Who are you expecting? Biases in face perception reveal prior expectations for sex and age

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A person's appearance contains a wealth of information, including indicators of their sex and age. Because first impressions can set the tone of subsequent relationships, it is crucial we form an accurate initial impression. Yet prior expectation can bias our decisions: Studies have reported biases to respond "male" when asked to report a person's sex from an image of their face and to place their age closer to their own. Perceptual expectation effects and cognitive response biases may both contribute to these inaccuracies. The current research used a Bayesian modeling approach to establish the perceptual biases involved when estimating the sex and age of an individual from their face. We demonstrate a perceptual bias for male and older faces evident under conditions of uncertainty. This suggests the well-established male bias is perceptual in origin and may be impervious to cognitive control. In comparison, the own age anchor effect is not operationalized at the perceptual level: The perceptual expectation is for a face of advanced age. Thus, distinct biases in the estimation of age operate at the perceptual and cognitive levels.

Introduction

When we look at a face we have a clear expectation of its basic structure in terms of the constituent elements and their configuration. Expectation also plays a role in the perception of attributes such as sex and age (Armann & Bülthoff, 2012; Voelkle, Ebner, Lindenberger, & Riediger, 2012). There is a bias to respond "male" when asked to report a person's sex from an image of their face (Armann & Bülthoff, 2012; Cellerino, Borghetti, & Sartucci, 2004) that has also been reported in chimpanzees (de Waal & Pokorny, 2008). A similar "male bias" has also been found for body shape (Johnson, Iida, & Tassinary, 2012) and motion (Troje, Sadr, Geyer, & Nakayama, 2006). It has been suggested that, in human history, misclassifying a man as female has generally proved to be potentially more dangerous than misclassifying a woman as male (Armann & Bülthoff, 2012). Whenever judgments are made under uncertainty and the costs of errors are asymmetrical in this way, it has been argued that human decision-making should be biased toward making less costly errors. This bias might increase overall error rates, but it minimizes overall cost (Haselton & Buss, 2000; Haselton & Nettle, 2006).

Bias is also apparent when participants are asked to estimate the age of a person from an image of their face. An own age anchor effect has been reported, whereby the estimated age of a face is closer to the participant's own (Ebbesen & Rienick, 1998; Vestlund, Langeborg, Sörqvist, & Eriksson, 2009). This bias may represent a socially relevant cost reduction strategy (as has been proposed to explain "male bias") or it may reflect social exposure to a greater number of individuals within an age range similar to our own.

In considering the male bias and the own age anchor effect, it has been observed that a distinction can be made between *perceptual* biases in the processing of sensory information and *cognitive* response biases in the criteria used to categorize that information (Armann & Bülthoff, 2012; Webster, Kaping, Mizokami, & Duhamel, 2004). In other words, when we are uncertain about the sex of a face we may actually "see"

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it as more male. Conversely, we may change the way we use the rating scale we usually apply to faces such that we essentially broaden the category of stimuli to which we will apply the label "male." A heuristic bias underlying our judgments about another person's sex and age could in principle be implemented at either (or both) of these levels. Establishing the origin of these biases is an important question because they impact on how we interact with people in a range of consequential settings and because the success of any strategy to overcome a bias will depend on its origin.

Here, we establish the level of processing at which prior expectations are implemented using a model of age and sex estimation formulated within a Bayesian framework. We do this by using the Bayesian framework to establish the form of any perceptual bias acting on our estimate of the age or the sex of a face. In particular, as the Bayesian framework suggests, this bias should become more apparent as uncertainty about the stimulus increases, forcing the participant to "fall back" on their perceptual expectation of the stimulus value. The isolation of the perceptual bias is achieved in two ways: (a) analytically, using data from a traditional rating task, and (b) experimentally, using a forced-choice task.

