homes can identify the gender of male and female faces of people from different ethnicities in the same way as young adults. We hypothesized that this mainly female environment would lead by exposure to a female-gender bias. A sample of 40 participants aged 20-30 and 70-80 years identified the sex-of-face of 120 images of young and old adults, male and female faces, black and white faces, presented in a randomized sequence in a self-paced computer task. The young group was significantly more accurate and faster than the older group in sex-of-face identification. Men's faces were identified as male faster than female faces as female by both young and old adults. Men's faces were also more accurately identified by younger adults, but in care home residents, this was only the case for faces of young white and older black men. Faces of white older women were identified more accurately than those of black older women by the care home residents, especially in the women-only sample when men were excluded from statistical analysis. Because the known masculinity bias in women prevailed beyond the menopause, it is discussed whether rather than fertility hormones, women's testosterone would be a likely candidate explaining the male advantage in sex-of-face identification throughout the life-span.

Keywords
Sex-of-face identification; masculinity bias; life-span; women's testosterone

1. Introduction

The current study investigates whether older adults who live in care homes can identify the gender of male and female faces of people from different ethnicities in the same way as young adults. Due to the greater longevity of women in the UK [1], the population of care homes tends to be formed by a majority of women. A number of these are widows who are living without their husbands for the first time. Moreover, care homes are also predominantly staffed by females who are employed in the care and nursing professions. Thus, residents do not come into contact with males with much frequency, and often not at all if housebound. According to face recognition theory, familiarity and exposure breed face recognition biases, for instance for the own race, while contact with people of different racial origins mediates the race bias [2]. Likewise, more contact with the same gender can produce an own-gender bias, with women recognizing more faces and more female faces [3]. In addition, older people can show an old-age bias, recognizing older faces better than a younger age group [4]. Thus, given such exposure-borne biases, we expected that care home residents, based on their daily environmental experience would be able to determine the gender of a face more accurately and faster for female, and possibly older female faces than for male faces.

However, the above studies were referring to face *recognition* which involves memory and identification of individual faces. In contrast, studies on face *preference* use a forced-choice method asking participants which of two faces seems more attractive. The preference method does not require participants to identify individual faces, but instead two faces are compared and a choice is made for one under different task instructions (forced-choice). In this face preference literature, another bias is more important, and that is the preference of women for male faces, and the more masculine, the better. This is of course a statement that is too general, but it reflects that the majority of this research assumes that this preference is biologically determined: Women prefer masculine faces at times when their fertility is likely to be highest [5-7], unless they suffer from low self-esteem [8], or judge the masculinity of faces on the basis of a long-term relationship attractiveness rather than for a short-term occasion [9].

In the current study, we used neither a recognition nor a forced-choice task. Instead we used a sex-of-face identification task where attention was given to just one individual face at a time [10]. On the basis of the biological hormonal theory, we predicted that in a sex-of-face identification task, the present mainly female sample should not show better identification of male faces because the menopause would be more than several years in the past.

There seems to be only one study that does not explain a preference for male faces with biological reasons [11]. DeBruine et al. showed in a large study which compared 30 nations that a preference for male faces increased, the more health decreased. This result still held when controlled for wealth and mating strategies. Age and sickness may be a vulnerability factor which causes a desire for male protection to become more important. This vulnerability also shows in older adults being more focused on positive faces [12] and paying less attention to fearful faces

[13] which suggests an active defense mechanism against anxiety and threat. Hence, based on this background research, one would rather predict that female care home residents would show better identification of male faces.

1.1 The Current Study

In the current study, participants were asked to determine the gender of young and old, male and female, white and black faces. Designations of people can become dated over time and new definitions arise of what is acceptable language. Minear and Park [14] who created the pictures of faces in the present database used the terms ‘African-American’ and ‘Caucasian’, but in the most recent APA Publication Manual 7 this is evaluated as inappropriate. Instead, it says ‘Whenever possible, use the racial and/or ethnic terms that your participants themselves use’ [15] such as ‘black’. We have not used the term ‘ethnic’ for the images of the various faces because it refers to the cultural dimension and not to the physical differences between faces [15].

