How do we form romantic bonds?

Investigating the effect of attraction on social cognition

Iliana Samara

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Colofon

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Contents

Chapter 1

A general introduction to emotions as motivational states, their perception, and their influence on subsequent action

Attraction as a motivational state

Imagine a day with no emotions. Not feeling happy upon seeing your partner, excited when your favourite team wins or disappointed when you miss the train. Some would consider this a relief, whereas others a horrific scenario. But despite their initial reaction, all would eventually realize that emotions help us make sense of the world around us. Emotions guide us. Our emotional responses inform us about what we should attend to, whether our decisions align with our goals, and prepare our action response plan (Frijda, 1986). The influential somatic marker hypothesis (Damasio, 1994, 1996), also illustrates that emotions, reflected in physiological changes, act as markers that ultimately influence decision-making. Therefore, emotions are crucial in navigating our social environment.

Emotion and motivation go hand in hand (Both, Everaerd, & Laan, 2003). Indeed, humans want to act upon seeing stimuli associated with reward or threat (Schultz, 1998). Typically, stimuli associated with reward trigger an approach behaviour, whereas stimuli associated with a threat, an avoidance behaviour (e.g., Lazarus, 1991). One of the emotional states associated with reward is sexual arousal. For example, a common reaction upon seeing someone we are attracted to is that we might direct our attention towards them and try to be as physically close to them as possible. In other words, experiencing attraction leads us to increase our proximity to another (Montoya, Kershaw, & Prosser, 2018).

In the sections below, I outline how attraction influences attention, social perception, physiological and behavioral mimicry, and bond formation.

Attention toward mate-relevant information

Attention is necessary for navigating our environment. Attention acts as a gatekeeper, ensuring that crucial information receives further processing, while simultaneously filtering out distracting information (e.g., Posner, 1980; Yantis & Jonides, 1990). Attraction also influences attention. Recent studies have also shown that attractive stimuli capture attention, and the level of capture is also associated with trait levels of sexual desire (Prause, Janssen, & Hetrick, 2008).

Attractiveness (i.e., attractive targets presented as stimuli) modulates our attention (Sui & Liu, 2009). This is not surprising, given that visual attractiveness influences our partner choice (Asendorpf, Penke, & Back, 2011; Sidari et al., 2021; Roth, Samara, & Kret, 2021a), a decision that can heavily impact our well-being (Soons, Liefbroer, & Kalmijn, 2009). Like other animals, humans orient their attention to attractive individuals (Grammer, Fink, Møller, & Thornhill, 2003). Previous research has consistently shown that attention is captured and held by attractive faces (Lindell & Lindell, 2014; Maner et al., 2003; Maner, Gailliot, & DeWall, 2007). In Chapter 2, I investigate whether attractive faces modulate attention and gaze cuing. Crucially, since previous research has taken place in a typical laboratory setting divorced from real-life dating decisions, in Chapter 3, I investigate whether attractiveness modulates attention using eye tracking methods in a speed-dating setting. Speed dates are convenient for examining the characteristics defining a successful interaction from its start in an ecologically valid manner (Finkel & Eastwick, 2008; Eastwick & Finkel, 2008b).

Our emotional state modulates social perception

Emotions are, in essence, a tendency to act (Frijda, 1986; Lang, 1994). They inform us about whether a specific goal has been attained and prepare an action response plan fitting to the situation. For example, in one study (Both et al., 2003) participants viewed a sexually arousing vs. a fear-inducing film (Laan, Everaerd, & Evers, 1995; van der Velde, Laan, & Everaerd, 2001) while their t-tendon reflex, reflecting a tendency to act (Bonnet, Decety, Jeannerod, & Requin, 1997), was measured. The results showed that the t-tendon reflex was activated in the highly arousing films (i.e., the sexually arousing, anxiety, and fear-inducing films) compared to the neutral films. This finding suggests that participants were more likely to act when sexually aroused and likely to approach the appetitive stimulus. In other words, sexual arousal prepares humans for approach behavior.

Our emotional states influence not only our behavior but also our perception. Does our emotional state influence how we perceive the emotional states of others? Maner et al.'s (2005) influential study has suggested precisely that. In that study, participants watched a romantic, scary, or neutral video clip and then viewed a series of faces and indicated whether the target faces were feeling happy, sexually aroused, angry, or frightened. In fact, the target faces were neutral. The results demonstrated that participants projected their own emotional state onto the target faces. Men were more likely to indicate that a target face of an attractive female was sexually aroused after watching the romantic video clip, and participants in general that the target face of a black male was angrier. Thus, previous evidence suggests that people tend to project their own emotional state to others. However, it should be noted that in Maner et al. (2005) the stimuli used i.e., a film depicting an attractive white woman, combined with the finding that men were more likely to indicate that only high-attractive white women and not black women (independent of attractiveness level) were sexually aroused, might indicate that this result is not due to projection, but a recency effect. In other words, men responded based on the most recent example they had in mind, instead of projecting their own emotional state onto the target faces. Furthermore, it is unclear how the stimuli used in that study were standardized and validated. Therefore, the reported results could be due to an artefact, as for example facial redness has been shown to increase perceptions of aggression and attractiveness in men (Stephen, Oldham, Perrett, & Barton, 2012). Thus, in Chapter 4, I conceptually replicate the methods of Maner et al. (2005) to examine the effect of emotional states on social perception.

The finding about men being more likely to perceive arousal and interest in women while being themselves aroused is well-known. This finding is called the sexual overperception bias (Abbey, 1982) and has been replicated consistently for the past fifty years (e.g., see La France, Henningsen, Oates, & Shaw, 2009). The effect is supposed to be because men incur fewer costs associated with selecting the wrong mate; on the contrary, men would incur damages if they were to miss a mating opportunity, as outlined by the Error Management Theory (EMT, Haselton, 2003; Haselton & Buss, 2000). Thus, it is more likely that men exhibit a higher percentage of false positives in terms of detecting attraction in others compared to women, who tend to be more cautious when selecting a romantic partner (Trivers, 1972).

Previous research has examined the underlying mechanism of the sexual overperception bias (e.g., Howell, Etchells, & Penton-Voak, 2012; Perilloux, Easton, & Buss, 2012). One of the main mechanisms suggested is trait sexual desire levels, self-rated attractiveness, and projecting one's own emotional state onto others (A. J. Lee, Sidari, Murphy, Sherlock, & Zietsch, 2020). In fact, it was argued that projection can fully explain gender differences and thus, accounts for the sexual overperception bias. In Chapter 7, I argue against this explanation. Furthermore, in Chapter 5, I examined this hypothesis in a speed-dating paradigm (Samara, Roth, & Kret, 2021).

If our own interest in others influences how we perceive their intentions (Samara et al., 2021; Prochazkova, Sjak-Shie, Behrens, Lindh, & Kret, 2022), then it would follow that when we are not interested in another, we would be able to accurately infer their interest. Indeed, previous research has found exactly this effect (Place, Todd, Penke, & Asendorpf, 2009; Place, Todd, Zhuang, Penke, & Asendorpf, 2012). In a computerized task, participants watched excerpts from speed-dating videos and indicated whether the daters were attracted to their partners. Indeed, participants were accurate significantly more than chance level. The authors argued that being able to accurately infer the interest of others facilitates creating a map of interpersonal connections in our immediate social environment (Simao & Todd, 2002), which might facilitate future partner selection (Penke & Asendorpf, 2008; Penke & Denissen, 2008). In Chapter 6, I examine whether third-party observers are able to detect attraction in strangers on a brief blind date.

Inter-individual coordination and bond formation

Feeling attracted to another person prompts us to approach them, and eventually likely attempt to form a romantic bond (Montoya et al., 2018). One important aspect of forming romantic bonds is inter-individual coordination (IIC), an umbrella term that includes mimicry, physiological synchrony, and coordination (Mayo & Gordon, 2020). During human courtship, we can record multiple behavioural patterns, so much so that such displays have been termed "the human courtship dance" (Birdwhistell, 1970). Crucially, it is well-documented that such IIC facilitates the formation of social bonds (Lakin, Jefferis, Cheng, & Chartrand, 2003; Mogan, Fischer, & Bulbulia, 2017; Hess & Fischer, 2014; Prochazkova et al., 2022).