We use data from a conventional rating task to recover perceptual biases independent of the way in which the rating scale is used. During the rating task participants are asked to rate the strength of a stimulus according to some dimension, i.e., "How old is this face?" While carrying out this task, participants may not consider physically equal increments in the stimulus to be subjectively equal. Under these circumstances it is possible to apply the Bayesian framework to assess specifically how the participant changes their use of the rating scale under conditions of increasing uncertainty. Any bias that increases with increased uncertainty is proposed to constitute the perceptual expectation inherent in the processing of the stimuli.

Additionally, we isolate perceptual biases experimentally by using a forced-choice relative judgment between two stimuli presented simultaneously. The forced-choice task avoids the use of subjective rating criteria by simplifying the judgment to a single comparison (e.g., which is older/ more female) between two physically present stimuli. In this case the perceptual bias is accessed more directly by the experiment because the task itself reduces the influence of any cognitive decision making process on the responses given by the participant.

For both of these tasks we model perception as a process of Bayesian estimation, considering the observer's sensory representation to provide a noisy estimate of the true value of any given stimulus attribute (see Trommershauser, Kording, & Landy, 2011). Crucially, the purely sensory estimate is combined with prior knowledge about the probable value of the attribute so as to produce a more robust estimate. This prior probability distribution embodies not only expectations about the structure of the environment (Girshick, Landy & Simoncelli, 2011; Stocker & Simoncelli, 2006) but also the likely consequences of errors for the observer (Haselton & Buss, 2000; Haselton & Nettle, 2006). As uncertainty about the stimulus value increases (corresponding to an increasingly broad *likelihood function*), the influence of the prior will effectively be to "pull" the resulting percept (taken to be the maximum a posteriori estimate of the attribute value) towards the peak of the prior distribution. We exploit this dependence of the influence of the prior on sensory uncertainty to establish the form of perceptual priors in making sex and age judgments.

The Bayesian framework requires that uncertainty about the stimulus is manipulated. We achieve this in two different ways: (a) by jittering the phase spectrum of the face and (b) by decreasing the presentation duration of the face. The shorter the duration of the face, the less information about the face should be available to the observer. On the other hand, by jittering the phase spectrum of the face this creates a "noise like" alteration of the image itself but leaves the amplitude information contained in the image unaltered. These two different manipulations, carried out separately, are crucial to ensure that either individual manipulation of uncertainty is not affecting perception of the face in ways that are not related to a change in the level of uncertainty.

Previous studies indicate that participants rate faces as more masculine and closer to their own age than the face is in reality. It is unclear, however, whether we should expect to find that these biases are uncovered only in the rating task or in both the rating and the forced-choice task. We predict that any bias operating at the perceptual level will be uncovered via Bayesian analysis when doing either task. Any bias that is apparent in the rating data but not the Bayesian analysis is expected to represent a cognitive bias arising from a criterion based use of the rating scale during the rating task.

Experiment 1a and 1b: Sex judgment tasks

Method

Materials

Stimuli for the sex judgment experiments consisted of morphed images of young adult Caucasian faces varying in strength from male to female, shown on a computer monitor at a viewing distance of approximately 57 cm (Figure 1a). Ten individual male and 10 female identities were created by morphing together eight neutral expression, front facing, Caucasian faces

