Tinder for orang-utans: comparing sexually selective cognition among Bornean orang-utans (Pongo pygmaeus) and humans (Homo sapiens)

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Chapter 4

Attractiveness modulates attention, but does not enhance gaze cueing

Abstract

Attractiveness is an important aspect of human society. Attractive people enjoy multiple societal privileges and are assigned positive personality traits, and both men and women find attractiveness important when it comes to partner choice. Our universal preference for beauty might be reflected in implicit perception of human faces. In a series of three studies, we use Bayesian methods to investigate whether attractiveness or attractive traits modulate implicit attention and gaze cuing in a large community sample. In Experiment 1, we used a dot-probe task to measure attentional bias toward attractive faces. The results demonstrate that participants reacted faster when the probe appeared behind an attractive face but not when it appeared behind an unattractive face, suggesting that specifically attractive faces captured attention. In Experiment 2, we used a similar method to test whether facial symmetry, an often-mentioned characteristic of attractive faces, modulated attention. However, we found no such effect. In Experiment 3, we used a gaze-cuing task to test whether participants were more likely to follow the gaze of attractive faces, but no such effect was found. To conclude, attractiveness affects our implicit attention toward faces, but this does not seem to extend to gaze cuing.

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Data availability statement

The datasets and materials generated and/or analysed during the current study are available via Dataverse: https://doi.org/10.34894/MLGUDE

Introduction

Beauty is an important aspect of our social environment, as reflected in the high prevalence of attractive people featured on billboards, in magazines, and on TV. The use of expressive and almost perfectly symmetrical faces is meant to attract our attention. This choice is reasonable, given that the preference for attractive faces is widespread, expressed in some aspects of daily life (Langlois et al., 2000) and already present in newborn infants (Damon, Mottier, et al., 2017). Relatively speaking, attractive people enjoy more societal privileges (Little, Jones, et al., 2011), are assigned positive personality traits (Dion et al., 1972; Griffin & Langlois, 2006), and can choose from a greater pool of potential mates (Karraker et al., 2017). In addition, attractiveness might be positively associated with health (Nedelec & Beaver, 2014; Shackelford & Larsen, 1999; but see Cai et al., 2019). Thus, attractiveness serves as an important cue that can bias social decision making. In the current article, we investigate whether attractive and symmetrical faces modulate attention more readily than unattractive and asymmetrical faces, as well as whether attractive faces enhance gaze cuing more strongly than unattractive faces.

Facial attractiveness is especially important in partner choice (Rhodes, 2006; Thornhill & Gangestad, 1999), and this is evident from the fact that attractive faces capture and hold our attention (Lindell & Lindell, 2014). Being able to readily detect an attractive potential mate and interpret their emotions, intentions, and focus of attention might convey evolutionary benefits. Namely, it allows for the selection of suitable partners from the environment (Maner & Ackerman, 2015) and consequently bond with them (Müller et al., 2013). Whether attractive faces attract attention for these reasons or, alternatively, because they stand out and are oddballs in the environment is unclear from previous studies (Ma et al., 2019; Ma, Zhao, et al., 2015). These studies have established that attention is modulated by attractive faces relative to intermediately attractive faces. However, it is possible that unattractive faces might modulate attention in a similar fashion. Therefore, it is necessary to incorporate both attractive and unattractive faces to elucidate how this attentional bias might arise. Moreover, the topic of how attractiveness mediates perception of variant facial cues, such as gaze, has received relatively little attention, even though this has been investigated for other more subtle facial characteristics, such as familiarity (Deaner et al., 2007) and dominance (Jones et al., 2010; Ohlsen et al., 2013).

Given our strong preference for attractive individuals, it is not surprising that beauty modulates attention. Indeed, humans automatically attend to attractive faces of opposite-sex individuals (Lindell & Lindell, 2014). Previous research has shown that this attentional bias is evident in both sustained and implicit attention paradigms. For example, in free-viewing paradigms where two faces are presented at the same time, people attend longer to the more attractive face (Leder et al., 2016). Crucially, sustained attention for attractive faces is still apparent after controlling for low-level features, such as luminance and contrast (Li et al., 2016), suggesting that the actual configuration of the face contributed to the attentional bias and not just low-level differences between attractive and unattractive faces. Furthermore, it has recently been suggested that attractiveness interferes with top-down goals. Specifically, presenting attractive faces reduces performance in a visual search task and target orientation judgment (Nakamura & Kawabata, 2014; Sui & Liu, 2009).

A well-known paradigm by which attentional biases can be measured is the dot-probe task (MacLeod et al., 1986; van Rooijen et al., 2017). In the dot-probe task, participants view two photographic stimuli presented briefly (typically for approx. 300 ms) on the left and right of the display. Next, one of these stimuli is replaced by a probe. Participants are instructed to quickly and accurately indicate the location of the probe. The interpretation of possible results is straightforward: Since participants selectively attend to salient images, participants respond faster when the probe appears at the same location as the attention-grabbing image (i.e., a congruent trial). Thus, we can infer attentional biases from reaction times (RTs) in the dot-probe task. This paradigm has also been used to investigate attentional bias as a function of attractiveness. For example, Maner et al. (2007) used a modified dot-probe paradigm that presented only one picture per trial. Their findings showed that participants disengaged slower from attractive faces than neutral faces, suggesting that attractiveness holds attention. This effect has since been replicated in further studies that employed the original dot-probe paradigm (Ma et al., 2019; Ma, Zhao, et al., 2015): They found that single individuals had trouble disengaging from attractive faces but did not find evidence that attractive faces capture attention. Thus, while both studies found evidence for a disengagement effect of attractiveness, evidence for immediate capture of attention has not been found using the dot-probe paradigm.

However, the previous studies investigating bottom-up effects of attractiveness on attention suffer from three methodological limitations. First, Ma et al. (2015, 2019) paired face stimuli with pictures of objects. Therefore, instead of two faces competing for attention (e.g., attractive and intermediately attractive), there was one face and one household object. Thus, the saliency of the neutral stimuli differed very strongly from the faces they were paired with. Second, Ma and colleagues and Maner et al. (2007) only compared attractive faces with intermediately attractive faces. Given that both attractive and unattractive faces may possess features that distinguish them from an average face (Lin et al., 2020; Said & Todorov, 2011), including the comparison between intermediately attractive and unattractive faces is necessary to conclude that specifically attractive faces modulate attention. Third, Ma and colleagues presented stimuli for 500 ms, which is not an ideal presentation duration to study initial engagement, because individuals can shift attention within this time period (Petrova et al., 2013). As a consequence, it remains unclear whether the attractiveness of a face influences immediate attentional capture.