Previous researchers have posited the "pair-bonding hypothesis", which assumes that the strength of a given couple is crucial for bond maintenance, and successful offspring rearing (Rasmussen, 1981). In simple terms, couples with a greater IIC are more likely to form a bond, remain together, and be better at child-rearing. As mentioned above, this is not a new hypothesis; however, the mechanism underlying this has not been well defined. In a recent paper, we argued that IIC underlies and supports the formation of interpersonal bonds (Roth, Samara, Tan, Prochazkova, & Kret, 2021).

A recent study (Prochazkova et al., 2022) examined the factors underlying attraction in a blind date setting, specifically physiological synchrony and behavioural mimicry. Participants were coupled to members of the opposite sex and went on a 4-minute speed date while their physiological responses and their eye movements (using eyetracking glasses) were recorded. The authors found that overt signals such as smiles, nods, and laughter and their mimicry did not predict attraction. However, attraction was predicted by physiological synchrony, the coupling of electrodermal and heart rate responses between individuals. The finding that mimicry of facial expressions was not associated with attraction contradicts previous research showing that mimicry of facial expressions facilitates liking and social bonding (Chartrand & Bargh, 1999; Cheng & Chartrand, 2003; Lakin et al., 2003) and couples are more likely to mimic their partner's facial expressions than friends' (Maister & Tsakiris, 2016; Kret & Akyüz, 2022, for a different interpretation). The discrepancy between the findings of Prochazkova et al. (2022) and previous research could be due to methodological differences, specifically regarding the coding schemes used. Specifically, the authors examined mimicking a more general type of affect (positive vs. non-positive), and specific emotional expressions were not coded. For example, all types of smiles (polite, genuine, or coy smile) were coded as simply a "smile". A more detailed look at specific emotional expressions might reveal more subtle differences in how these specific expressions (such as polite vs. genuine smiles) might communicate attraction and facilitate bonding. This is especially relevant in light of the fact that during a speed-date interaction, people display more coy smiles but not other types of smiles when attracted to each other than when they are not attracted to each other (Samara, Roth, Nikolic, Prochazkova, & Kret, 2022; Givens, 1978; Guerrero & Wiedmaier, 2013). In Chapter 8, I review the role of mimicry and physiological synchrony in bond formation in both human and nonhuman primates. In Chapter 9, I examine whether the mimicry of specific emotional facial expressions facilitates bond formation in a speed-dating paradigm.

Chapter Overview

The present dissertation consists of six empirical research articles and two theoretical papers focusing on the effect of sexual arousal on social perception and decision-making. Specifically, in **Chapter 2**, I examine the modulation of attention and gaze cuing by attractive faces and in **Chapter 3**, I investigate this further in a real-life setting using eyetracking. In **Chapter 4**, I conceptually replicate previous work by Maner et al. (2005) and examine whether high motivational states influence social perception in a "functional" way. Specifically, I examine whether fear increases the likelihood of perceiving others as angrier and whether men are more likely to perceive women as sexually aroused after viewing sexually arousing stimuli. In **Chapter 5**, I investigate whether people are more likely to correctly perceive attraction in a potential partner as a function of their interest in their partner, their trait sexual desire, and their self-rated attractiveness using a speed-dating paradigm. In **Chapter 6**, I examine whether third-party observers are able to detect attraction in people on a speed date. In **Chapter 7**, I discuss a proposed mechanism underlying the sexual overperception bias. In **Chapter 8**, I review the role of mimicry and physiological synchrony in bond formation. In **Chapter 9**, building on the previous chapter, I examine whether mimicking specific emotional expressions facilitates bond formation in a speed-dating paradigm.

I would like to note that I am a co-author for the work described in Chapter 2 (third author), and Chapter 7 (second author), which are authored by my colleague Tom S. Roth. I wish to include these chapters to provide a clear overview of the effect of motivational states on cognitive processing. With the permission of Tom S. Roth, the manuscripts of Chapters 2 and 7 are included in this dissertation.

Part I

Attraction modulates attention

Chapter 2

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 cueing in a large community sample. In Experiment 1, we used a dot-probe task to measure attentional bias towards 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 cueing.

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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 television. 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 new born infants (Damon, Mottier, Méary, & Pascalis, 2017). Relatively speaking, attractive people enjoy more societal privileges (A. C. Little, Jones, & DeBruine, 2011), are assigned positive personality traits (Dion, Berscheid, & Walster, 1972; Griffin & Langlois, 2006), and can choose from a greater pool of potential mates (Karraker, Sicinski, & Moynihan, 2017). In addition, attractiveness might be positively associated with health (Nedelec & Beaver, 2014; Shackelford & Larsen, 1999; 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 cueing 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, Van Leeuwen, Van Baaren, Bekkering, & Dijksterhuis, 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 (Y. Ma, Zhao, Tu, & Zheng, 2015; Y. Ma, Xue, & Tu, 2019)). 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, Shepherd, & Platt, 2007) and dominance (B. C. Jones et al., 2010; Ohlsen, van Zoest, & van Vugt, 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, Mitrovic, & Goller, 2016). Crucially, sustained attention for attractive faces is still apparent after controlling for low-level features, such as luminance and contrast (J. Li, Oksama, & Hyönä, 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 judgement (Nakamura & Kawabata, 2014; Sui & Liu, 2009).

A well-known paradigm by which attentional biases can be measured is the dot-probe task (van Rooijen, Ploeger, & Kret, 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 (Maner, Gailliot, & DeWall, 2007). This effect has since been replicated in further studies that employed the original dot-probe paradigm (Y. Ma et al., 2015, 2019): 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 et al. (2015, 2019) 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, Fischer, Johnson, & Ebner, 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 et al. 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, Wentura, & Bermeitinger, 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, Rampone, Makin, & Jessop, 2019; Che, Sun, Gallardo, & Nadal, 2018; A. 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, Sumich, & Byatt, 1999). People perceive them as healthy looking (B. 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 (A. C. Little 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 towards symmetrical partners. Thus far, no study 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, Ramsey, Griffin, & Langlois, 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 (Lakin & Chartrand, 2003; Prochazkova & Kret, 2017). In line with this idea, single people are more likely to mimic attractive others (Farley, 2014; Birnbaum, Mizrahi, & Reis, 2019), 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 (B. C. Jones et al., 2010; Ohlsen et al., 2013) enhance gaze cueing. 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 towards 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, Cullen, Clavin, & Newell, 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, Sullivan, & Hatfield, 1994), and that men will take 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 towards 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, modulates attention in a dot-probe task, and (c) whether facial attractiveness modulates gaze following in a modified Posner cuing task. Unattractive and asymmetrical faces are 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 to 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 old, *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 inches, resolution: 1920 × 1080 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 (D. S. Ma, Correll, & Wittenbrink, 2015). This face database consists of 597 high-resolution, standardized colour photographs of male and female faces of varying ethnicity between the ages of 18 and 65 years old. The faces have been validated previously by independent judges on several scales, including on attractiveness (D. S. Ma 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 2-way analysis of variance (ANOVA; 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 ($BF_{01} = 4.18 \pm 0.02\%$) and attractiveness categories ($BF_{01} = 3.72 \pm 0.03\%$). In addition, we found strong evidence for the null hypothesis when testing the interaction between sex and attractiveness category ($BF_{01} = 78.95 \pm 0.67\%$); suggesting that age did not substantially differ across stimulus categories.

Procedure

The experiment involved a dot-probe paradigm (for a review, see van Rooijen et al., 2017)[1]. 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 5 practice trials).

The sole instruction participants received was to tap on a black dot as fast as they could (see Figure 1). Every trial started with a dot appearing in the mid-bottom of the screen until participant response. Subsequently, two stimuli (i.e., an (un)attractive and an intermediately attractive face) were displayed for 300ms. 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 2000ms inter-trial interval (ITI). The reaction time (RT) of the participant from tapping on the probe from stimulus offset was used as

[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.

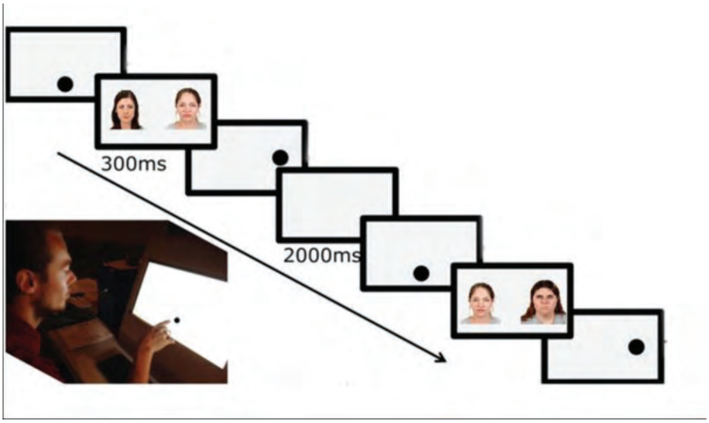

Figure 1. Trial outline of the dot-probe task. Stimuli from the Chicago Face Database (D. S. Ma et al., 2015). Copyright 2015 by University of Chicago, Center for Decision Research. Adapted with permission.