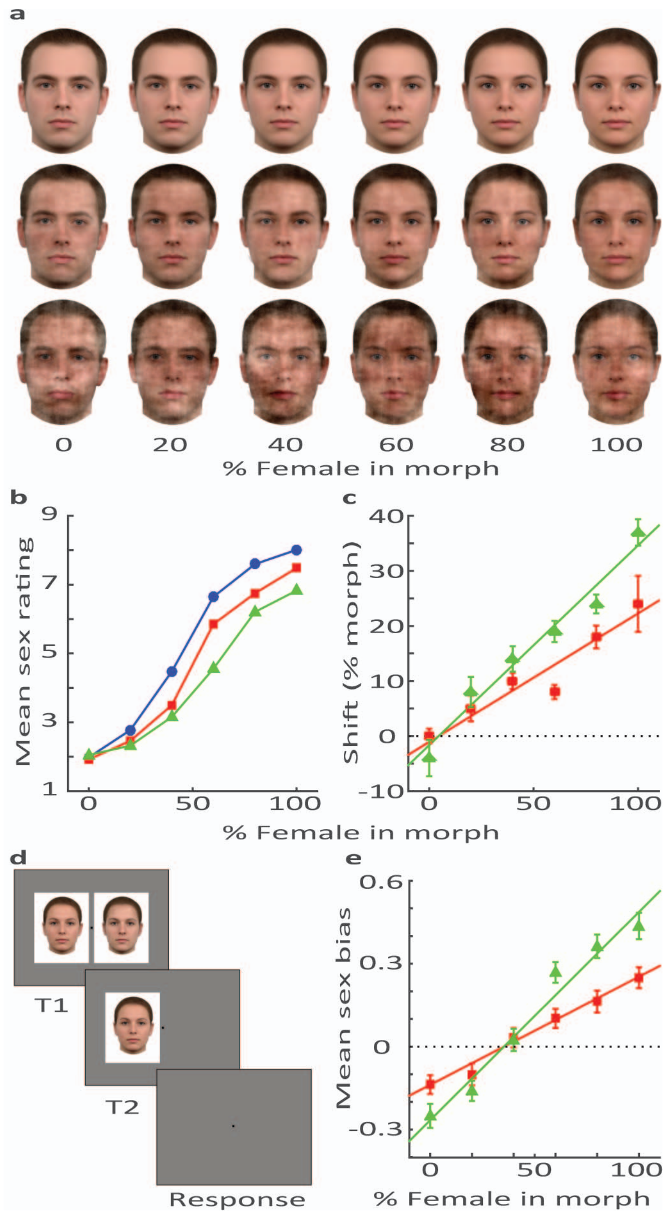

Figure 1. Stimuli, procedure and results of the sex judgment tasks. (a) Example of a male to female morphed continuum (top row). Two levels of uncertainty were created by phase jittering the images: 30° (middle row) and 60° (bottom row). (b) Mean ratings of the femaleness of the faces: unaltered (blue/circles), 30° jitter (red/squares), 60° jitter (green/triangles). (c) Rating data expressed as the shift required to make the unaltered stimulus appear as female as the stimulus at the same physical femaleness but obscured by 30° phase jitter (red/squares), 60° phase jitter (green/triangles). Error bars are bootstrapped standard errors. (d) Illustration of the procedure of the forced choice task. (e) Forced-choice task data expressed as the standardized shift in perception of sex with duration, 500 ms (red/squares) and 250 ms (green/triangles). Error bars are between-subjects standard errors.

of the same sex. These faces were chosen at random from a set of 20 faces per sex taken from the Radboud (Langner et al., 2010) and Utrecht ECVP (Psychological Image Collection at Stirling [PICS], 2014) face databases. Face images were masked by an oval outline to remove shoulders and outer hairline. By averaging eight out of 20 possible faces per sex we were able to create a set of 10 individual faces that were also standardized in terms of sex characteristics. This reduced the possibility that one stimulus face was significantly more masculine or feminine than the rest. Each male face was paired with one female face and these male/female pairs were morphed to create a continuum of faces varying in steps of 20% between the male and the female endpoints. Two tasks were carried out with these stimuli: a rating task and a forced-choice task. For the rating task, these stimuli were also phase jittered (with color information preserved) and shown within the outline of the face to create uncertainty about the sex of the face without changing the basic image statistics. Two levels of phase jittering were applied, 30° and 60°, corresponding to the standard deviation of the jitter introduced within the phase spectrum of the image. The area outside the oval facial region was occluded by a white mask.

Experiment 1a rating task

Participants

Thirty undergraduate psychology students (15 female and 15 male) enrolled at UNSW Australia participated for course credit. All participants had normal or corrected-to-normal vision.