Identification of the gender of a face does not require memory for a particular face but only the decision whether the face that is seen is male or female. As such, this task seems fairly easy for the older sample especially because there was no memory requirement as in a recognition task and the response was self-paced without an upper time limit. While decisions faces are usually made within a very short time of 100 ms, longer exposure times increased confidence in judgements, but did not change the judgement itself [16]. We could expect that the two age groups would be able to identify the gender of a face their own age faster because the own-age effect appears to be a robust effect [17, 18] based on an immediate fast perceptual impression, while the own-race effect requires more thought [19]. Nevertheless, in other studies, the own-age effect was limited to the young comparison group and involved both early perceptual impressions and later retrieval of episodic information [20-22]. This may occur because young people have less contact with their older relatives and the older population in general [23, 24]. However, it was also demonstrated that young adults appear to have an own-age bias only when recognizing young against old faces, but show no bias if they have to remember just young, or just old faces [25].

We devised the sex-of-face identification task self-paced because our older group was up to 81 years of age and hence we expected that they would need more time [26]. We also just presented one face at a time, only once, in a randomized order, rather than several faces at the same time, which decreases the processing load for older age groups [27] and avoids repetition priming [28].

The fact that younger adults are better in identifying contemporary famous persons [29] led to the assumption that older adults are less adapt in accessing semantic knowledge. However, a recent study showed that semantic priming was intact in older adults [30]. In the current study, we used anonymous images of faces from different age groups and ethnicities that were collected in Dallas, Texas, USA [14]. Previous research has shown that skin pigmentation does not change the accuracy of gender identification of faces but may lengthen latencies [31]. The study took place in East Sussex, UK, with a fairly large share of mainly white British residents. The last available census date is from 2001 and thus not up to date. However, it is estimated that ethnic minority citizens gradually leave the most deprived areas and settle in more gentrified ones, leading to less segregation in the UK [32]. The health and social care sector in the UK employs a large number of individuals who are immigrants from a variety of countries world-wide.

The aim of the study was to investigate whether the social phenomenon of female-dominated care homes would provide evidence for female-biased face processing based on familiarity. We investigated whether the increased exposure to female faces in old age residential care homes would lead to better identification of female than male faces by their inhabitants compared to a young age control group from the same area in the UK. Based on previous research, we expected somewhat extended reaction times towards black faces (same race bias) in the older sample and extended reaction times towards older faces (same age bias) in the younger sample.

2. Methods

2.1 Participants

For the current study, G*Power analysis showed that with an *a priori* small effect size of .25, an alpha-level of .05, power of .80, and testing a difference of two age groups as between-factors, a repeated measurement MANOVA required a minimum sample size of $N = 32$. All participants who had consented were tested. The older age group of white participants was recruited in two private care homes in East Sussex. To match the older age group, we recruited the younger, also white age group of participants at the University of Sussex which is located in the same geographic area as the care homes, rather than at the London Metropolitan University (which is the authors' institutional affiliation) with a more diverse student population. Thus, all participants were white British. Vision was intact or corrected by glasses. The sample consisted of N=40 participants. The younger age group, n=24, 24 to 31 years, 6 men, were healthy individuals and received no financial incentive to participate. The older age group, n=16, 70 to 81 years, 5 men, had no history of psychiatric or neurological disorders and also did not receive a reward for taking part in the experiment. The younger age group will be called 'young adults' or 'young group' and the older age group will be called 'older adults' or 'old age group' in the report of the results.

2.2 Material

Images were selected from an internet database of facial images [14], see Figure 1 for examples of women's faces. Stimulus images were selected for two age groups, and for white and black people, respectively. Nine images of older men needed to be added to the database-drawn images and these were formatted in the same way as those from the data base. Because the participants lived in a white-majority county, we tried to match this environment and showed them double as many white faces (20 images) than black faces (10 images) of each gender and age in the experiment (120 images in total). Thus, the experiment aimed to map the white-majority environment where participants were living without imposing an ethnic parity that would have been artificial from their point of view insofar as it would not have been in accordance with their daily experiences. An equal amount of white and black faces may have overestimated performance of the older group in the care homes because of an experimental training effect. Images depicted young women aged 20-30 years, young men aged 20-30 years, older women aged 70-80 years, and older men aged 70-80 years.

Figure 1 Examples of stimulus images of women's faces. (Left column 'old', right column 'young') [14].

A Toshiba Satellite Pro L20 Windows 7 laptop with a 15'' screen was used for testing. The 120 images of faces on a uniformly greyish background were each presented once in a randomized sequence using Superlab 5.0. Images were presented until the participant responded. A break after the 33rd and the 106th image was allowed for a brief rest. Participants were instructed to identify the gender of the person on the image by responding 'm' for male and 'f' for female. No feedback was given. Superlab measured reaction times and accuracy.