Apart from a general preference for attractiveness, humans also have an aesthetic preference for symmetry (Bertamini et al., 2019; Che et al., 2018; Little, 2014). Importantly, this preference seems widespread in nature: Bilateral symmetry is associated with increased mating success in multiple animal species (Møller & Thornhill, 1998). In humans, attractive faces tend to be more symmetrical than unattractive faces (Perrett et al., 1999; Rhodes et al., 1999). People perceive them as healthy looking (Jones et al., 2001; Rhodes et al., 2007), and indeed, symmetry has been linked to genetic health and developmental stability, which would explain why a preference for symmetrical partners could be beneficial (Little, Jones, et al., 2011). Because of the saliency of symmetry, Wagemans (1995) suggested that it should be detected rapidly. While it has been shown that women can correctly identify symmetrized versions of a male face in a forced-choice paradigm (Oinonen & Mazmanian, 2007), it has not yet been established whether such symmetrical faces rapidly modulate the attention of viewers. The evolutionary significance of symmetry might translate into an attentional bias toward symmetrical partners. Thus far, no study has directly investigated whether that is indeed the case by comparing modulation of attention by symmetrized, original, and asymmetrized stimuli.

Because humans have such a strong preference for attractive people, they might pick up other variant and invariant facial characteristics more readily in attractive faces. For example, people identify facial expressions more quickly in attractive faces than in unattractive faces (Taylor & Bryant, 2016) and classify attractive faces more rapidly and accurately in a sex classification task (Hoss et al., 2005). In addition, one may want to know what information an attractive person is perceiving from the environment by following their gaze to infer their desires and goals (Baron-Cohen, 2014) and obtain social information about them. These sources of information might increase the likelihood of a successful approach, because the network of collected information can help to create an exchange of shared interests. Alternatively, mimicking the gaze of attractive opposite-sex conspecifics might facilitate becoming the object of attraction, because mimicking can increase bonding (Chartrand & Lakin, 2013; Prochazkova & Kret, 2017). In line with this idea, single people are more likely to mimic attractive others (Birnbaum et al., 2019; Farley, 2014), and couples show more mimicry compared to platonic friends (Maister & Tsakiris, 2016). Thus, copying the gaze direction of an attractive other might enhance bonding. However, it has not been established whether this translates to mimicking the gaze direction of attractive faces. Previous studies have reported that familiarity (Deaner et al., 2007) and facial masculinity (Jones et al., 2010; Ohlsen et al., 2013) enhance gaze cuing. It is not known, however, whether people are following the gaze direction of an attractive other more readily than that of an unattractive other. These previously observed effects of familiarity and facial masculinity might generalize to facial attractiveness of both males and females as well.

Age and sex of the perceivers might modulate biases toward attractiveness. Previous studies on age and attractiveness perception have found that older people are less selective when it comes to rating faces on attractiveness: Overall, they give higher attractiveness ratings than younger people (Ebner et al., 2018; Kiiski et al., 2016). This bias also translates to memory: Younger people show better memory for attractive faces than older people (Lin et al., 2020). These results are in line with the idea that attractiveness is of reduced relevance for older people. In contrast, for younger people, it might be a salient social signal that they, for example, use to identify suitable mates. Similarly, attractiveness might be a more salient signal for men than for women. This is reflected in the fact that men report that they find attractiveness more important when it comes to mate choice than women (Bech-Sørensen & Pollet, 2016; Sprecher et al., 1994) and that men will exert more effort to see attractive opposite-sex faces than women (Hayden et al., 2007). Thus, the bias for attractive faces may differ between age groups and sexes.

In the present study, we investigated attractiveness biases in a large Western community sample of adults with a wide age range. We examined (a) whether people have an attentional bias toward attractive faces and unattractive faces, compared to intermediately attractive faces in a dot-probe task; (b) whether subtle differences in facial symmetry, a trait that has been linked to attractiveness, modulate attention in a dot-probe task; and (3) whether facial attractiveness modulates gaze following a modified Posner cuing task. Unattractive and asymmetrical faces were added as a control as they form another "extreme" category of a face type that is, like very attractive or symmetrical faces, not very common.

In Experiment 1, if participants would selectively attend to more attractive faces, we expected faster RTs on trials in which the probe appeared behind the attractive face (in the attractive vs. intermediate condition) and possibly the intermediate face (in the unattractive vs. intermediate condition). However, if participants would selectively attend to both attractive and unattractive faces because both deviate from the average face, we expected faster RTs on trials in which the probe appeared behind the attractive face (in the attractive vs. intermediate condition) and unattractive face (in the unattractive vs. intermediate condition). We had similar expectations for Experiment 2; if facial symmetry is a salient social signal, we would expect participants to selectively attend to the most symmetrical face in each condition. However, if very symmetrical and asymmetrical faces both attract attention because they deviate from average, we would expect faster RTs on trials where the probe appears behind the symmetrized or asymmetrized stimulus (paired with original picture). Furthermore, in Experiment 3, we expected that people would follow the gaze direction of attractive faces particularly, which would make them respond faster on congruent trials where the probe appeared in the location the attractive face was gazing at. In addition, in all three experiments, we expected the biases to be more pronounced in male participants and in younger participants, since attractiveness is a more salient signal for these groups.

Experiment 1

Method

Participants

Experiment 1 included 150 participants (82 females, mean age = 31.49 years, *SD* = 12.79, ranging from 18 to 74 years old). Participants were visitors at the Apenheul Primate Park (Apeldoorn, the Netherlands). All participants self-reported normal or corrected-to-normal vision and were heterosexual. The experimental procedures were in accordance with the Declaration of Helsinki, and the study was reviewed and approved by the Psychology Ethics Committee of Leiden University (CEP17-0719/254). Participants were not compensated for their participation.

Experimental Design

The experiment held a randomized within-subjects design, where independent variables comprised attractiveness category of the stimuli, participant's age, and sex. The dependent variable was RT (in ms).

Apparatus

The task was performed on a touchscreen (Dell corporation, model S2240Tb, 21.5 in., 1,920 × 1,080 pixels), which was connected to a Dell laptop computer (model OPTIPLEX 990) and ran via E-Prime (Version 2.0; Psychology Software Tools). The touchscreen was located in a public but quiet corner of an indoor visitor enclosure of the park. To minimize potential distractors, we set up the touchscreen on a table adjacent to a wall. Participants sat at a distance of approximately 60 cm from the touchscreen.

Stimuli

Stimuli were selected from the Chicago Face Database (CFD) 2.3 (Ma, Correll, et al., 2015). This face database consists of 597 high-resolution, standardized color photographs of male and female faces of varying ethnicity between the ages of 18 and 65 years. The faces have been validated previously by independent judges on several scales, including on attractiveness (Ma, Correll, et al., 2015). Based on these CFD attractiveness ratings, we selected stimuli depicting 10 attractive, 10 unattractive, and 20 intermediately attractive White individuals.

We tested whether age differed between the stimulus categories, using a Bayesian two-way analysis of variance (Sex × Attractiveness Category), since older faces may be perceived as less attractive than younger faces (Ebner, 2008). We found moderate evidence for the null hypothesis that age did not differ between the sexes (BF_{01} = 4.18 ± .02%) and attractiveness categories (BF_{01} = 3.72 ± .03%). In addition, we found strong evidence for the null hypothesis when testing the interaction between sex and attractiveness category (BF_{01} = 78.95 ± .67%), suggesting that age did not substantially differ across stimulus categories.