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 pre-determined 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 < 250ms. The upper exclusion level was determined per subject. Specifically, we computed the median RT and the median absolute deviation (MAD; Leys, Ley, Klein, Bernard, & Licata, 2013) per subject. The following conservative filter was applied per subject (upper limit RT $=$ Median $+ 2 \times$ MAD). The lower and upper filter resulted in exclusion of 4.7% overall. Hereafter, we mean-centered the reaction times by subject (i.e., how fast did the participant react relative to their own mean RT).

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 popularity over the last few years, because they have a number of benefits compared to frequentists analyses (Kruschke, Aguinis, & Joo, 2012; Makowski, Ben-Shachar, Chen, & Lüdecke, 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, 7 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's t priors with 3 degrees of freedom for the thresholds, and default half Student's 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 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's 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: (1) the median estimate and the median absolute deviation of this estimate, (2) the 89% credible interval (89% CI; McElreath, 2018), and (3) 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, Gelman, & Gabry, 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 ($\mathrm{elpd}_{\mathrm{LOO}}$), which quantifies predictive accuracy, for each model. Then, we calculated the difference in $\mathrm{elpd}_{\mathrm{LOO}}$ ($\Delta\mathrm{elpd}_{\mathrm{LOO}}$) between the models and the standard error of the difference. If $\Delta\mathrm{elpd}_{\mathrm{LOO}}$ 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 4 chains of 3000 iterations (500 warmups), resulting in a total posterior sample of 10,000. Furthermore, we checked whether the models converged by inspecting trace plots, histograms and 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 (see Figure 2). This was the case for both women ($\Delta\mathrm{estimate}_{\text{attractive-intermediate}} = 2.11$ [0.30], 89% CI [1.63, 2.61], $pd = 1.00$; $\Delta\mathrm{estimate}_{\text{unattractive-intermediate}} = -1.45$ [0.31], 89% CI [-1.94, -0.96], $pd = 1.00$) and men ($\Delta\mathrm{estimate}_{\text{attractive-intermediate}} = 3.17$ [0.59], 89% CI [2.22, 4.11], $pd = 1.00$; $\Delta\mathrm{estimate}_{\text{unattractive-intermediate}} = -1.73$ [0.32], 89% CI [-2.25, -1.22], $pd = 1.00$).

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 (see Table 1). We found a robust interaction effect of Condition and Probe Location (see 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], $pd = .99$).

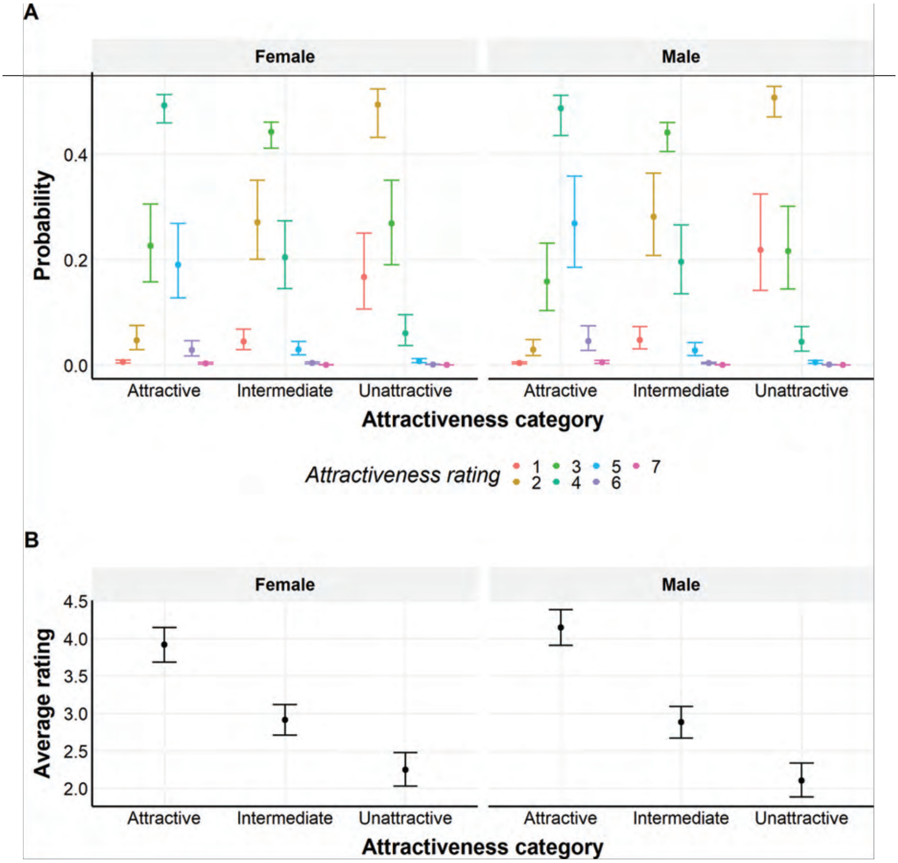

Figure 2. Validation of the stimuli of Experiment 1. Probability of receiving high attractiveness ratings was higher for stimuli categorized as "attractive" (A). This is also depicted in (B), which treats the ratings as a continuous variable for visualization purposes.

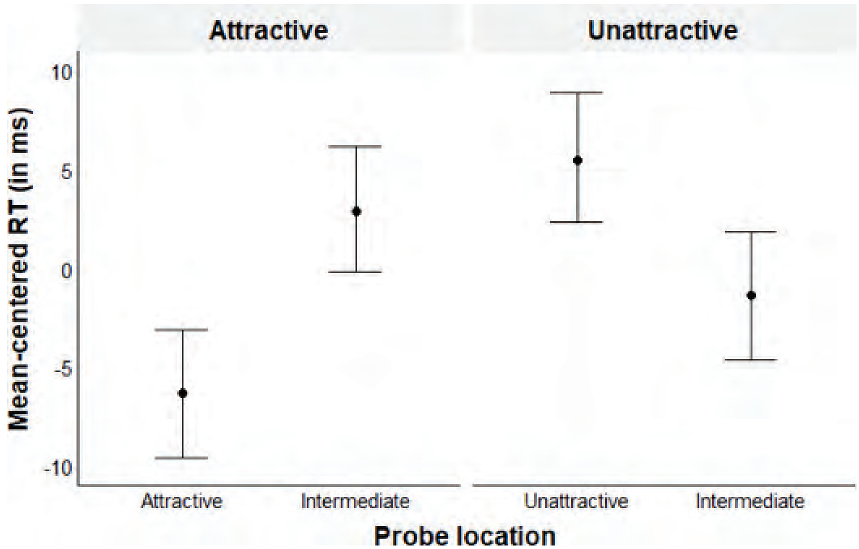

Figure 3. By-subject mean-centered RTs per Condition and Probe Lo-cation. Dots indicate the median reaction times (RT), while error bars represent the 89% Credible Interval. In the attractive conditions, partici-pants reacted faster when the probe appeared behind the attractive face. The opposite pattern 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 3-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 ($\Delta elpd_{LOO} = 3.5$ [0.9]). For the model that included the 3-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.

Table 1. Model output for the simple model of Experiment 1.

Parameter	Median estimate	*SD*	89% CI
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 [unattractive 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
$N_{\text{obs}} = 11437$			
$N_{\text{subj}} = 150$			

Note: All categorical independent variables were sum-to-zero coded.

Experiment 2

Methods

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 non-heterosexual participants ($N = 10$), they were excluded from further analyses. Therefore, the dataset for Experiment 2 included 140 participants (68 females, mean age = 38.66 years old, $SD = 11.64$, 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, 1280 $\times$ 1024 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 3 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 9000 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 dataset contained 7789 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 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 Experiment 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 dependent variable, and the interaction between Condition and Probe Location as independent variables (see Table 2). We found no effect of facial symmetry on reaction time in any of the three conditions (see 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 = 0.99 [2.91], 89% CI [-3.66, 5.66], pd = .64; symmetrized vs. asymmetrized: median difference = 1.67 [2.97], 89% CI [-3.14, 6.32], pd = .71).