2.3 Procedure

The study was vetted by the Ethics committee of the Psychology Department of the London Metropolitan University according to the rules and regulations of the British Psychological Society in the United Kingdom which are in accordance with the Declaration of Helsinki [33]. Participants were given an info sheet, signed a consent form, and received a debrief sheet after the experiment. Testing was carried out individually in a separate room. There were five practice trials with faces that were not used in the experiment thereafter to familiarize participants with the response buttons. These trials were not analyzed. The duration of the experiment varied from 5-15 minutes.

2.4 Data Generation

The individual files were aggregated as one text file and prepared within Excel. There were some missing trials, 2 of 400 trials for older female black faces (0.5%), 2 of 400 trials for young female black faces (0.5%), 2 of 800 trials for young female white faces (0.25%), 1 of 800 trials for young male white faces (0.13%), and 3 of 800 trials for old male white faces (0.38%); it is clear that these missing data were negligible. Data were then imported into SPSS, averaged and analyzed per face category. Two datasets of participants from the younger age group were excluded because although they were 100% correct, they showed extremely extended reaction times with outlier mean values between 20,000 and 80,000 ms which is much longer than even for young children where maximum reaction times are usually under 10,000 ms [34].

3. Results

Data were screened for outliers in an item-based fashion to make sure that our results do not hinge on just a handful of face images. First, because we had 20 images of white faces, reaction times were averaged across groups of 10 images each for young and older faces, respectively and then compared with each other in pairwise t-tests (two-tailed). There were no significant differences between the two random groups of white male faces, t (39) = -.38, p = .708 (young white male faces) and t (39) = -1.21, p = .232 (older white male faces). However, there were significant differences between the two random groups of white female faces: t (39) = 2.77, p = .008 (young white female faces) and t (39) = -5.20, p = .001 (older white female faces). Hence, the total percentage of wrongly identified faces was ascertained as 2.9%, equivalent to responses to 140 trials, in comparison to 97.1% correctly identified faces, equivalent to 4,648 trials for the entire sample. Item-based frequencies of the misidentified face images showed that there were five female images that were especially difficult to assess in terms of gender identity as they showed more than 10 misidentifications. Figure 2 shows that the most difficult to identify female faces were from both age groups and from both white and black faces.

Figure 2 Faces that attracted more than 10 gender misidentifications [14] (see items set in bold in Table 1).

Also all the other misidentified faces occurred across categories, see Table 1. Older black male faces were the easiest to identify as men's faces as they were only misidentified on one single trial in the entire sample. Thus, all stimuli were used for statistical analyses because there was no bundling of misidentified cases in just one category.

Table 1 Frequencies of 140 gender-misidentified faces per category.

	Frequency	**Per Cent**
Young White Female Faces		
FemYoungWhite 1	**12**	**8.6**
FemYoungWhite 2	**11**	**7.9**
FemYoungWhite 13	5	3.6
FemYoungWhite 8	2	1.4
FemYoungWhite 11	2	1.4
FemYoungWhite 15	2	1.4
FemYoungWhite 7	1	.7
FemYoungWhite 9	1	.7
FemYoungWhite 12	1	.7
Total	37	26.4
Young Black Female Faces		
FemYoungBlack 5	**10**	**7.1**
FemYoungBlack 9	4	2.9
FemYoungBlack 8	2	1.4
FemYoungBlack 3	1	.7
Total	17	12.1
Older White Female Faces		
FemOldWhite 12	3	2.1
FemOldWhite 2	2	1.4
FemOldWhite 3	2	1.4
FemOldWhite 10	2	1.4
FemOldWhite 19	2	1.4
FemOldWhite 17	1	.7
FemOldWhite 18	1	.7
Total	13	9.3
Older Black Female Faces		
FemOldBlack 3	**14**	**10.0**
FemOldBlack 1	**12**	**8.6**
FemOldBlack5	5	3.6
FemOldBlack6	3	2.1
FemOldBlack2	1	.7
FemOldBlack7	1	.7
FemOldBlack8	1	.7
FemOldBlack9	1	.7
FemOldBlack 10	1	.7
Total	39	27.8
Young White Male Faces		
MaleYoungWhite 9	3	2.1
MaleYoungWhite 7	2	1.4
MaleYoungWhite 2	1	.7