Procedure

The experiment involved a dot-probe paradigm (MacLeod et al., 1986; for a review, see van Rooijen et al., 2017). In the task, two stimuli were presented next to each other, each centralized in one half of the screen. All paired images consisted of an attractive or unattractive face and an intermediately attractive face. Location of the stimuli and the probe was balanced between trials. Participants only saw pictures of opposite-sex individuals. In total, participants performed 80 trials presented in random order (excluding five practice trials).[1]

The sole instruction participants received was to tap on a black dot as fast as they could (Figure 1). Every trial started with a dot appearing in the midbottom of the screen until participant response. Subsequently, two stimuli (i.e., an (un) attractive and an intermediately attractive face) were displayed for 300 ms. Next, a dot (probe) appeared in place of either the (un)attractive face or in place of the intermediately attractive face. The probe remained on the screen until participant response. Every trial ended with a 2,000-ms intertrial interval. The RT of the participant from tapping on the probe from stimulus offset was used as a dependent variable in all further analyses.

After the experiment, participants validated all 40 stimuli (presented in a random order) by rating their attractiveness on a 7-point ordinal scale (*very unattractive, fairly unattractive, somewhat unattractive, neutral, somewhat attractive, fairly unattractive, very unattractive*). We used these scores to determine whether the ratings of the participants aligned well with the predetermined attractiveness categories (attractive, intermediate, unattractive).

Statistical Analyses

We first filtered out extremely fast or slow responses. For fast trials, we excluded all trials with RTs < 250 ms. The upper exclusion level was determined per subject. Specifically, we computed the median RT and the median absolute deviation (Leys et al., 2013) per subject. The following conservative filter was applied per subject (upper limit RT = median + 2 * median absolute deviation). The lower and upper filter resulted in exclusion of 4.7% overall. Hereafter, we mean-centered the RTs by subject (i.e., how fast did the participant react relative to their own mean RT).

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1 Due to a coding error, an additional sensitive, touchable area was presented in the middle of the screen on the slide showing the probe. Technically, a participant's RT could be logged if they clicked this additional sensitive area instead of the probe. However, because this sensitive area was transparent and thus invisible to the participants, it is highly unlikely that they tapped within that area instead of tapping the probe. Also, the fact that no participants had an extreme amount of extremely fast or extremely slow responses suggests that they were following the instruction to tap the probe properly.

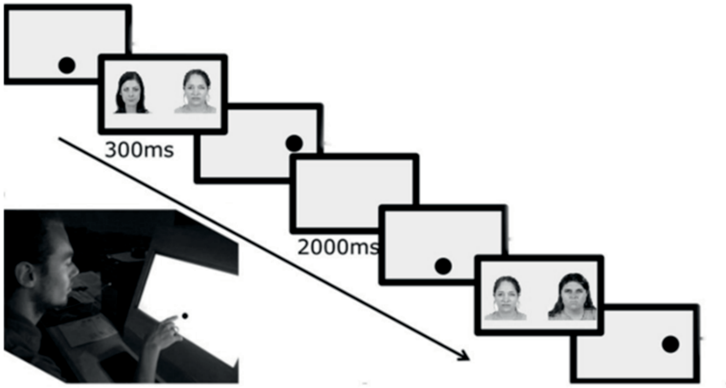

Figure 1. Trial Outline of the Dot-Probe Task. Stimuli from Chicago Face Database (https://chicagofaces.org/default/). Copyright 2015 by University of Chicago, Center for Decision Research. Adapted with permission.

All analyses were done in R statistics Version 4.2 (R Core Team, 2018). We fitted Bayesian mixed models using the brms package (Bürkner, 2017, 2018). Bayesian analyses have gained in popularity over the past few years because they have a number of benefits compared to frequentist analyses (Kruschke et al., 2012; Makowski et al., 2019). While frequentist methods (e.g., *p*-value null-hypothesis testing; see Wagenmakers, 2007) inform us about the credibility of the data given a hypothesis, Bayesian methods inform us about the credibility of our parameter values given the data that we observed. This is reflected in the different interpretation of frequentist and Bayesian confidence intervals: The first is a range of values that contains the estimate in the long run, while the latter tells which parameter values are most credible based on the data (Kruschke et al., 2012; McElreath, 2018). Furthermore, Bayesian methods allow for the inclusion of prior expectations in the model, are less prone to Type I errors, and are more robust in small and noisy samples (Makowski et al., 2019). Altogether, these reasons make Bayesian methods a useful tool for data analysis.

First, we investigated whether the attractiveness ratings of the stimuli given by our subjects matched with the categories that we used. To examine this question, we fitted a Bayesian mixed model with an ordinal dependent variable (attractiveness rating, seven levels) and the interaction between sex and attractiveness category as independent variables. Furthermore, we added random intercepts per subject and stimulus and allowed the effect of attractiveness category to vary by subject by adding random slopes. We used regularizing Gaussian priors with $M = 0$ and

SD = 1 for the fixed effects, default Student *t* priors with 3 degrees of freedom for the thresholds, and default half Student *t* priors with 3 degrees of freedom for the random effects and residual standard deviation.

To test our main hypothesis, we created a model that used by-subject mean-centered RT as the dependent variable and the interaction between condition (attractive vs. intermediate or unattractive vs. intermediate) and probe location (behind intermediate or behind (un)attractive stimulus). Furthermore, to explore the effect of sex and age, we created two more complex models that included the three-way interaction between condition, probe location, and sex and age, respectively. All categorical fixed effects were sum-to-zero coded, and age was *z*-transformed. In all models, we added random intercepts per subject and trial number (to control for order effects) and allowed slopes of the interaction between condition and probe location to vary by subject. We used regularizing Gaussian priors with *M* = 0 and *SD* = 5 for all fixed effects, a Gaussian prior with *M* = 0 and *SD* = 10 for the intercept, and default half Student *t* priors with 3 degrees of freedom for the random effects and residual standard deviation, which were weakly informative.

We used multiple measures to summarize the posterior distributions for each variable: (a) the median estimate and the median absolute deviation of this estimate, (b) the 89% credible interval (CI; McElreath, 2018), and (c) the probability of direction (*pd*). The 89% CI indicates the range within which the effect falls with 89% probability, while the *pd* indicates the proportion of the posterior distribution that is of the median's sign (Makowski et al., 2019). We have chosen an 89% CI instead of the conventional 95% to reduce the likelihood that the CIs are interpreted as strict hypothesis tests (McElreath, 2018). Instead, the main goal of the credible intervals is to communicate the shape of the posterior distribution.

Furthermore, we used leave-one-out cross-validation (PSIS-LOO-CV; Vehtari et al., 2017) to compare the predictive accuracy of the more complex models that include sex and age, respectively, to that of the simpler model. Using PSIS-LOO-CV, we calculated the expected log predictive density (elpdLOO), which quantifies predictive accuracy, for each model. Then, we calculated the difference in elpdLOO (ΔelpdLOO) between the models and the standard error of the difference. If ΔelpdLOO is small (< 4) and the *SE* is large relative to the difference, this suggests that models have similar predictive performance.