Procedure

Participants were shown an individual face and asked to rate how female or how male it appeared on a scale of one (male) to nine (female). They were not informed about the ratio of sexes presented in the study. Faces subtending approximately 11.5×15.0 degrees of visual angle were each presented for 300 ms and were randomly drawn from the 10 continua at three levels of uncertainty (unaltered, 30° and 60° phase jitter). Each face was shown only once. Participants completed a block consisting of 180 trials (10 individual continua, six levels of femaleness and three levels of noise).

Experiment 1b forced-choice task

Participants

Forty undergraduate psychology students (20 female and 20 male) enrolled at UNSW Australia or the University of Western Sydney participated for course credit. All participants had normal or corrected-to-normal vision.

Procedure

Participants were shown two faces simultaneously and asked to indicate which of the two appeared more male or more female. All participants carried out both the female and the male choice versions of the study in separate blocks and the order of completion of the blocks was counterbalanced such that half the participants completed the female choice task first. Participants were not informed about the ratio of sexes presented in the study. On each trial, two different individuals both at the same morph level were presented side by side. Faces subtended approximately 11.5 × 15.0 degrees of visual angle and were presented with inner edges of the image 0.6° apart.

Uncertainty about the sex of one face was introduced by presenting one of the two faces for either 250 ms (very high uncertainty) or 500 ms (moderately high uncertainty) while the other face was presented for 1000 ms. Both faces onset at the same time, however, one face offset before the other.

For each participant, half of the stimulus identities were randomly assigned to the moderately high uncertainty condition and half to the very high condition. The identities were then paired with each other such that each pair was displayed showing each morph level. Within an identity pair, the identity displayed at the shorter duration was randomly assigned as was its location to the right or left of fixation. The remaining identities were presented under the same conditions with one displayed at the very high uncertainty/ shortest presentation duration. One block consisted of a total of 240 trials (2 uncertainty levels × 6 morph levels × 4 repetitions of each morph level × 5 identities). Participants completed a total of 480 trials across both blocks.

Results

Experiment 1a rating task

Results of the rating task show that participants were equally likely to rate 100% male faces as appearing very strongly male regardless of the level of uncertainty in the stimulus (Figure 1b). Overall, as the percentage of female in the morphed stimulus face increased, the rating of its femaleness also increased. However, the rating of the faces was not uniform across the three uncertainty levels. As the level of uncertainty increased, so the rated femaleness of the face decreased, producing a significant interaction between level of female in the face (morph level) and uncertainty level, $F(10, 280) = 17.98$, $p < 0.0001$, $\eta_p^2 = 0.391$. This pattern of results was the same for both male and female participants as indicated by a lack of interaction between participants' own sex, the morph level and the uncertainty level, $F(10, 280) = 1.14$, $p = 0.332$, $\eta_p^2 = 0.039$.

To estimate the "perceptual shift" induced by manipulation of sensory uncertainty, these data were transformed and expressed in terms of the percentage of the male face required to be added to a morph without phase jitter to produce the rating given to the uncertain face (Figure 1c). This shows that a 100% female face obscured by 60° phase jitter appears equivalent to an unaltered face containing approximately 60% female in the morph.

A Bayesian analysis of these data is presented in the Appendix. It reveals that: (a) the perceptual shift will be zero at the value of the stimulus that corresponds to the peak of the prior; (b) the direction of the shift will depend upon which side of the prior the stimulus lies; (c) the magnitude of the shift will increase monotonically with the level of noise in the representation of the uncertain stimulus; (d) the magnitude of the shift will increase linearly (assuming Gaussian prior and likelihood distributions) with the difference in the stimulus value and the peak of the prior. This description fits the data from the ratings task very well. The raw data are well fit by straight lines with a common x-intercept at 4.6% female with slopes of 0.23 for 30° and 0.36 for 60° jitter, explaining 95.6% of the variance in the data. The data thus provide evidence for a strong and consistent male prior with a peak centered around 4.6% female (95% CI: −8.0% to 16.0% female).