MaleYoungWhite 3	1	.7
MaleYoungWhite 10	1	.7
MaleYoungWhite 17	1	.7
MaleYoungWhite 18	1	.7
Total	10	7.1
Young Black Male Faces		
MaleYoungBlack 8	5	3.6
MaleYoungBlack 9	2	1.4
MaleYoungBlack 2	1	.7
MaleYoungBlack 3	1	.7
MaleYoungBlack 4	1	.7
MaleYoungBlack 5	1	.7
MaleYoungBlack 6	1	.7
Total	12	8.6
Older White Male Faces		
MaleOldWhite 14	4	2.9
MaleOldWhite 4	1	.7
MaleOldWhite 9	1	.7
MaleOldWhite 12	1	.7
MaleOldWhite 15	1	.7
MaleOldWhite 16	1	.7
MaleOldWhite 17	1	.7
MaleOldWhite 19	1	.7
Total	11	7.8
Older Black Male Faces		
MaleOldBlack 7	1	.7
Total	1	.7
Total Number of Misidentifications	140	100

To test whether gender decision making was influenced by features of the displayed faces, a 2 (face age) by 2 (face gender) by 2 (face color) by 2 (age group) MANOVA with repeated measures on the first three factors was computed for accuracy and reaction times. We analyzed the complete sample first. We report the results for the female-only samples either explicitly in the text, or in brackets in order to be able to confirm the prediction that older females would show faster reaction times for female faces due to higher exposure in their care homes. The two analyses could thus corroborate each other increasing the reliability of the results.

Accuracy. In general, young participants were more correct (M = 98.4% [98.5%]) than the older age group (M = 94.1% [93.7%]), $F(1, 38) = 45.79$, $p < .001$, $\eta^2 = .56$ [$F(1, 27) = 44.12$, $p < .001$, η = .64].

A significant effect of the gender of the face was found as male faces (M = 98.3%, [98.9%]) were identified more correctly than female faces (M = 94.2%, [93.4%]), $F(1, 38) = 26.87$, $p < .001$, $\eta^2 = .43$, [$F(1, 27) = 47.73$, $p < .001$, $\eta^2 = .66$].

However, the two-way interaction between the gender of the face and the participant age group showed that better identification of the male faces was minimal in young participants (female faces *M* = 97.2% [97.3%]; male faces *M* = 99.7% [99.7%]), but pronounced in the older age group (female faces *M* = 91.3% [89.4%]; male faces *M* = 97.0% [98.1%]), $F(1, 38) = 4.50$, $p = .041$, $\eta^2 = .11$ [$F(1, 27) = 15.27$, $p = .001$, $\eta^2 = .38$.]

A main effect of skin color of the face also made a difference for the determination of the gender of the face as white faces were easier to judge by the white participants (*M* = 97.5% [97.5%]) than black faces (*M* = 95.1% [94.7%]), $F(1, 38) = 20.60$, $p < .001$, $\eta^2 = .36$, [$F(1, 27) = 22.38$, $p = .001$, $\eta^2 = .47$].

However, a two-way interaction of skin color with age group showed that color of the face was immaterial to the young participants (white faces *M* = 99.0% [98.9%]; darker faces *M* = 97.9% [98.4%]), but relevant for the accuracy of the judgement of the older age group (white faces *M* = 95.9% [96.1%]; black faces *M* = 92.3% [91.4%]), $F(1, 38) = 6.25$, $p = .017$, $\eta^2 = .15$, [$F(1, 27) = 11.31$, $p = .002$, $\eta^2 = .31$].

The age of the face interacted two-way with the gender of the face, $F(1, 38) = 9.57$, $p = .004$, $\eta^2 = .21$, [$F(1, 27) = 14.08$, $p = .001$, $\eta^2 = .36$], and three-way with the participant age group, $F(1, 38) = 13.51$, $p = .001$, $\eta^2 = .27$, [$F(1, 27) = 11.79$, $p = .002$, $\eta^2 = .32$]. Post hoc independent samples t-tests show that the young group was always more accurate than the older group, $p_s < .012$. Figure 3 shows that this difference between young and older participants was especially pronounced with regards to images of older female faces.