All models were run with four chains of 3,000 iterations (500 warmups), resulting in a total posterior sample of 10,000. Furthermore, we checked whether the models converged by inspecting trace plots and histograms, as well as checking the Gelman–Rubin diagnostic (Depaoli & van de Schoot, 2017). For all models, no indication of divergence was found.

Results

Validation of stimuli

The ordinal mixed model showed that subjects gave substantially higher attractiveness ratings to stimuli that were classified as attractive and lower ratings to stimuli that were classified as unattractive (Figure 2). This was the case for both women ($\Delta\text{estimate}_{\text{attractive-intermediate}}$ = 2.11 [.30], 89% CI [1.63, 2.61], pd = 1.00; $\Delta\text{estimate}_{\text{unattractive-intermediate}}$ = −1.45 [.31], 89% CI [−1.94, −.96], pd = 1.00) and men ($\Delta\text{estimate}_{\text{attractive-intermediate}}$ = 3.17 [.59], 89% CI [2.22, 4.11], pd = 1.00; $\Delta\text{estimate}_{\text{unattractive-intermediate}}$ = −1.73 [.32], 89% CI [−2.25, −1.22], pd = 1.00).

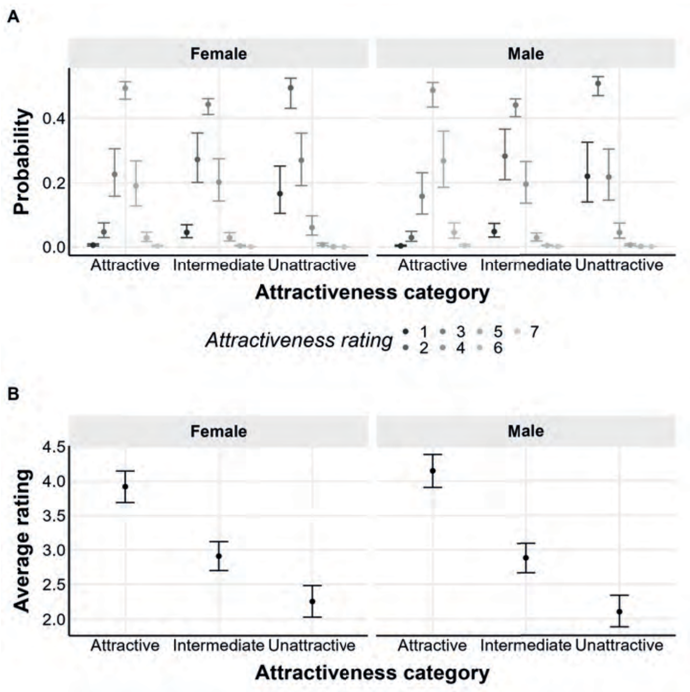

Figure 2. Validation of the Stimuli of Experiment 1. Probability of receiving high attractiveness ratings was higher for stimuli categorized as "attractive" (a). This is also depicted in (b), which treats the ratings as a continuous variable for visualization purposes. See the online article for the color version of this figure.

Simple Model

To test our main prediction that attractiveness would significantly influence RT, we ran a Bayesian mixed model with by-subject mean-centered RT per trial as the dependent variable and the interaction between condition and probe location as independent variables (Table 1; see Appendix G for model stability checks). We found a robust interaction effect of condition and probe location (Figure 3), meaning that people reacted faster on trials in which the probe appeared behind an attractive face than when it appeared behind an intermediate (median difference = 9.23 [2.21], 89% CI [5.67, 12.74], *pd* = 1.00), while an opposite pattern was found when unattractive faces were paired with intermediate faces (median difference = −6.92 [2.33], 89% CI [−3.29, −10.56], *pd* = .99).

Table 1. Model Output for the Simple Model of Experiment 1. Note: all categorical independent variables were sum-to-zero coded.

Parameter	Median estimate	SD	89% CI lower bound	89% CI upper bound
Intercept	0.17	1.54	-2.26	2.73
Probe Location [intermediately attractive]	0.58	0.69	-0.52	1.69
Condition [attractive vs. intermediate]	-1.88	0.71	-3.02	-0.75
Condition [attractive vs. intermediate]: Probe Location [intermediately attractive]	4.03	0.88	2.64	5.45
Random effects				
sd [intercept] Trial order	12.36	1.27	10.50	14.54
sd [intercept] Subject	0.47	0.42	0.05	1.34
sd [by-subject slope] Probe Location [intermediately attractive]	0.96	0.82	0.10	2.62
sd [by-subject slope] Condition [attractive vs. intermediate]	1.81	1.05	0.26	3.59
sd [by-subject slope] Condition [attractive vs. intermediate]: Probe Location [intermediately attractive]	6.58	1.04	4.94	8.25
N_{obs} = 11437				
N_{subj} = 150				

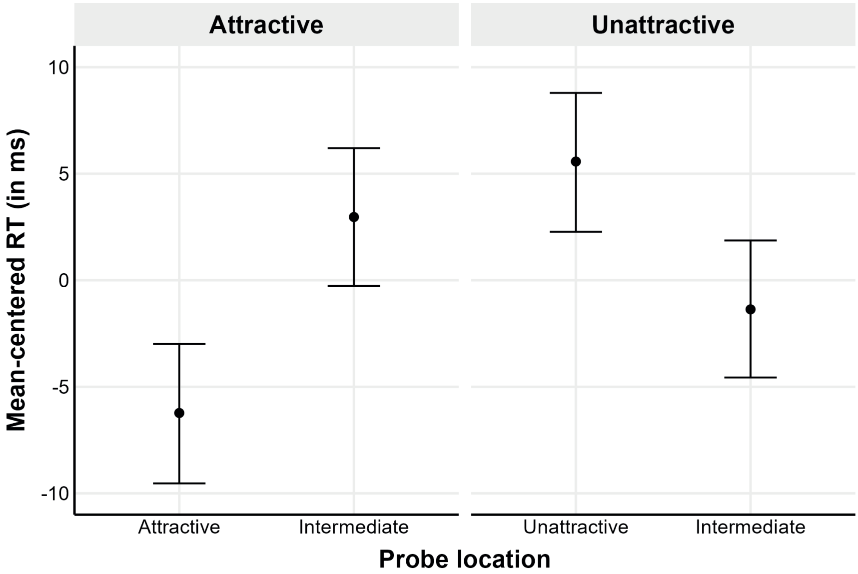

Figure 3. By-Subject Mean-Centered RTs per Condition and Probe Location. Dots indicate the median reaction time (RT), while error bars represent the 89% credible interval. In the attractive conditions, participants reacted faster when the probe appeared behind the attractive face. The opposite pattern was found for unattractive faces. This suggests that specifically attractive faces modulate initial attention.

Age and Sex

We investigated whether adding either age or sex to the model did improve the predictive accuracy relative to the simple model. When comparing the model that included the three-way interaction between age, condition, and probe location to the simple model, we found that the predictive accuracy of the simple model was slightly better ($\Delta elpd_{LOO}$ = 3.5 [.9]). For the model that included the three-way interaction between sex, condition, and probe location, on the other hand, we found that it performed slightly better than the simple model. However, the difference was small and the standard error of the difference was relatively large ($\Delta elpd_{LOO}$ = 3.7 [3.6]). Altogether, this suggests that adding age or sex to the simple model did not substantially increase the predictive accuracy.