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 ($\Delta elpd_{LOO}$ = 0.5 [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 old, 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.

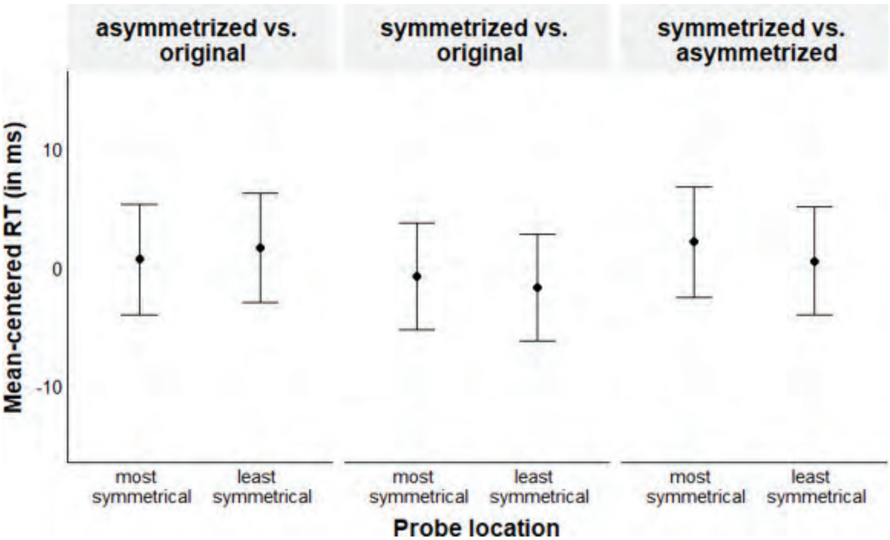

Figure 4. By-subject mean-centered RTs per Condition and per Probe Location. Dots indicate the median reaction times (RT), while error bars represent the 89% Credible Interval. As can be seen, symmetry did not substantially affect reaction time in any of the three conditions.

Experiment design & procedure

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 (in 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 analyse 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.

Table 2. Model output for the simple model of Experiment 2.

Parameter	Median estimate	*SD*	89% CI
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] 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
$N_{\text{obs}} = 7789$			
$N_{\text{subj}} = 138$			

Note: All categorical independent variables were sum-to-zero coded.

Procedure

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

As in Experiment 1, participants validated all stimuli (both front-facing and side-facing) after the experiment in a randomized order by rating their

[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.

attractiveness on a 7-point ordinal scale. Again, we used these scores to determine whether the ratings of the participants aligned well with the pre-determined 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.

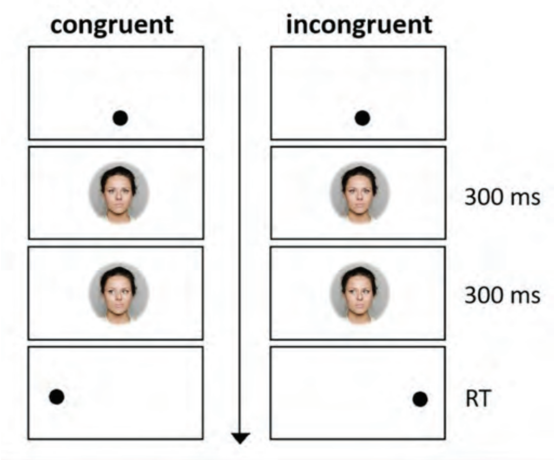

Figure 5. Schematic outline of a trial in the gaze cueing task. Stimuli from Oslo Face Database by Leknes Affective Brain lab (https://sirileknes.com/oslo-face-database/). Copyright 2014 by Leknes Affective Brain lab. Adapted with permission. RT = reaction time.

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 9000 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 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.

Results

Validation of stimuli

The ordinal mixed model showed that subjects rated as 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 (Δestimate$_{\text{attractive-intermediate}}$ = 1.81 [0.34], 89% CI [1.26, 2.38], *pd* = 1.00; Δestimate$_{\text{unattractive-intermediate}}$ = -2.25 [0.35], 89% CI [-2.83, -1.68], *pd* = 1.00) and men (Δestimate$_{\text{attractive-intermediate}}$ = 2.01 [0.34], 89% CI [1.46, 2.54], *pd* = 1.00; Δestimate$_{\text{unattractive-intermediate}}$ = -2.25 [0.35], 89% CI [-2.83, -1.68], *pd* = 1.00).

Simple model

To test our main prediction that attractiveness would significantly influence gaze cueing, 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 (see Table 3). We found a robust main effect of Gaze Congruency on RT (see 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 [-0.52, 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 = -0.61 [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 = 0.67 [2.36], 89% CI [-3.11, 4.37, *pd* = .61).

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 3-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 (Δelpd$_{\text{LOO}}$ = 4.6 [1.8]). The results were similar for the model that included the 3-way interaction

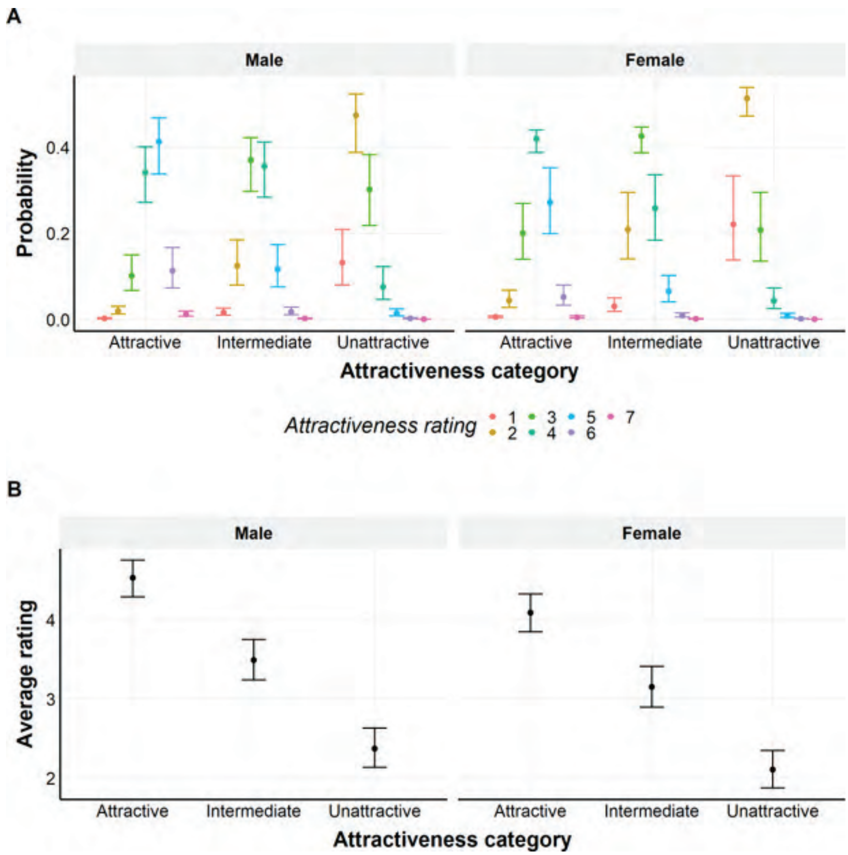

Figure 6. Validation of the stimuli of Experiment 3. Probability of receiving high attractiveness ratings was higher for stimuli categorized as "attractive" (A). This is also depicted in (B), which treats the ratings as a continuous variable for visualization purposes.

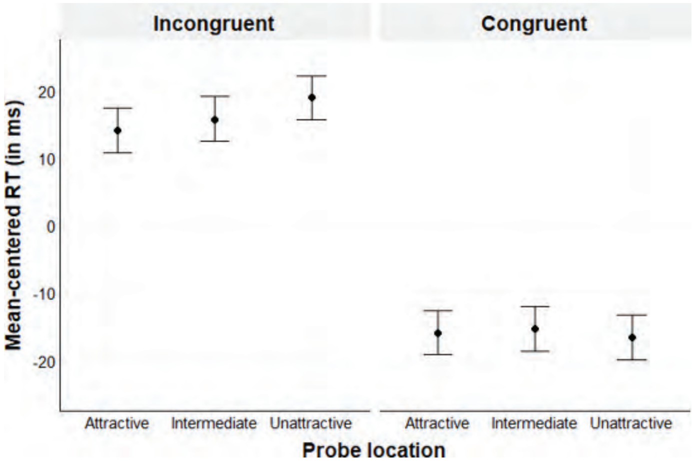

Figure 7. By-Subject Mean-Centered RTs per Level of Gaze Congruency and Attractiveness Category. Dots indicate the median reaction times (RT), while error bars represent the 89% Credible Interval. On both congruent and incongruent trials, we found no evidence for attractiveness resulting in a stronger gaze cuing effect.

between Sex, Attractiveness Category and Gaze Congruency: the simple model performed slightly better than the complex model ($\Delta \text{elpd}_{\text{LOO}} = 3.5$ [2.2]). Altogether, these findings suggest that adding Age or Sex to the simple model did not increase the simple model's predictive accuracy.