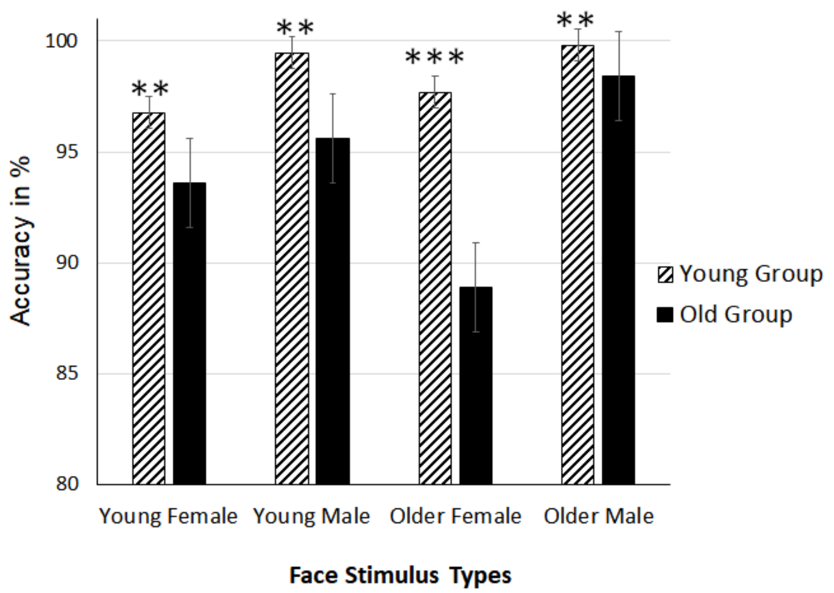

Figure 3 The effect of age and gender of the face on young and old adults' decisions. * = $p < .05$, ** = $p < .01$, *** = $p < .001$.

The skin color of the face was important for the accuracy of the gender identification as all two-way and three-way interactions were significant, $p_s < .015$ [$p_s < .002$], as well as the four-way interaction with the faces' age and gender and the participant groups, $F(1, 38) = 35.46$, $p < .001$, $\eta^2 = .50$ [$F(1, 27) = 19.68$, $p < .001$, $\eta^2 = .44$].

Post-hoc pairwise t-tests showed that male faces were always better identified as male by young people independently of the skin color, $p_s > .042$, see Figure 4. In contrast, the older age group significantly better identified young white male than young white female faces, and faces of older black men were significantly better identified than those of older black women. Or to phrase it in another way, the older group was the least accurate in identifying the gender of older women's black faces.

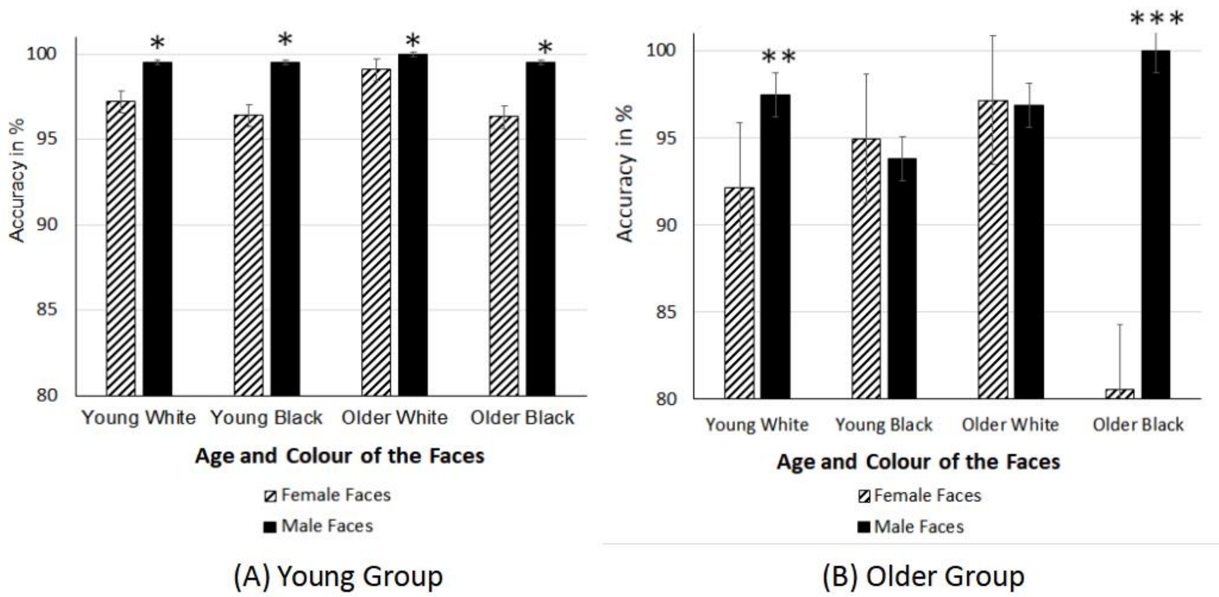

Figure 4 Accuracy of gender identification in relation to the age, gender and color of faces. * = $p < .05$, ** = $p < .01$, *** = $p < .001$.