Experiment 2

Method

Participants

Experiment 2 included 150 new participants. Participants had normal or corrected-to-normal vision and could participate regardless of their sexual orientation. However, given the small number of nonheterosexual participants (N = 10), they were excluded from further analyses. Therefore, the data set for Experiment 2 included 140 participants (68 females, mean age = 38.66 years, SD = 11.64, ranging from 17 to 67 years old). Participants were visitors at the Apenheul Primate Park (Apeldoorn, the Netherlands). The experimental procedures were in accordance with the Declaration of Helsinki, and the study was reviewed and approved by the Psychology Ethics Committee of Leiden University (CEP19-0612/343). Participants were not compensated for their participation.

Experimental Design

The experiment held a randomized within-subjects design, where the fixed factor comprised the location of the probe (behind symmetrical or asymmetrical face) and the combination (symmetrized vs. original, asymmetrized vs. original, symmetrized vs. asymmetrized). The dependent variable was RT (in ms).

Apparatus

The task was performed on a touchscreen (Iiyama ProLite T1930SR-1, 1,280 × 1,024 pixels), which was connected to a Dell desktop computer (model OPTIPLEX 3020) and ran via E-prime (Version 2.0; Psychology Software Tools). The touchscreen was located in a public but quiet corner of the park. To minimize potential distractors, we set up the touchscreen on a table adjacent to a wall. Participants sat at a distance of approximately 60 cm from the touchscreen.

Stimuli

We selected faces from the Young Adult White Faces Dataset (DeBruine & Jones, 2017). This stimulus set contains manipulated and original portraits of 20 young men and 20 young women with a neutral facial expression. We used the 50% symmetric, 50% asymmetric, and the original portraits of each individual. This allowed us to test whether subtle differences in facial characteristics of the same individual modulated attention.

Procedure

The experiment involved a dot-probe paradigm, similar to Experiment 1. Participants performed 60 trials, consisting of 20 trials of three different combinations (i.e., symmetrical-original, asymmetrical-original, symmetrical-asymmetrical). Within each combination, the probe appeared 10 times behind each category, and the location of the probe was balanced. Participants were only presented with pictures of opposite-sex individuals. The participants' RT to the probe was the dependent variable for our analyses.

Statistical Analyses

We first excluded extremely fast and slow reactions times, following the same method as described for Experiment 1. The lower and upper filter resulted in exclusion of 524 of 9,000 trials (6.24%). We further excluded two subjects because the filtering criterion resulted in more than 25% of their responses being excluded. Therefore, the final data set contained 7,789 trials of 138 participants (67 females).

Our statistical methods were similar to those described for Experiment 1, with a few exceptions. To test our hypothesis, we created a model that used by-subject mean-centered RT as the dependent variable and the interaction between condition (symmetrized vs. original, asymmetrized vs. original, symmetrized vs. asymmetrized) and probe location (behind symmetrical/behind asymmetrical face). Furthermore, in contrast to Experiments 1 and 3, this experiment did not include a stimulus validation.

Results

Simple Model

To test our main prediction that facial symmetry would significantly influence RT, we ran a Bayesian mixed model with by-subject mean-centered RT per trial as the dependent variable and the interaction between condition and Probe Location as independent variables (Table 2; see Appendix G for model stability checks). We found no effect of facial symmetry on RT in any of the three conditions (Figure 4); in each condition, the differences in RT between the probe locations were negligible (asymmetrized vs. original: median difference = −1.01 [3.05], 89% CI [−5.92, 3.82], *pd* = .63; symmetrized vs. original: median difference = .99 [2.91], 89% CI [−3.69, 5.66], *pd* = .64; symmetrized vs. asymmetrized: median difference = 1.67 [2.97], 89% CI [−3.14, 6.32], *pd* = .71).

Table 2. Model Output for the Simple Model of Experiment 2. Note: all categorical independent variables were sum-to-zero coded.

Parameter	Median estimate	SD	89% CI lower bound	89% CI upper bound
Intercept	0.44	2.15	-2.98	3.93
Condition [asymmetrized-original]	0.76	1.20	-1.19	2.67
Condition [symmetrized-original]	-1.67	1.21	-3.62	0.23
Probe Location [most symmetrical]	0.28	0.87	-1.10	1.66
Condition [asymmetrized-original]:Probe Location [most symmetrical]	-0.79	1.21	-2.70	1.17
Condition [symmetrized-original]:Probe Location [most symmetrical]	0.25	1.19	-1.65	2.14
Random effects				
sd [intercept] Trial order	15.51	1.78	12.99	18.63
sd [intercept] Subject	0.59	0.53	0.06	1.67
sd [by-subject slope] Condition [asymmetrized-original]	2.34	1.74	0.22	5.60
sd [by-subject slope] Condition [symmetrized-original]	1.98	1.58	0.21	5.16
sd [by-subject slope] Probe Location [most symmetrical]	1.68	1.28	0.18	4.17
sd [by-subject slope] Condition [asymmetrized-original]:Probe Location [most symmetrical]	2.26	1.75	0.23	5.69
sd [by-subject slope] Condition [symmetrized-original]:Probe Location [most symmetrical]	2.69	1.88	0.27	6.12
N_{obs} = 7789				
N_{subj} = 138				

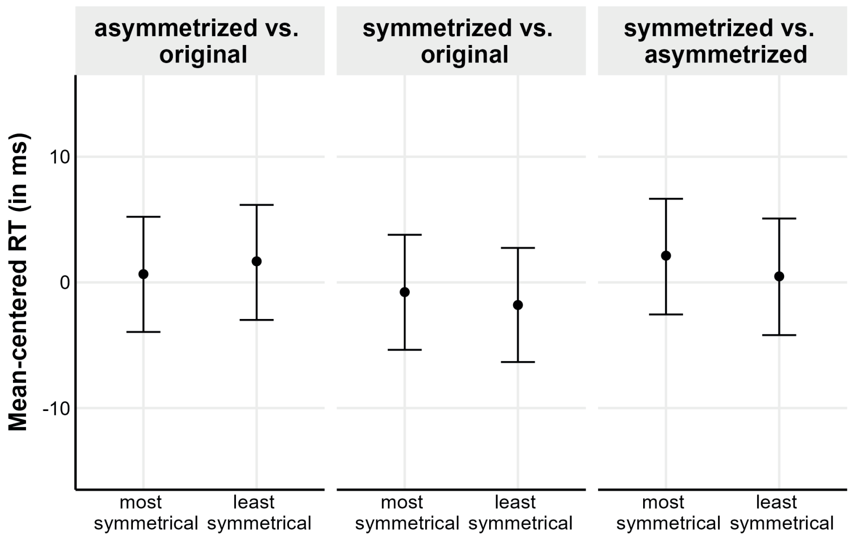

Figure 4. By-Subject Mean-Centered RTs per Condition and per Probe Location. Dots indicate the median reaction time (RT), while error bars represent the 89% credible interval. As can be seen, symmetry did not substantially affect reaction time in any of the three conditions.