Table 3. Model output for the simple model of Experiment 2.

Parameter	**Median estimate**	***SD***	**89% CIs**
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
$N_{\text{obs}} = 8425$			
$N_{\text{subj}} = 150$			

Note: All categorical independent variables were sum-to-zero coded.

Discussion

Attractiveness is a salient social signal that affects not only our judgements, 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 cueing. The results show, first, that participants had an attentional bias towards attractive faces, but not towards unattractive faces. Second, attention was not differentially modulated by facial symmetry. Third, gaze cueing 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 towards attractive faces, is in line with previous research (Y. Ma et al., 2015, 2019; Maner, Gailliot, Rouby, & Miller, 2007). Using a similar dot-probe study as in the current study, (Y. Ma et al., 2015, 2019) showed that Chinese undergraduate students (n = 108 females: Ma et al., 2015a; n = 109 males: Ma et al., 2019) had difficulties disengaging from attractive faces. While they found no overall attentional bias towards 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 did not only include 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 towards 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 would be 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, Gangestad, & Thornhill, 1999). Furthermore, recent data-driven approaches to facial attractiveness have cast doubt on the importance of symmetry (Holzleitner et al., 2019; A. Jones & Jaeger, 2019). For example, Jones and 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 conclude that shape averageness is a more accurate predictor of attractiveness. Therefore, based on this perspective, we suggest that future research might study attentional biases towards averaged versus non-averaged faces.

Our third key result, that gaze cueing was not modulated by facial attractiveness, was not in line with our prediction. We did find a strong cueing 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 cueing (Deaner et al., 2007; Hori et al., 2005; Ohlsen et al., 2013). Given that attractiveness is such an important criterion for partner choice, it is surprising that gaze cueing was not modulated by facial attractiveness. One likely explanation is methodological: Jones and colleagues (2010) found a significant effect of facial dominance on gaze cueing when side-looking stimuli were presented for 200ms, but not when they were presented for 400ms or 800ms. On the contrary, in our study, we used a presentation duration of 300ms. 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 cueing paradigm allows only for indirect inference of the isolated effect of attractiveness on gaze cueing. 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 cueing paradigm has its merits. Such a paradigm would help to further elucidate the link between attractiveness and gaze cueing.

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 Experiment 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, Rouby, & Miller, 2007; Maner, Gailliot, & DeWall, 2007) or in participants who are not in a romantic relationship (Y. Ma et al., 2015, 2019). 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 cueing; while we did not find evidence that attractive opposite-sex faces enhance gaze cueing, 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 (Waynforth, 2007; Place, Todd, Penke, & Asendorpf, 2010), but future work could establish whether this generalizes to implicit gaze cueing. 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 towards 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 post-reproductive age had a similar bias towards 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 towards 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 cueing. Nevertheless, we believe that incorporating individual motivations and applying more ecologically valid paradigms can help to further elucidate the link between attractiveness and gaze cueing.

Chapter 3

Individual attractiveness preferences differentially modulate immediate and voluntary attention

Abstract

Physical attractiveness plays a crucial role in mate choice for both men and women. This is reflected in visual attention: people immediately attend towards and look longer at attractive faces, especially when they are motivated to find a partner. However, previous studies did not incorporate real-life dating decisions. Here, we aimed to combine attentional tasks with individual attractiveness ratings and a real-life mate choice context, namely a speed-dating paradigm. We investigated whether heterosexual single young adults showed biases in immediate and voluntary attention towards attractive faces and preferred dating partners. In line with previous research, we found considerable individual differences in individual attractiveness preferences. Furthermore, our results showed that men had a bias towards attractive faces and preferred dating partners in the immediate attention task, while results for women were mixed. In the voluntary attention task, however, both men and women had an attentional bias towards attractive faces and preferred dating partners. Our results suggest that individual attractiveness preferences are good predictors of especially voluntary attention. We discuss these findings from an evolutionary perspective and suggest directions for future research.

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All data, code, and materials that are associated with this paper and used to conduct the analyses are accessible on the Leiden University archiving platform DataverseNL.

Introduction

Physical attractiveness permeates important aspects of human interaction and shapes our judgements about people. Previous research shows that people associate positive personality traits with attractive people (Dion et al., 1972; Griffin & Langlois, 2006), consider them more cooperative (Andreoni & Petrie, 2008), and attractive people have even been shown to fare better in the labor market (Maestripieri, Henry, & Nickels, 2017; Nault, Pitesa, & Thau, 2020). In addition, physical attractiveness has an important influence on mate choice, and its weight in shaping mate choice has important effects in fundamental aspects of our psychology, such as attention. For example, previous research has shown that people's attention is drawn faster and for longer duration to attractive stimuli (Leder et al., 2016; Lindell & Lindell, 2014). However, given that human mate choice is such a fundamentally complex and multifaceted phenomenon, researchers have treated it in a wide variety of distinct approaches that may capture only some of said complexity. For example, human mate choice has been studied by focusing on cognitive processes (Maner & Ackerman, 2015; Roth, Du, Samara, & Kret, 2022; Todd, Penke, Fasolo, & Lenton, 2007), attractiveness ratings (Roth, Samara, & Kret, 2021a; Asendorpf et al., 2011), and real-life interactions (Eastwick & Finkel, 2008a; Perilloux et al., 2012; Prochazkova et al., 2022). Even though previous studies have integrated multiple methods to investigate mate choice, no previous study has examined the influence of attractiveness on visual attention and linked this to decisions in a realistic mate choice context. Given the context-sensitivity of cognitive processes (Kenrick, Neuberg, Griskevicius, Becker, & Schaller, 2010), we explore how individual attractiveness preferences and partner preferences shape our immediate and voluntary attention using a novel setting. Specifically, here, we combine well-established cognitive tasks with attractiveness rating tasks and a speed-date paradigm to examine whether and how these different approaches to studying human mate choice concord.

Physical attractiveness is strongly associated with attraction to a mate (Roth, Samara, & Kret, 2021a; Luo & Zhang, 2009), and both women and men mention physical attractiveness as an important criterion for mate selection (Buss & Barnes, 1986; Rhodes, 2006). Furthermore, physically attractive people have more sexual partners (Karraker et al., 2017) and a higher reproductive success (Jokela, 2009). From an evolutionary perspective, attractiveness has been proposed to be a cue of genetic quality in terms of health or fertility: by selecting an attractive partner, one can increase the likelihood of bearing offspring with high genetic quality (Rhodes, 2006; Thornhill & Gangestad, 1999). Some studies indeed suggest that attractiveness is positively correlated with health (Mengelkoch, Gassen, Prokosch, Boehm, & Hill, 2022; Nedelec & Beaver, 2014), although this has been heavily debated (Cai et al., 2019; B. C. Jones, Holzleitner, & Shiramizu, 2021;

Pátková et al., 2022). Accordingly, people rate attractive faces as healthier than unattractive faces (Rhodes et al., 2007), although this could be the result of a general halo effect for attractive people (Dion et al., 1972; Kalick, Zebrowitz, Langlois, & Johnson, 1998). Altogether, by selecting an attractive mate, humans might confer their offspring a selective advantage, thereby increasing their reproductive success.

If selecting a physically attractive mate indeed results in greater fitness, this may be reflected in specific cognitive mechanisms that help people to identify, and feel attracted to, physically attractive mates. Some of these mechanisms may be understood as perceptual biases, previously termed sexually selective cognition (Maner & Ackerman, 2015). These biases have been shown to interact with different cognitive processes. For example, men and women will exert more effort to see pictures of attractive than unattractive opposite-sex stimuli (Hayden, Parikh, Deaner, & Platt, 2007), although this opposite-sex bias is especially strong in men (Levy et al., 2008). When it comes to recognition memory, people seem to specifically remember attractive faces (Lin et al., 2020; Marzi & Viggiano, 2010). Importantly, this memory bias seems to be strongest for young participants, who are at the age where they are most likely to start getting involved in romantic interactions (Lin et al., 2020). These examples show how attractiveness can modulate human cognition.