Reaction Times. The same analysis of variance was run for reaction times. The older age group (*M* = 1634 ms [1606 ms]) was considerably slower to decide than the young age group (*M* = 929 ms [951 ms]), $F(1, 38) = 23.16$, $p < .001$, $\eta^2 = .39$ [$F(1, 27) = 11.27$, $p = .003$, $\eta^2 = .31$].

A female face took longer to be identified as female (*M* = 1400 ms [1434 ms]) than a male face as male (*M* = 1164 ms [1123 ms]), $F(1, 38) = 17.66$, $p < .001$, $\eta^2 = .33$ [$F(1, 27) = 25.45$, $p < .001$, $\eta^2 = .50$]. However, this varied with age as shown in a significant two-way interaction of gender of the face and the participant age group in the whole sample, $F(1, 38) = 8.79$, $p = .005$, $\eta^2 = .20$, which did not reach significance in the women-only sample, $F(1, 27) = 3.21$, $p = .085$, $\eta^2 = .11$. Post-hoc pairwise t-tests showed that male faces were only somewhat faster identified in the young age group (female faces *M* = 964 ms; male faces *M* = 894 ms [female faces *M* = 1004 ms, male faces *M* = 898 ms]), but this difference was significant, $t(21) = 2.31$, $p = .031$ [$t(15) = 3.93$, $p = .001$]. The older age group, though, was considerably faster in gender identification of male faces (*M* = 1433 ms) than of female faces (*M* = 1835 ms), $t(15) = 3.20$, $p = .006$ [male faces *M* = 1347 ms, female faces *M* = 1864 ms, $t(10) = 3.57$, $p = .005$].

The other features of the faces besides gender also had an impact on reaction times. The gender of the face interacted with its age, $F(1, 38) = 7.38$, $p = .010$, $\eta^2 = .17$ [$F(1, 27) = 5.79$, $p = .024$, $\eta^2 = .19$]. The gender of the face also interacted with its color, $F(1, 38) = 4.12$, $p = .050$, $\eta^2 = .10$, [$F(1, 27) = 3.42$, $p = .076$, $\eta^2 = .12$] and the factors gender, age and color of the face interacted three-way, $F(1, 38) = 4.12$, $p = .050$, $\eta^2 = .10$ [$F(1, 27) = 4.66$, $p = .041$, $\eta^2 = .16$]. Figure 5 shows that all male faces were identified faster except for young black faces which were gender-identified at the same speed in the mixed sample, while the women-only sample also identified the young male black faces quicker than the young female black faces. This three-way effect of age, gender and color of faces did not interact four-way with age group, $F(1, 38) = 3.40$, $p = .073$, *ns* [$F(1, 27) = 1.77$, $p = .195$, *ns*], that is, there was no difference over the life-span.

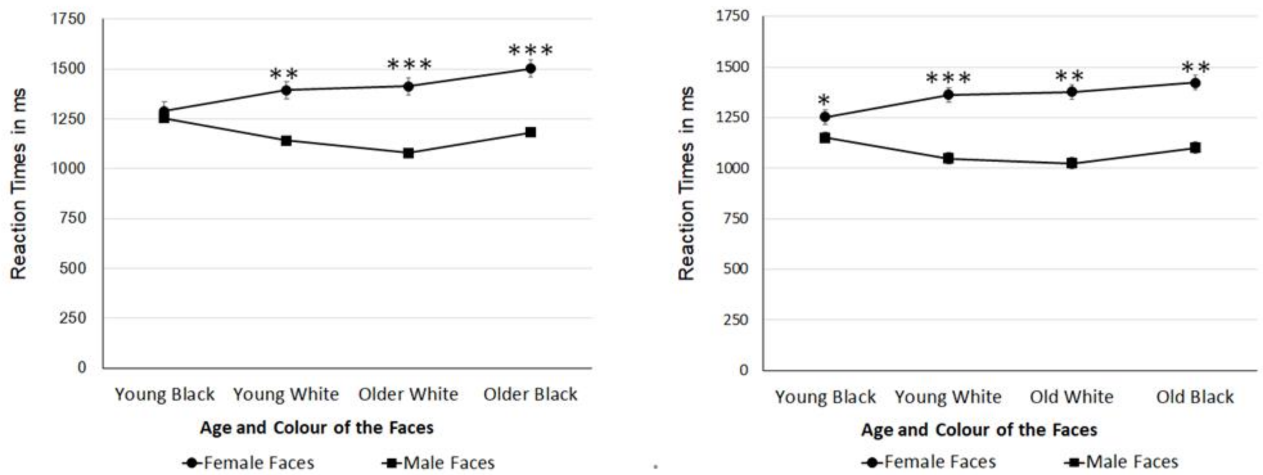

Figure 5 Reaction times of gender identification in relation to the age, gender and color of faces. Mixed sample (left), women-only sample (right). * = $p < .05$, ** = $p < .01$, *** = $p < .001$.