4

Age and Sex

We investigated whether adding either age or sex to the model did improve the predictive accuracy relative to the simple model. Both the model including sex ($\Delta elpd_{LOO}$ = 4.4 [1.7]) and the model including age ($\Delta elpd_{LOO}$ = .5 [2.9]) had a slightly lower predictive accuracy than the simple model. Altogether, this suggests that including age or sex did not improve the predictive accuracy of the model.

Experiment 3

Method

Participants

Experiment 3 included 150 new participants (73 females, mean age = 30.98 years, *SD* = 12.65, ranging from 18 to 70 years old). Participants were visitors at the Apenheul Primate Park (Apeldoorn, the Netherlands). All participants self-reported normal or corrected-to-normal vision and were heterosexual. The experimental procedures were in accordance with the Declaration of Helsinki, and the study was reviewed and approved by the Psychology Ethics Committee of Leiden University (CEP18-0531/272). Participants were not compensated for their participation.

Experimental Design

The experiment held a randomized within-subjects design, where independent variables comprised congruence (looking direction congruent with dot or not), attractiveness category of the stimulus (attractive, intermediate, unattractive), age, and sex. The dependent variable was RT (ms).

Stimuli

Faces were selected from the Oslo Face Database (Chelnokova et al., 2014). This database includes 200 faces (100 females) with a neutral expression and with three gaze directions: left, center, and right. All stimuli have been rated for attractiveness. Based on these ratings, we chose 10 attractive, 10 intermediate, and 10 unattractive faces of each sex.

The ages of the people in the photographs were not recorded, so it was not possible to analyze whether age differed between the stimulus categories. However, because the database consists of pictures of students, it is likely that they are in the same age range.

Procedure

The procedure and apparatus for Experiment 3 were similar to Experiment 1. However, we used a modified Posner cuing task (Deaner et al., 2007; Posner, 1980) to test gaze following. Instead of showing two pictures on the side, one front-facing picture was presented in the middle of the screen for 300 ms. Hereafter, the same face was again presented in the middle of the screen but now looking either to the left side or the right side of the screen for 300 ms. After this, the location of the probe would either be congruent (same side as looking direction) or incongruent (opposite side of looking direction (Figure 5). Participants performed 60 trials in total.[2]

As in Experiment 1, participants validated all stimuli (both front-facing and side-facing) after the experiment in a randomized order by rating their attractiveness on a 7-point ordinal scale. Again, we used these scores to determine whether the ratings of the participants aligned well with the predetermined attractiveness categories (attractive, intermediate, unattractive). Subjects rated both the central-looking stimuli and the side-looking stimuli. However, because central and side ratings correlated very strongly (r_s = .82, 89% CI [.82, .83], *pd* = 1.00), we used only the central ratings for further validation.

Statistical Analyses

We first excluded extremely fast and slow reactions times, following the same method as described for Experiment 1. The lower and upper filter resulted in exclusion of 476 of 9,000 trials (5.29%). The highest number of excluded trials per participant was 10.

Our statistical methods were similar to those described for Experiment 1, with a few exceptions. To test our hypothesis, we created a model that used by-subject mean-centered RT as the dependent variable and the interaction between attractiveness category (attractive, intermediate, unattractive stimulus) and gaze congruency (probe location congruent/incongruent with gaze direction). Due to convergence problems, it was not possible to add by-subject random slopes for the interaction to the model; therefore, the random-effect structure consisted of only random intercepts per subject and trial number.

2 Due to a coding error, an additional sensitive, touchable area was presented in the middle of the screen on the slide showing the probe. Technically, a participant's RT could be logged if they clicked this additional sensitive area instead of the probe. However, because this sensitive area was transparent and thus invisible to the participants, it is highly unlikely that they tapped within that area instead of tapping the probe. Also, the fact that no participants had an extreme amount of extremely fast or extremely slow responses suggests that they were following the instruction to tap the probe properly.

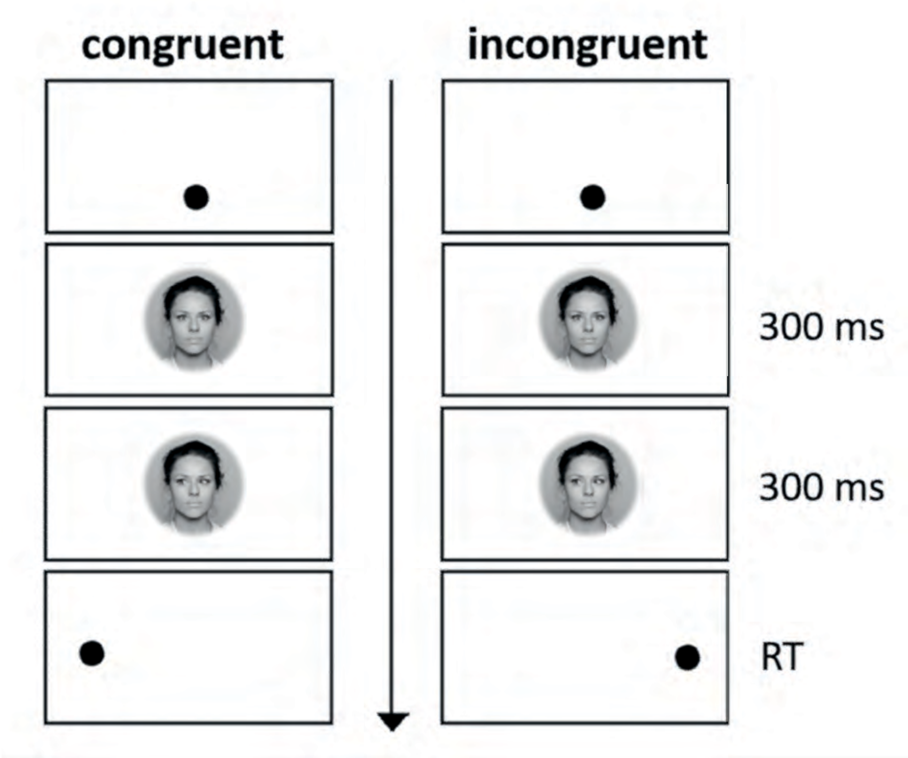

Figure 5. Schematic Outline of a Trial in the Gaze-Cuing Task. Stimuli from Oslo Face Database by Leknes Affective Brain lab (https://sirileknes.com/oslo-facedatabase/). Copyright 2014 by Leknes Affective Brain lab. Adapted with permission. RT = reaction time.