Apart from effort and memory biases, the majority of experimental studies on cognition and mate choice have focused on processes of visual attention. Several studies show attentional biases towards physically attractive faces: they are attended to first and hold our attention for a longer time (Lindell & Lindell, 2014). Physically attractive faces are also preferentially attended to in preferential looking paradigms (Leder et al., 2016; Mitrovic, Goller, Tinio, & Leder, 2018). When it comes to immediate attention, previous work has shown that people identify faces that were previously rated as attractive extremely quickly. For example, when presented with two pictures at the same time for 100ms, participants could select the most attractive picture above chance level (Guo, Liu, & Roebuck, 2011). In addition, using a dot-probe paradigm with a slightly longer time scale of 300ms Roth et al. (2022) demonstrated that participants showed an attentional bias towards attractive faces paired with intermediately attractive faces, but not towards unattractive faces paired with intermediately attractive faces. However, it should be noted that attractiveness categories were predefined by a different participant sample in this study (D. S. Ma et al., 2015).

Such an approach is typical in studies investigating attractiveness, where traditionally researchers have focused on average ratings of general attractiveness. This approach is based on the notion that people strongly agree on which features and characteristics are attractive (Langlois et al., 2000). However, recent research has emphasized that it is important to disentangle shared and idiosyncratic contributions to judgments (Martinez, Funk,

& Todorov, 2020) because ample evidence shows that beauty is – at least partly – in the eye of the beholder, as agreement on attractiveness is about 50 percent (Hönekopp, 2006; Bronstad & Russell, 2007). Importantly, such individual preferences can also influence date success, i.e. willingness to meet again after a first date (Baxter et al., 2022). These inter-individual variations are possibly the result of differences in environments (Germine et al., 2015), such as culture (Zhan et al., 2021) and close social relationships (Bronstad & Russell, 2007). Nevertheless, most traditional laboratory studies did not take idiosyncratic preferences of participants into account, even though there can be considerable inter-individual variation in perceiving attractiveness. Taking these individual differences into consideration might reveal more pronounced effects of attractiveness on cognition. Thus, in the present study, we aimed to examine whether and the manner in which idiosyncratic attractiveness preferences influence immediate attention.

When it comes to voluntary attention, that is, where attention is allocated when able to do so freely, multiple studies have found that participants focus their attention on their sex of interest, or on the most attractive person of their sex of interest, depending on the design. For instance, Dawson & Chivers (2016, 2018) presented sexually explicit stimuli to participants that contained same-sex or opposite-sex people and found that heterosexual participants fixated more on the opposite-sex stimuli. Mitrovic and colleagues (2016) extended these findings by presenting same-sex and opposite-sex stimuli varying in attractiveness to heterosexual and homosexual participants. They found that participants attended most to the attractive faces corresponding to their sexual preference. Follow-up studies modified this paradigm by using the participants' own attractiveness ratings of the stimuli, instead of predefining stimuli as attractive or unattractive, and yielded similar results: people spent more time looking at faces that they found attractive (Leder et al., 2016; Mitrovic et al., 2018). Thus, a plethora of studies shows that people selectively attend to the more attractive face they are presented with.

Cognition can be substantially influenced by top-down processes (Kenrick et al., 2010; Schaller, Kenrick, Neel, & Neuberg, 2017), and attentional biases related to mate choice are no exception to this. More specifically, mating motivations seem to modulate attentional processing of attractiveness. For example, Ma and colleagues (2015, 2019) used a dot-probe paradigm with 500 ms presentation duration to study whether immediate attention was modulated by attractiveness and relationship status. They found that single participants' attention was captured by attractive faces the most, and that these same participants had trouble disengaging from attractive facial stimuli. When it comes to voluntary attention, similar results have been found: single participants showed a stronger positive correlation between perceived physical attractiveness and attention than committed participants (Mitrovic et al., 2018). This suggests that the bias towards physical attractiveness is especially pronounced when it is adaptive, i.e., for people that might be looking for a partner.

It has been suggested that men are more attuned to physical attractiveness than women (Buss, 1989). This has been supported by questionnaire studies, where women seem to place less emphasis on physical attraction of their partner than men do (Bech-Sørensen & Pollet, 2016). This is also reflected in cognition: men show a stronger correlation between stimulus attractiveness and preferential looking (Mitrovic et al., 2018). Similar patterns have been found in immediate attention studies (Maner, Gailliot, & DeWall, 2007; Zhang, Maner, Xu, & Zheng, 2017), although this finding is not always replicated (Roth et al., 2022). However, these sex differences do not always become apparent in studies that investigate real-life interactions. On the contrary, both women and men seem to rely mostly on physical attractiveness of their partners to make mate choice decisions during speed-dates (Roth, Samara, & Kret, 2021a; Eastwick & Finkel, 2008a; Luo & Zhang, 2009). Thus, while some studies report sex differences in attractiveness bias in attentional paradigms, these differences do not seem to be reflected in dating decisions. This raises the question whether these different approaches to studying mate choice capture the same processes and to what extent they are actually informative with regard to real-life mate choice.

Here, we therefore combined two paradigms that have been used frequently to study immediate and voluntary attention in the context of human mate choice with a realistic paradigm to study human mate choice, namely speed-dating. More specifically, we investigated the association between individual preferences for attractiveness and date outcome, respectively, on immediate and voluntary attention in non-committed young adults. To test immediate attention, we employed a dot-probe task (MacLeod, Mathews, & Tata, 1986). In the dot-probe task, participants briefly view two pictures presented on the display, one of which is then replaced by a dot. Participants are asked to indicate the location of the dot (right vs. left) using the corresponding keyboard keys. To investigate voluntary attention, we used a preferential looking task, where participants can freely view two stimuli in each trial (Leder et al., 2016), while their eye movements were recorded with an eye tracker. We combined these two cognitive tasks with a speed-date paradigm in order to create a realistic mate-choice context. Speed-dating has been shown to have strong ecological validity, as participation in a speed-dating experiment can translate into real-world romantic relationships 55. Furthermore, we aimed to examine how the results of two different but well-established types of paradigms (i.e., speed dating and cognitive tasks) relate to each other. This is because these two pervasive paradigms may be capturing fundamentally different processes relevant to mate choice that are, nonetheless, relevant to understanding the role of perceived attractiveness. As such, we believe the integration of these paradigms has the potential to more holistically inform the complex phenomenon that is human mate choice.

Our study aimed to contribute to the understanding of the interplay between cognition, attractiveness, and mate choice in two main ways. First, we linked idiosyncratic attractiveness preferences not only to voluntary, but also immediate attention. Second, we studied whether attractiveness-related attentional biases are indeed reflective of actual mate choice. Regarding our analyses, we first explored whether there were idiosyncratic differences in attractiveness ratings in our sample, as reflected in inter-rater reliability of attractiveness ratings. With regards to individual attractiveness preferences and the dot-probe task, we expected that participants would respond faster to the dot when it replaced a picture they themselves had previously rated as highly attractive; whereas they would respond slower to the dot when the distractor was a picture they had rated as highly attractive. With regards to date outcome and the dot-probe task, we expected people to respond faster to the dot when it replaced a picture of a person they later felt attracted to on a speed-date. However, we expected them to respond slower when the distractor was a picture of a person they later felt attracted to while on a speed-date. With regard to individual attractiveness preferences and preferential looking, we expected a positive association between individual attractiveness rating and looking time. Furthermore, regarding date outcome and looking time, we expected participants to look longer at people they later felt attracted to on a speed-date. For each analysis, we also explored whether the relationships would be more pronounced for men than for women.

Methods

Participants

Eighty (N = 80) participants were recruited for a speed-dating event and divided into four groups of 10 male and 10 female participants. In line with the inclusion criteria, all participants reported that they were between 18 and 26 years old, heterosexual, single, Dutch-speaking, and not under treatment for psychiatric disorders. All but 2 participants indicated that they were interested in pursuing a long-term relationship. Ten participants did not attend the experimental session and three participants (1 woman) withdrew their participation before the speed-dating sessions, leading to a final sample of 67 ($N = 67$; 35 women: $M_{age} = 22.03$, $SD = 2.26$; men: $M_{age} = 22.61$, $SD = 1.75$). All participants provided informed consent in accordance with the declaration of Helsinki. Participants received a complementary ticket to Apenheul Primate Park (Apeldoorn, the Netherlands) for their participation. The study was approved by the Leiden University Ethics Committee (CEP: 2020-02-20-M.E.Kret-V1-2169).