To recap, we double-checked whether results would also hold if men were omitted from the analyses in both the young and the old age groups. The effects stayed significant, with F and η^2 values much increased in the MANOVA of accuracy, while the reaction times analysis of the women-only sample sometimes showed attenuated p-values, but values of the three-way interaction of age, gender and color of the faces increased like in the accuracy analysis.

4. Discussion

The aim of the study was to investigate whether the social phenomenon of female-dominated care homes would provide evidence for female-biased face processing based on familiarity. The hypothesis was that care home residents should be able to decide about the gender of a face better and faster when identifying female rather than male faces when compared to young age controls because (a) they are no longer fertile and the face recognition preference literature suggests that young women react fast to masculine faces because of their hormone balance, (b) their daily environment is dominated by female carers and previous literature suggests that biases can arise simply as a mere exposure effect. We were not making any assumptions about preference because this would have required a forced-choice task paradigm [35]. Our study showed some expected results, and some surprising results.

Not surprisingly, the young group was significantly more accurate and faster than the older group. Very often old age is associated with a decreasing ability to identify faces, however, while this is often the case, older participants are also aware of this process and often evaluate their own judgments as less reliable [36]. Men's faces were identified as male more accurately and faster, not only in the group of young adults, but also in the older age group and in the all-women sample. This result does not confirm that (a) exposure to a mainly female environment would lead to a sex-of-face identification bias for female faces and (b) that only fertile women would show a masculinity bias for male faces. A masculinity bias for male faces was even demonstrated in a large sample of 245 4-5-year-old children: At an age that is many years before puberty, the speed of sex-of-face identification was facilitated by attractiveness for female faces, but only by masculinity for male faces [10]. Hoss et al. explain that the masculinity effect would be due to children's greater familiarity with female faces [37], in the same way as we assumed that care home residents would have higher familiarity with female faces as these are more common in the caring professions. Thus, if there is only one dominant facial prototype, the female face, male faces deviate stronger from the prototype than the various female exemplars and thus this contrast would facilitate male sex-of-face identification. Hence, from this facial prototype perspective, male faces are not identified in their own right but as 'not-female': Hoss et al. showed that children made the least mistakes with low attractive, high masculinity faces. In short, also in this developmental study with a similar hypothesis, for a sex-of-face identification advantage for male faces to occur, a high fertility-related hormone level was not required.

The hypothesis of an own-age bias with extended reaction times towards older faces in the younger sample was not confirmed. The young group also did not show an own-race bias. Instead, there was significantly better accuracy for male face identification. There were also faster reaction times for male faces and this effect occurred without a significant age difference. However, the older sample showed an own-race bias, not in general, but to some degree. Astonishingly, while the care home residents showed equal accuracy when determining the gender of images of older white faces, they identified the gender of images of older male black faces with significantly more accuracy than those of older female black faces. The difference was nearly 20%. This result became even more pronounced when men participants were excluded from analysis.

Thus, also in the environment of care homes with predominantly female residents and staff, better identification of male faces occurred. De Bruine et al. [11] found in a very large sample of 4794 women from 30 countries that a preference for male faces increased the more health decreased. They concluded that such a preference may reflect a desire for male protection. This was independent of cross-cultural differences in wealth or women's mating strategies. Future research may investigate whether this hypothesized desire is indeed based on a feeling of vulnerability which requires a 'male security guard' or 'provider' rather than a friend and partner of the opposite sex, or whether it is a mixture of these two aspects. It is a limitation of the current study that we did not use a questionnaire about loneliness and asked participants about their interest in finding a partner of the opposite sex because we assumed that the care home would provide female companionship. Our results clearly refute the theory that better identification of masculine faces would be a reflection of just young women's desire at the peak of their estrogen levels.