Results

Validation of Stimuli

The ordinal mixed model showed that subjects rated the central-facing stimuli classified as attractive as substantially more attractive and the stimuli classified as unattractive as less attractive (Figure 6). This effect was similar for both women ($\Delta\text{estimate}_{\text{attractive-intermediate}}$ = 1.81 [.34], 89% CI [1.26, 2.38], *pd* = 1.00; $\Delta\text{estimate}_{\text{unattractive-intermediate}}$ = −2.25 [.35], 89% CI [−2.83, −1.68], *pd* = 1.00) and men ($\Delta\text{estimate}_{\text{attractive-intermediate}}$ = 2.01 [.34], 89% CI [1.46, 2.54], *pd* = 1.00; $\Delta\text{estimate}_{\text{unattractive-intermediate}}$ = −2.25 [.35], 89% CI [−2.83, −1.68], *pd* = 1.00).

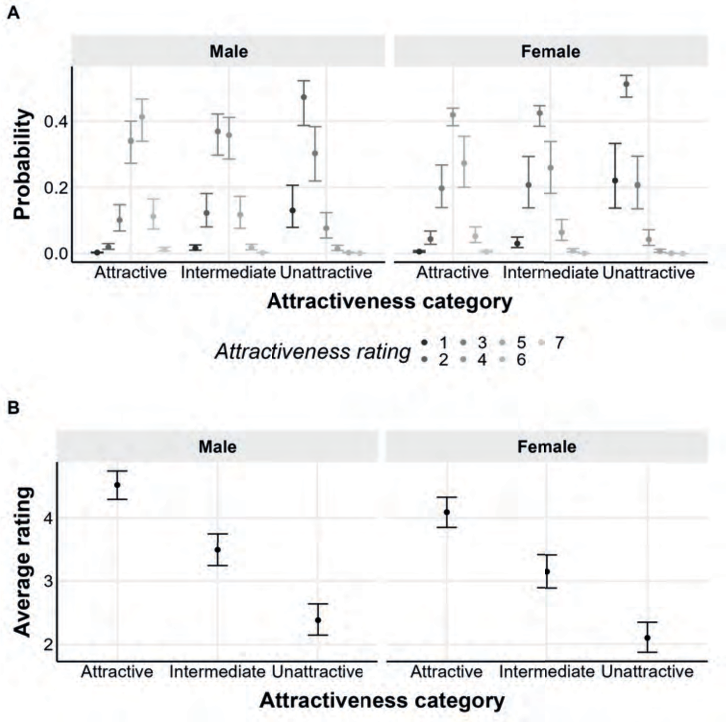

Figure 6. Validation of the Stimuli of Experiment 3. Probability of receiving high attractiveness ratings was higher for stimuli categorized as "attractive" (a). This is also depicted in (b), which treats the ratings as a continuous variable for visualization purposes.

4

Simple Model

To test our main prediction that attractiveness would significantly influence gaze cuing, we ran a Bayesian mixed model with by-subject mean-centered RT per trial as dependent variable and the interaction between attractiveness category and gaze congruency as independent variables (Table 3; see Appendix G for model stability c). We found a robust main effect of gaze congruency on RT (Figure 7), suggesting that people responded faster when the probe appeared on the side that was congruent with the gaze direction of the stimulus (median difference = 32.16 [1.33], 89% CI [30.01, 34.32], *pd* = 1.00).

We found no clear effect of attractiveness category on RT for congruent and incongruent trials. Specifically, on incongruent trials, there was no substantial difference in RT between attractive and intermediate stimuli (median difference = −1.68 [2.33], 89% CI [−5.39, 2.09], *pd* = .76), as well as for unattractive and intermediate stimuli (median difference= 3.22 [2.39], 89% CI [−.52, 6.92], *pd* =

.91). However, people responded slightly faster when the stimulus presented was attractive than unattractive (median difference = 4.84 [2.35], 89% CI [1.13, 8.56], *pd* = .98). Regarding congruent trials, we found no substantial difference in RT between attractive and intermediate (median difference = −.61 [2.26], 89% CI [−4.29, 3.06], *pd* = .60), unattractive and intermediate (median difference = −1.25 [2.38], 89% CI [−5.04, 2.45], *pd* = .70), or attractive and unattractive stimuli (median difference = .67 [2.36], 89% CI [−3.11, 4.37], *pd* = .61).

Table 3. Model Output for the Simple Model of Experiment 3. Note: all categorical independent variables were sum-to-zero coded.

Parameter	Median estimate	SD	89% CI lower bound	89% CI upper bound
Intercept	0.16	1.42	-2.06	2.48
Attractiveness Category [attractive]	-1.09	0.95	-2.58	0.46
Attractiveness Category [intermediate]	0.06	0.95	-1.48	1.57
Gaze Congruency [incongruent]	16.08	0.67	15.00	17.16
Attractiveness Category [attractive]: Gaze Congruency [incongruent]	-1.10	0.95	-2.59	0.44
Attractiveness Category [intermediate]: Gaze Congruency [incongruent]	-0.58	0.95	-2.07	0.96
Random effects				
sd [intercept] Trial order	9.63	1.18	7.90	11.67
sd [intercept] Subject	0.47	0.42	0.05	1.33
N_{obs} = 8425				
N_{subj} = 150				

Age and Sex

We investigated whether adding either age or sex to the model improved the predictive accuracy relative to the simple model. When comparing the model that included the three-way interaction between age, attractiveness category, and gaze congruency to the simple model, we found that the predictive accuracy of the simple model was slightly better ($\Delta elpd_{LOO}$ = 4.6 [1.8]). The results were similar for the model that included the three-way interaction between sex, attractiveness category, and gaze congruency: The simple model performed slightly better than the complex model ($\Delta elpd_{LOO}$ = 3.5 [2.2]). Altogether, these findings suggest that adding age or sex to the simple model did not increase the simple model's predictive accuracy.

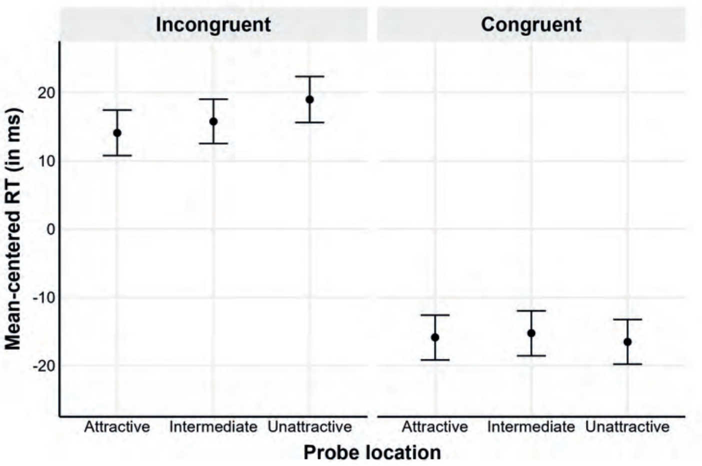

Figure 7. By-Subject Mean-Centered RTs per Condition and per Probe Location. Dots indicate the median reaction times (RT), while error bars represent the 89% credible interval. On both congruent and incongruent trials, we found no evidence for attractiveness resulting in a stronger gaze cuing effect.