Experiment 1b forced-choice task

The data from the forced-choice task are also consistent with a prior for male faces. Figure 1e presents these data expressed as the standardized shift in perception of sex as the presentation duration of one face decreased. This shift has been calculated as the (inverse Normal transformed) proportion of times the briefer stimulus was chosen as more male. The same observations can be made with these data as for the rating task: The data are well fit by straight lines with slopes of 3.9×10^{-3} (500 ms/ moderately high uncertainty) and 7.5×10^{-3} (250 ms/ very high uncertainty), explaining 97.3% of the variance in the data. In this instance the peak of the prior is situated at 35.35% female (95% CI: 29.4% to 40.5% female).

Summary

Under conditions of uncertainty, participants display a bias to perceive faces as more masculine. This effect holds whether the task is a rating task or a

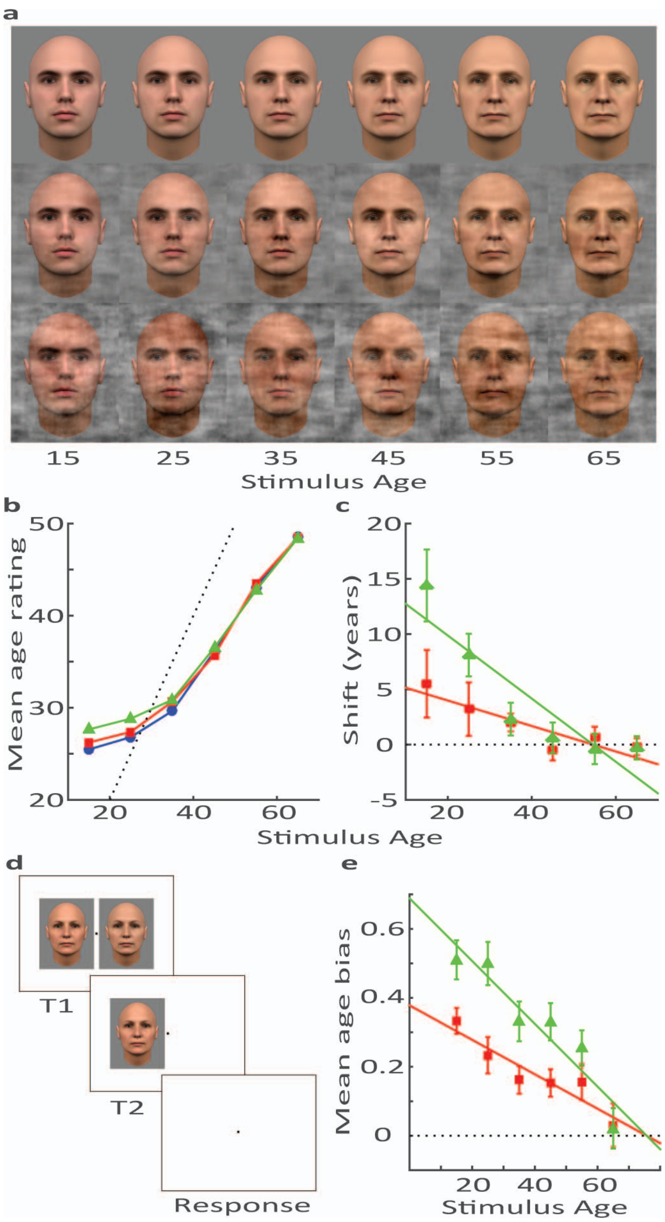

Figure 2. Stimuli, procedure and results of the age judgment tasks. (a) Example of a continuum of faces varying in steps of 10 years between 15 and 65 years of age (top row). Two levels of phase jittering were also applied: 30° (middle row) and 60° (bottom row). (b) Age ratings: unaltered faces (blue/circles), 30° jitter (red/squares), 60° jitter (green/triangles). A veridical rating would lie on the dotted black line. (c) Rating task data expressed as the shift required to make the unaltered stimulus appear as old as the stimulus at the same physical age but obscured by 30° phase jitter (red/squares) or 60° phase jitter (green/triangles). Error bars are bootstrapped standard errors. (d) Illustration of the procedure of the forced choice task. (e) Forced-choice task data expressed as the standardized shift in perception of age with duration, 500 ms (red/squares) and 250 ms (green/triangles). Error bars are between-subjects standard errors.