While this biological hypothesis is clearly refuted, the exposure hypothesis needs further research. Our initial hypothesis was that high exposure to female faces may generate an advantage for female-gender face identification in the older age group. We found that this was not the case, but on the contrary, male faces were better identified. It must be stated, however, that we did not count the exact numbers of male and female staff members in the actual care home at the time of the data collection. Another limitation with respect to the exposure hypothesis is that we did not measure the length of time that the care home residents were living in the institution. One the one hand, according to the exposure theory, we cannot exclude the possibility that those living since a longer time in a mainly female staffed care home would develop a better identification of female faces. On the other hand, according to the prototype theory, it would be predicted that longer exposure would not make any difference to the male face advantage because a stronger female face prototype would only increase the distinctiveness of the male face exemplars.

The older age group and in particular the older women identified the gender of the images of the faces of older white men and women to the same degree, but were significantly more in accurate when judging the gender of images of older black male than female black faces. In general, female faces are much more determined by attractiveness than male faces [10]. As Figure 1 shows, the faces of the elderly US women in the database could be quite groomed, whether white or black. Thus, it appears, that the mainly elderly women in the current sex-of-face identification task may have felt somewhat competitive towards same-aged women of another ethnicity. Such selective discrimination can also occur on an institutional level, for instance, an older black female like BBC news presenter Moira Stuart appears not to have had the same attraction as an older black male like Trevor MacDonald [38, 39]. The result that the older group showed less attention to some older female faces than others is a further hint that it was not just exposure but probably a competitive bias that created a sex-of-face identification bias in these female care home residents. Indeed, in previous research with 23-year-old women it was found that the 'male' hormone testosterone level was a predictor for an advantage for masculine faces in a forced-choice task, and not the 'female' reproductive-relevant hormones progesterone and estrogen [40]. Other researchers have shown that women's testosterone is relevant for a masculinity preference in face processing in the second half of the female menstruation cycle after ovulation [41]. Likewise, the degree of masculinity of a face itself is determined by the levels of testosterone and indicates competitiveness [42, 43]. The current life-span study on gender identification of face images gives some reasons to develop a new hypothesis for future research which is in contrast to the hypothesis of a fertility-related estrogen-based advantage for male faces that was derived from research with just young women: The masculinity bias would be instead determined by a combination of a testosterone-driven bias which may prevail into old age and a contrasting visual distinctiveness effect of male faces compared to a prototype face.

Thus, the study provided important results which could be a base for the development of a more extensive and detailed study that would control levels of testosterone levels in men and women across the life-span to test its impact on the masculinity bias in face processing. It is well known that testosterone levels decline during the life-span in men [44]. Most interestingly, while men's testosterone levels continuously decrease by 60.2% during the life-span, in women, who on average have only about 5% of the testosterone of men, it decreased by only 30% [45]. However, testosterone levels are not an encapsulated biological process. Testosterone levels in boys surpass those in girls at about ten years of age [45, 46] and are mediated by the quality of the relationship with the parents [46]. Testosterone in adults is also mediated by romantic relationships [47] which can cause men's testosterone level to drop while women's testosterone level increases. Women's jealousy of other women shows a clear correlation with testosterone levels [48]. Moreover, on performance measures, aggressiveness and focus were testosterone-dependent in young female college rugby players, but female rivalry was related to the stress hormone estradiol [49].

Competitiveness and testosterone were found to be more highly related in elite than non-elite women athletes [50]. Thus, in such a future hormone-controlled life-span study of the masculinity bias in face processing, one could also expect a cohort effect as average modern young women may be likely to compete in both the marriage and the labor market while this would not have been the case in the older generation that we tested.

Author Contributions

Chris Lange-Küttner and Donna Martinez-Claras developed the experiment, analysed the data and wrote the report. Donna Martinez-Claras collected the data in the care homes and the University of Sussex. Chris Lange-Küttner created the figures, processed all revisions of the manuscript and conducted additional statistical analyses.

Competing Interests

The authors have declared that no competing interests exist.

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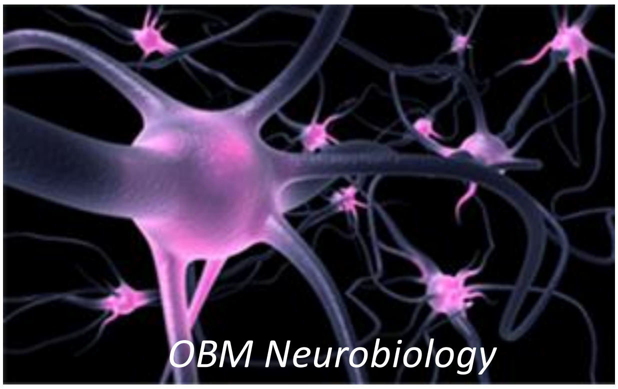
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