4

Discussion

Attractiveness is a salient social signal that not only affects our judgment but also biases our attention and perception of other social information. In the current study, we investigated how facial attractiveness and symmetry modulated attention. Moreover, we investigated whether facial attractiveness modulated gaze cuing. The results show, first, that participants had an attentional bias toward attractive faces but not toward unattractive faces. Second, attention was not differentially modulated by facial symmetry. Third, gaze cuing was not affected by the attractiveness of the face. Fourth, we found no evidence for differences in attractiveness bias between men and women or between younger and older participants. These results will be discussed in more detail in the sections below.

Our first key result, that people had an attentional bias toward attractive faces, is in line with previous research (Ma et al., 2019; Ma, Zhao, et al., 2015; Maner, Gailliot, Rouby, et al., 2007). Using a similar dot-probe task as in the current study, Ma and colleagues showed that Chinese undergraduate students (*n* = 108 females: Y. Ma et al., 2015; *n* = 109 males: Y. Ma et al., 2019) had difficulties disengaging from attractive faces. While they found no overall attentional bias toward attractiveness faces, only participants who were single and primed with romantic words showed this effect. The current study builds on this work and extends it in several ways. First, we not only included the comparison between attractive and intermediately attractive faces but also included the comparison between unattractive and intermediately attractive faces. Consequently, we can conclude that participants selectively attended to attractive but not unattractive faces. This finding suggests that the attentional bias toward attractive faces is not merely the result of attractive faces deviating from the average face, as this is the case for unattractive faces as well. Second, using a large community sample with a wide age range, we were able to show that attractiveness also influences attention in Western people, regardless of their age or gender. Third, we limited the stimulus presentation duration to 300 ms to make it unlikely that participants shifted gaze once their attention had been captured by one of the two presented images (Petrova et al., 2013). Longer presentation durations allow such oculomotor shifts to occur; however, they are not recorded and thus yield noisier data (van Rooijen et al., 2017). Therefore, our results are likely to represent an attentional capture effect, while the previous studies mainly found disengagement effects. Thus, with a few methodological adjustments and a more heterogeneous sample, we were able to show that attention to attractive faces is likely a more general effect than previously assumed.

Our second key result, namely that facial symmetry does not affect implicit attention, was against our expectations. If facial symmetry were an important signal reflecting mate quality, one would expect symmetrical faces to modulate implicit attention. It is important to note that some recent studies have questioned the evolutionary importance of facial symmetry. For example, not all studies show that symmetry correlates with health (Pound et al., 2014), and symmetrical faces are more attractive even after removing symmetry information by showing only half of the face. This indicates that other factors that are correlated with symmetry may cause the high attractiveness ratings for symmetrical faces (Scheib et al., 1999). Furthermore, recent data-driven approaches to facial attractiveness have cast doubt on the importance of symmetry (Holzleitner et al., 2019; Jones & Jaeger, 2019). For example, Jones & Jaeger (2019) recently studied the differential effects of facial characteristics on the perception of attractiveness. They concluded that symmetry of facial shape is not informative when it comes to predicting attractiveness. Instead, they concluded that shape averageness is a more accurate predictor of attractiveness. Therefore, based on this perspective, we suggest that future research might study attentional biases toward averaged versus nonaveraged faces.

Our third key result, that gaze cuing was not modulated by facial attractiveness, was not in line with our prediction. We did find a strong cuing effect, but this effect was seemingly unaffected by attractiveness category of the stimuli, as participants did not respond faster on congruent trials in the Posner paradigm when attractive faces were displayed. Our findings contradict previous literature describing the effect of evolutionarily relevant facial characteristics on gaze cuing (Deaner et al., 2007; Hori et al., 2005; Jones et al., 2010; Ohlsen et al., 2013). Given that attractiveness is such an important criterion for partner choice, it is surprising that gaze cuing was not modulated by facial attractiveness. One likely explanation is methodological: Jones et al. (2010) found a significant effect of facial dominance on gaze cuing when side-looking stimuli were presented for 200 ms but not when they were presented for 400 ms or 800 ms. On the contrary, in our study, we used a presentation duration of 300 ms. Thus, it might be the case that the subtle effect of facial attractiveness on reflexive gaze following manifests itself only at very short presentation durations. Furthermore, the current gaze-cuing paradigm allows for only indirect inference of the isolated effect of attractiveness on gaze cuing. However, this paradigm does not provide any information about how a person would behave in a situation where people varying in attractiveness look in different directions. In this scenario, would the person shift their gaze in congruence with the most attractive person or not? To answer this question, we believe that an approach that combines the dot-probe and gaze-cuing paradigm has its merits. Such a paradigm would help to further elucidate the link between attractiveness and gaze cuing.

One important limitation of our study is the lack of data on motivation of the participants with regard to mate searching. This could possibly explain the null effects that we found in Experiments 2 and 3. Previous work has suggested that motivations might affect implicit cognition in partner choice contexts (Maner & Ackerman, 2015). Consequently, empirical studies have found that attentional biases for attractive faces do not always generalize to all people. For example, attentional biases for attractive faces might only become apparent in people with a short-term mating strategies (Maner, Gailliot, & DeWall, 2007; Maner, Gailliot, Rouby, et al., 2007) or in participants who are not in a romantic relationship (Ma et al., 2019; Ma, Zhao, et al., 2015). It is theoretically possible that people who are motivated to find a partner are more likely to show an implicit attentional bias for symmetrical faces, for example. In line with this idea, sociosexuality predicted explicit preferences for symmetrical male faces in women (Quist et al., 2012). Therefore, we want to emphasize the need for future studies to incorporate relationship status and measures of sociosexuality when investigating implicit cognition. The same applies to context-dependent gaze cuing; while we did not find evidence that attractive opposite-sex faces enhance gaze cuing, this does not rule out such an effect in other mate choice contexts. For example, people might follow the gaze of attractive same-sex conspecifics in a mate choice context to identify which opposite-sex individuals they attend to. Such explicit mate choice copying has been described for both men and women (Place et al., 2010; Waynforth, 2007), but future work could establish whether this generalizes to implicit gaze cuing. Thus, incorporating individual motivations and exploring different mate choice contexts might help to further elucidate the effect of attractiveness on implicit cognition.

Importantly, we found no effect of sex on bias toward attractiveness in either of the experiments. Our findings are in line with what (Maner et al., 2003) call the *opposite-sexed beauty captures the mind* hypothesis and contrast with the *one-sided gender bias* hypothesis. Thus, both men and women in our study seemed to selectively focus on attractive opposite-sex faces. Similarly, we found no effect of age group on attractiveness bias: Participants of both reproductive and postreproductive age had a similar bias toward attractive faces. Taken together, these results suggest that the effect of attractiveness on social cognition generalizes over sex and age. However, studies using a clear mate search context are necessary to confirm these findings.

In conclusion, our findings corroborate previous research on attractiveness bias by showing an implicit attentional bias toward attractive faces, likely reflecting an attention capture effect, in a Western sample with a wide age range. Thereby, our results demonstrate how facial attractiveness, a characteristic that is highly relevant from an evolutionary perspective, affects implicit social cognition. However, we did not find an effect of attractiveness on gaze cuing. Nevertheless, we believe that incorporating individual motivations and applying more ecologically valid paradigms can help to further elucidate the link between attractiveness and gaze cuing.