forced-choice task and when uncertainty is induced by jitttering the phase spectrum of the image or by reducing the duration for which the face is visible. The similarity of the results across methods suggests that the male bias is being demonstrated due to the manipulation of uncertainty per se and despite differences in the task.

Experiment 2a and 2b: Age judgment tasks

Materials

Stimuli for age judgment experiments consisted of synthetic face images produced in Singular Inversions FaceGen Modeller 3.5 (Figure 2a). Ten male faces (100% male) and 10 female faces (100% female) used in the sex judgment experiments served as the input for FaceGen's Photo Fit feature to create individual faces. For each of the 20 individual faces, we rendered images with modeled age from 15 to 65 years in steps of 10 years. The texture and shape defining the modeled age were manipulated concordantly. All images were rendered with frontal orientation and default settings for lighting, and placed on a medium gray background. For the rating task, stimuli were phase jittered in the same manner as the sex judgment stimuli but with the jittered phase noise outside the facial region left visible in the images.

Experiment 2a rating task

Participants

Twenty-seven undergraduate psychology students (14 female and 13 male, mean age = 20.2 years, ranging from 18 to 31) enrolled at UNSW Australia participated for course credit. All participants had normal or corrected-to-normal vision.

Procedure

The task was the same as for the task where participants rated the sex of the face except for the following. Participants were asked to rate the perceived age of the face using a two-digit integer (between 10 and 99). Participants were not informed about the age range of the stimuli. Faces were each presented at a size of approximately 10.5 × 13.0 degrees of visual angle. Participants completed a block consisting of 180 trials (10 individual continua, six levels of ages and three levels of noise).

Experiment 2b forced-choice task

Participants

Twenty undergraduate psychology students (10 female and 10 male, mean age = 20.2 years) enrolled at UNSW Australia participated for course credit. All participants had normal or corrected-to-normal vision.

Procedure

The task was the same as for the forced-choice task judging the sex of the face except for the following. Participants were asked to indicate which of two faces appeared older or younger. All participants carried out both the old and the young choice versions of the study in separate blocks. Participants were not informed about the age range of the stimuli.

The male and female version of each identity was shown in separate blocks. On each trial, two different individuals at the same age level and sex were presented side by side. One block consisted of a total of 240 trials (2 uncertainty levels × 6 age levels × 4 repetitions of each age level × 5 identities). Participants completed a total of 480 trials across both blocks. Faces subtended approximately 11.5 × 15.0 degrees of visual angle and were presented with inner edges of the image 0.5° apart.

Results

Experiment 2a rating task

Similar consistency in the estimation of the prior for age is found between the rating and forced-choice tasks, demonstrating a prior for older faces. Participants' ratings of the age of faces were equivalent across uncertainty levels for stimuli aged 50 and above (Figure 2b). In contrast, at the youngest ages the estimated age increases with uncertainty, as shown by a significant interaction between facial stimulus age and uncertainty level $F(10, 260) = 2.84$, $p = 0.002$, $\eta_p^2 = 0.098$. Also apparent in these data is a tendency to overestimate the age of young faces and underestimate the age of older faces, while the most veridical performance is found at approximately the age of the participants (mean age = 20.2 years, ranging from 18 to 31). This own age anchor effect is considered to reflect a cognitive bias because it is factored out by transforming the data so that it represents the magnitude of the change in rating between phase jittered and unaltered stimuli of the same age (Figure 2c). This transformation allows the "perceptual shift" induced by manipulation of sensory uncertainty to be expressed as the equivalent shift in the unaltered stimulus that would be required to yield the rating found for the uncertain stimulus. This shows that a 15-year-old face obscured by 60° phase jitter appeared equivalent to an approximately 30-year-old unobscured face. The raw data are well fit by straight lines with a common intercept at 54.6 years with slopes of −0.12 for 30° and −0.29 for 60° jitter, explaining 82.9% of the variance in the data. From this we estimate the peak of the prior to be situated at 54.6 years of age (95% CI: 44.2, 59.9).