Procedure

After filling in several demographic questionnaires, the researchers took profile photos of the participants against a white background and also collected auditory and olfactory material, which will not be described in this paper. Hereafter, all participants completed a battery of cognitive tasks (the full methods are described in the Supplemental Material; preregistered using the AsPredicted database #36,394). Here, we focus on the dot-probe, preferential looking task, and attractiveness rating task. All tasks were controlled by an E-prime script (Eprime version 3; Psychology Software Tools, Pittsburgh, PA) in conjunction with the E-Prime Extensions for Tobii Pro (EET) for the preferential looking task. All stimuli were presented against a gray background. Furthermore, all tasks were presented on an 23.8-inch HP EliteDisplay 243m monitor with 1680 $\times$ 1050 resolution and 60Hz refresh rate.

In the dot-probe task, participants briefly view two pictures of the presented on the display, one of which is then replaced by a dot. Participants are asked to indicate the location of the dot (right vs. left) using the corresponding keyboard keys. In our study, all stimuli consisted of the opposite-sex participants' profile photos from the same group. In the case that one group consisted of fewer than 10 individuals, pictures of opposite-sex participants from the previous group were added to keep the number of trials consistent across participants. It is important to note that participants had not met their partners at that point in the experimental procedure and thus could not have known that these were replacement pictures. Each trial started with a centrally presented fixation cross for a jittered duration between 1020-1260 in increments of 60ms. Next, participants viewed the pictures of two opposite-sex participants for 300ms, one of which was then replaced by a dot until the participant indicated the correct location using the corresponding keyboard keys (*z* for *left*, *m* for *right*). Every trial ended with an inter-trial interval between 1380-1620ms in increments of 60ms. After completing 10 practice trials, participants viewed all possible combinations of the opposite-sex participants' photos (i.e., 45 dyads) twice, so each participant in a dyad would be presented as the probe (i.e., the picture replaced by the dot) and the distractor picture (i.e., the picture not replaced by the dot) leading to a total of 100 trials. Location of the probe and distractor pictures was pseudo-randomized across the trials. The task lasted approximately 8 minutes.

In the preferential looking task, in each trial, participants viewed two of the opposite-sex participants' pictures while their eye movements were recorded using an X2-60 Tobii eye-tracker (Tobii Pro, 2014) at a sampling rate of 60Hz. Participants placed their chin on a chin rest at approximately 50cm from the monitor. Each trial started with a centrally presented fixation cross for 720ms, followed by the two pictures presented on the display for

3000ms. Similar to the dot-probe task, in the case that one group consisted of fewer than 10 individuals, pictures of opposite-sex participants from the previous group were added to keep the number of trials consistent across participants. Every trial ended with a jittered ITI between 1380-1620ms in increments of 60ms. After performing 3 practice trials, participants completed 45 trials. The task lasted approximately 6 minutes.

In addition to the tasks described above, participants rated the attractiveness of all of the stimuli on a 7-point scale. The stimuli were presented sequentially for 3s on a computer monitor, after which the participants could indicate how attractive they found the person in the stimulus. The order of the tasks was randomized between participants.

After completing the tasks, participants went on a maximum of ten 4-minute speed dates (Perilloux et al., 2012; A. J. Lee et al., 2020). Men and women were seated at opposite sides of a table, their view of their partner occluded by a barrier. At the start of each date, the barrier was removed, and following the ring of the bell, participants had a four-minute date with their partner. After 4 minutes, participants indicated the date outcome, i.e., whether they would be interested in going on another date with them (yes/no); their prediction about whether their partner would be interested to go on another date with them (yes/no); and whether they knew their partner before the date (yes/no). Furthermore, we asked participants to indicate how attractive they found their partner (7-point scale) and how attractive they considered them as a long-term mate (7-point scale). It should be noted that these questions referred to attractiveness in general, and not specifically physical attractiveness. Participants had one minute to fill in the questionnaire after each date. Next, male participants rotated to their next prospective partner. After completing all possible date combinations, participants were debriefed about the purposes of the study.

Data processing

Dot-probe

In total, 58 participants completed the dot-probe task. In the second female group, we could not collect dot-probe data due to a technical issue. In total, we had 5220 datapoints for the dot-probe task before data filtering. One participant did not complete the pre-date attractiveness rating task. Therefore, we excluded this participant's data (90 trials) from the analysis that investigated the effect of attractiveness on immediate attention, leaving us with data from 57 participants. Next, we excluded outliers by subject: as a lower boundary, we used 200ms for anticipatory reaction times (Whelan, 2008). We calculated the upper limit by subject following Leys et al. (2013): we calculated the median absolute deviation (MAD) per subject and the median RT per subject. We then used a moderately conservative criterion to exclude trials: if the RT was slower than the subject's median RT + 2.5 × MAD, we excluded the trial. These outlier criteria resulted in the exclusion of 299 trials (5.83%). Hereafter, we centralized the RTs by subject. This was done to make it easier to set a prior for the Intercept. All factorial predictors were sum coded, and pre-date attractiveness ratings were centered at 4 because this was the middle option.

We followed a similar procedure for the analysis that investigated the association between date outcome (i.e., willingness to go on another date with dating partner) and post-date attractiveness rating on immediate attention. Two participants dropped out before the speed-date part of the experiment. Therefore, we had to exclude their data, leaving us with data from 56 participants. Some participants did not go on a speed date with every opposite-sex person they saw on the stimuli, either due to dropouts or unequal group size. After excluding the cases where date outcomes were missing for either the probe or the distractor stimulus, we ended up with 3460 data points out of the original 5220. Hereafter, we again excluded outliers by subject (see above), resulting in the exclusion of 209 trials (6.04%).

Eye-tracking

In total, 36 participants completed the eye-tracking task. One participant did not complete the pre-date attractiveness rating task and did not participate in the speed-dates. Therefore, we excluded their data (45 trials) from the analysis. Furthermore, we excluded 6 trials because participants were not looking at the stimuli, leaving us with 1569 trials from 35 participants to investigate the effect of attractiveness on voluntary attention. For the analysis that investigated the effect of date outcome and post-date attractiveness rating on voluntary attention, we had a smaller number of trials due to the fact that not all people that were rated for attractiveness participated in the speed-dates (either due to dropout or due to unequal group sizes). In total, we could include 1009 trials from 35 participants.

Eye-tracking data were recorded continuously throughout the task with a sampling rate of 60 Hz. Here, only data during the stimulus presentation were analyzed. Fixations on either area of interest (AOI) were logged using a custom E-prime script. We excluded practice trials (6.25%) and gaze samples where either the left or right pupil was not recorded (3.50%). Following these criteria, we were left with 90.25% of the data intact.

Statistical analyses

All analyses were performed in R statistics Version 4.1.3 (R Core Team, 2022). First, we calculated the Intra-Class Correlations (ICC) for the individual pre-date attractiveness ratings. We used the R package *irrNA* (Brueckl & Heuer, 2022), because it properly deals with missing values in the computation of ICC. In line with recommendations from McGraw and Wong (1996) we used the ICC(A, 1) to test for absolute agreement between rates. We report the ICC estimate and the 95% confidence interval.

Furthermore, we used the R package *correlation*(Makowski, Ben-Shachar, Patil, & Lüdecke, 2020) to test the relationship between pre-date attractiveness ratings, post-date attractiveness ratings, and date outcome. The *correlation* package allows for computation of a wide variety of correlations, such as Bayesian multilevel correlations. In our case, we used Bayesian multilevel Spearman correlations to investigate the association between pre-date and post-date attractiveness ratings. To test the relationships between date outcome and pre-date and post-date attractiveness ratings, respectively, we used Bayesian point-biserial correlations. These analyses were based on a dataset that consisted of only complete cases for all three variables of interest. In total, this concerned 482 datapoints of 58 participants.

For our main analyses, we used Bayesian mixed models. Bayesian analyses have gained in popularity over the past few years because they offer 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 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.