Experiment 2b forced-choice task

The results of the forced-choice task (Figure 2e) are presented as the standardized shift in perception of age as the presentation duration of one face decreased. This shift has been calculated as the inverse Normal transformed proportion of times the briefer stimulus was chosen as older. These data are well fit by straight lines with slopes of -9.1×10^{-3} (500ms) and -5.0×10^{-3} (250ms), explaining 91.4% of the variance in the data and suggesting a peak in the prior at 75.7years (95% CI: 65.3, 93.3).

Summary

When asked to rate the age of a face participants show an own age anchor effect. The effect can be isolated from a bias to perceive faces as older under conditions of uncertainty. This suggests that two different biases affect our judgments about the age of a face.

Discussion

Here we have successfully demonstrated the existence of perceptual priors for male and older faces using two different tasks. Bayesian analysis of both a rating task and a forced-choice task has demonstrated that under circumstances of increasing uncertainty participants are increasingly likely to perceive a face as male and older.

Despite the rating and forced-choice tasks yielding qualitatively similar estimates of the perceptual prior, they did not yield quantitatively identical estimates. This indicates that perceptual priors may be influenced to some extent by task demands or the precise position of the stimulus within the visual field (foveal for the rating task; mean eccentricity of 5.85° for the forced-choice experiments). Afraz, Pashkam, and Cavanagh (2010) have shown that biased responding to the age and sex of a face can be influenced by the location of the face in the visual field. They found that each participant showed an individual bias profile that was stable across time. Because of the differing location of stimuli between the rating and the forced-choice task, it is possible that the quantitative difference in our results might be due to visual field location effects. Nonetheless, both tasks show a prior for male and older faces.

One interesting aspect of the differences in the estimates of the priors between the two tasks and two manipulations of uncertainty leads us to believe that they are not caused by the task demands or differences between the uncertainty manipulations. When responding about the sex of the face it is the rating task with the phase jitter uncertainty manipulation that produces the more extreme estimate of the bias. Conversely, when responding about the age of the face, it is the forced-choice task with the duration based uncertainty manipulation that produces the most extreme bias estimate. For both of these tasks, if the phase jitter is interpreted as a property of the face, it is more parsimonious that this would lead to the estimate of the bias being more extremely male *and* more extremely old than that produced when manipulating the duration of the face. Additionally, the phase jitter could be expected to make the face look older or more male no matter what the age or sex of the jittered face. Instead the effect of the phase jitter increased as the difference between the original and the measured prior increased (when the face was more female or younger), as predicted by the Bayesian framework. Similarly, if one of the tasks promoted a certain kind of "shifted" responding, the more extreme bias would be the same across pairs of experiments. As this is not the case we propose that the manipulation of uncertainty is not the cause of the difference in the estimates of the priors, however, this is a question that deserves further study.

By using two different tasks, we have also demonstrated that this Bayes inspired method is capable of dissociating perceptual bias from cognitive expectation. In particular, we have demonstrated that a perceptual prior for older faces can be dissociated from the own age anchor effect. This dissociation is apparent in the age rating task. The basic rating task shows the previously described own age anchor effect. Overall, participants rate faces as closer to their own age. With increasing uncertainty, however, there is also a tendency to rate younger faces as appearing older than the same faces presented without uncertainty. This effect is isolated via the Bayesian analysis and shows a perceptual prior for older faces in isolation from the (cognitive) bias for faces the same age as the participants. The ability to establish this dissociation demonstrates the usefulness of this method for understanding the underlying cause of systematic inaccuracies in perceptual decision making. We anticipate this method has the potential to significantly contribute to our understanding of the origin of systematic biases for a wide range of stimulus classes.

Considering the biases in perception within the Bayesian framework, we suggest that they operate at the level of the representation of faces. In particular, it has been proposed that priors may be instantiated via anisotropy in the neural representation of the visual stimulus category under investigation (Clifford, Mareschal, Otsuka, & Watson, 2015; Fischer & Peña, 2011; Ganguli & Simoncelli, 2014). For example, Ganguli and Simoncelli (2014) recently established a model of visual processing that explicitly encodes a prior within a population of sensory neurons. They show that an efficient representation of a stimulus space can be achieved within a population of neurons where more cells with narrower tuning encode higher probability stimuli. This would suggest that the representation of faces in the visual cortex could be biased to represent male and older faces as though they are more prevalent in the environment. This suggestion is consistent with our findings because the same bias was uncovered using two different tasks. In particular the forced-choice task was designed to experimentally minimize the influence of a cognitive bias. These biases could then constitute a true inaccuracy in the experienced percept. The implication of this is that these effects could be impenetrable to cognitive control, suggesting that they would take a high level of vigilance, feedback, and corrective strategies to overcome. This possibility is worth investigating further as it would have practical implications for anyone who needs to accurately estimate the age or sex of a person from an image.

It can be noted that in this study, participants were not informed about the attributes of the faces they would see prior to experiencing the experiments. In addition, the study did not aim to examine the effect of manipulating either the participants' explicit expectation about the faces or the effect of biasing the attributes of the faces presented during the study. These factors would also be worth investigating in further research as they are highly relevant when considering the possible sources of perceptual and cognitive biases and relevant to the practical implications of research into biases.

Interestingly, the perceptual bias to perceive an older male face accords well with the finding that valence and in particular dominance are the most important dimensions uncovered when asking people to make first impression decisions about unfamiliar faces (Oosterhof & Todorov 2008; Vernon, Sutherland, Young, & Hartley, 2014). As older males are arguably the group with greater social power in most societies, both historically and presently in Australia where this study was carried out, the bias we have uncovered could represent a kind of cost minimization strategy. It may be better to "assume" (whether or not the individual has any direct control over this assumption) that an unfamiliar individual is likely to be more dominant until sufficient evidence has been gathered to the contrary. Given the suggestion that the underlying bias we have measured could be the result of an anisotropy in the representation of faces, this suggests that social factors interact with statistical prevalence to shape an individual's representational space for faces. What we are calling "social factors" could conceivably affect the neural representation of faces over the span of a person's life, over an evolutionary timescale or both. What this means is that the socially dominant position of men and older people could lead to the overrepresentation of older and male faces within the visual system and this may be something that is genetically specified or something that is developed through experience. Notably, Wild et al. (2000) have shown children at the ages of 7 to 10 display a strong bias to categorize both children's and adults' faces as male, suggesting that this bias is present from a very young age. To further explore this idea it will be interesting to extend the age range of the faces shown and the age range of participants when measuring the perception of both sex and age. At this point, whether or not social dominance is the true explanation for the biases we have uncovered remains to be seen.

Conclusion

In conclusion, we have demonstrated that under circumstances of increasing uncertainty participants are increasingly likely to perceive a face as male and older. This supports the existence of perceptual priors for male and older faces. This was shown by applying a Bayesian framework to the results of two different experimental tasks each using a different method to induce uncertainty. We predict that this effect is cognitively impenetrable and may be related to the social significance of male and older faces as those in positions of greater dominance in society.

Keywords: face perception, Bayesian modeling, perceptual bias

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