All models were created in the Stan computational framework and accessed using the *brms* package (Bürkner, 2017, 2018), version 2.17.0. All models were run with 4 chains and 5000 iterations, of which 1000 were warmup iterations. We checked model convergence by inspecting the trace plots, histograms of the posteriors, Gelman-Rubin diagnostics, and autocorrelation between iterations (Depaoli & van de Schoot, 2017). We found no divergences or excessive autocorrelation in any model.

Dot-probe

To analyze the dot-probe data, we used Bayesian mixed models with a Gaussian distribution. First, to study the association between attractiveness and immediate attention, we modeled Reaction time (mean-centered by subject) as a function of Attractiveness rating of probe picture and Attractiveness rating of distractor picture, and their interactions with Gender. We allowed the intercept and the effects of Attractiveness rating of probe picture and Attractiveness rating of distractor picture to vary by Subject. Second, to study the association between date outcome (i.e., willingness to go on another date with dating partner) and immediate attention, we followed the same procedure as described above. However, the predictors Attractiveness rating of probe picture and Attractiveness rating of distractor picture were replaced with Date again probe picture (binary: yes/no) and Date again distractor picture (binary: yes/no), also in the random effect formula.

We used a Gaussian prior with $M = 0$ and $SD = 2.5$ for the Intercept of the model. For the independent variables, we specified regularizing Gaussian priors with $M = 0$ and $SD = 5$. For all variance parameters, we kept the default Student's t priors with 3 degrees of freedom. After running the models, we used the *emmeans*-package (Lenth et al., 2023) to obtain estimates and pairwise contrasts based on the posterior predictive distribution. Using these values, we calculated multiple quantitative measures to describe the effects. First, we report the median estimate b, and median absolute deviation of the estimate between square brackets. Second, we report an 89% credible interval of the estimate (89% CrI). We have chosen 89% instead of the conventional 95% to reduce the likelihood that the credible intervals are interpreted as strict hypothesis tests (McElreath, 2018). Instead, the main goal of the credible intervals is to communicate the shape of the posterior distributions. Third, we report the probability of direction (*pd*), i.e., the probability of a parameter being strictly positive or negative, which varies between 50% and 100% (Makowski et al., 2019).

Eye-tracking

To analyze the eye-tracking data, we used a zero-one inflated beta model, which is suitable for continuous proportions containing zeros and ones. These models consist of two components, namely a beta component to describe the values between 0 and 1, and a binary component to predict the occurrences of zeros and ones (Ospina & Ferrari, 2012). For each trial we calculated a Looking time bias score by dividing the time fixating on the left picture by the total time fixating on the pictures. Thus, this score reflects the proportion of fixation time spent looking at the left picture. In looking time studies, it is common practice to calculate a looking time bias (proportion of total looking time). In the case of clear categories, this is no problem. For example, imagine a study where one examines attention to attractive vs. unattractive faces. One could calculate a looking time bias by calculating the proportion of time looking at the attractive face for all trials. However, in our case, we have no categorical variables but continuous ones, namely attractiveness ratings. Thus, we cannot calculate an informative bias like in the example above. Therefore, we have used the location of the photos as a reference point to calculate the looking time bias, by calculating the bias toward the left picture. Hereafter, we have tested whether this bias is affected by (1) the attractiveness ratings of the left and right picture, and (2) date outcome.

To study the association between attractiveness and voluntary attention, we modelled Looking time bias score (proportion of time looking at the left picture) as a function of Attractiveness rating of the left picture and Attractiveness rating of the right picture, and their interactions with Gender. We allowed the intercept to vary by Subject. Importantly, we weighed each trial by the looking time in that trial relative to the subject's average (see Data Processing). Thus, trials in which the participant paid more attention to the screen had a larger weight in the analysis. In this manner, we avoided that trials where participants were distracted or disinterested would have a large influence on the outcome of our analysis. Furthermore, we specified the same formulas for the precision parameter (*phi*; shape of the beta distribution), the zero-one inflation parameter (*zoi*; probability of observing a zero or a one), and the conditional one-inflation parameter (*coi*; probability of observing a one if a zero or one is observed). To study the association between date outcome (i.e., willingness to go on another date with dating partner) and voluntary attention, we followed the same procedure as described above. However, the predictors Attractiveness rating of the right picture and Attractiveness rating of the left picture were replaced with Date again right picture (binary: yes/no) and Date again left picture (binary: yes/no).

We used a Gaussian prior with $M = 0$ and $SD = 0.25$ for the Intercept of the beta component of the model. For the independent variables, we specified regularizing Gaussian priors with $M = 0$ and $SD = 0.5$. This also applied to the independent variables in the formulas for *phi*, *coi*, and *zoi*. For all variance parameters, we kept the default Student's t priors with 3 degrees of freedom. Furthermore, we kept the default logistic priors for the Intercepts of *zoi* and *coi*, and default Student's t prior with 3 degrees of freedom for the Intercept of *phi*.

After running the models, we used the *emmeans*-package (Lenth et al., 2023) to integrate the different model components, and provide estimates based on the posterior predictive distribution. Using these values, we calculated multiple quantitative measures to describe the effects (see *Statistical Analyses*). It is important to note, though, that the predictions are on the response scale (probability). This complicates interpretation for the continuous variables, because the slope on the response scale is not constant but is shallower or steeper depending on the value of the continuous variable. In the text we report the effect size measures for when the continuous variable of interest is set at 0, but in the Supplementary Material we provide similar measures for other values of the continuous variable of interest.

Model comparisons

For both the dot-probe and eye-tracking analyses, we additionally created a complete cases dataset in which we included only those cases for which we had pre-date attractiveness ratings, post-date attractiveness ratings, and date outcomes. Using these two datasets, we again ran the analyses described above (with pre-date attractiveness, post-date attractiveness, or date outcome as predictor, respectively). Hereafter, we used leave-one-out cross validation (PSIS-LOO-CV, Vehtari et al., 2017) to calculate the expected log predictive density (elpd_{LOO}), which quantifies predictive accuracy for each model. Then, we calculated the difference in elpdLOO ($\Delta\text{elpd}_{\text{LOO}}$) between all three models. If $\Delta\text{elpd}_{\text{LOO}}$ of two models is at least two *SE*s, this suggests that the models substantially differ in predictive performance (Johnson, Ott, & Dogucu, 2022). Therefore, we report both the $\Delta\text{elpd}_{\text{LOO}}$ and the *SE* of the difference. In total, the immediate attention dataset consisted of 3198 trials of 55 participants, while the voluntary attention dataset consisted of 1009 trials of 35 participants.

Results

Inter-rater agreement on attractiveness

When examining the inter-rater agreement on pre-date attractiveness ratings, we found an ICC(1, A) of 0.42 (95% CI [0.32, 0.52]). This result suggests that participants differed in their attractiveness preferences independent of gender. Furthermore, we explored the inter-rater agreement for men and women separately. For women, we found an ICC(1, A) of 0.25 (95% CI [0.14, 0.41]), while for men, we found an ICC(1, A) of 0.50 (95% CI [0.39, 0.64]). These results suggest that women had substantially lower agreement than men.

Correlations between attractiveness ratings and date outcome

We found that pre-date attractiveness rating, post-date attractiveness rating, and date outcome all showed a strong correlation. First, a point-biserial correlation indicated that pre-date attractiveness rating and date outcome were correlated ($r = 0.44$, 89% CrI [0.36, 0.50], $pd_+ = 1.00$). Second, we found that post-date attractiveness showed an even stronger correlation with date outcome ($r = 0.67$, 89% CrI [0.62, 0.71], $pd_+ = 1.00$). Third, a Spearman correlation showed that pre-date and post-date attractiveness were correlated ($r = 0.57$, 89% CrI [0.51, 0.62], $pd_+ = 1.00$).

Immediate attention (dot-probe)

Pre-date attractiveness ratings

We first examined the association between Pre-date attractiveness rating and Reaction time using a Bayesian mixed model with Gaussian distribution (Descriptives: Table S1-3; Model Table: Table S4). We found a robust overall effect of Pre-date attractiveness rating of distractor picture on Reaction time (b = 1.46 [0.53], 89% CrI [0.60, 2.29], pd_+ = 1.00), with participants responding slower by 1.46ms to the probe when there is an increase of 1 in attractiveness ratings of the distractor picture. There was no robust interaction with Gender ($b_{women-men}$ = -0.83 [1.06], 89% CrI [-2.49, 0.88], pd_- = .79). However, after visually inspecting the results, we wanted to explore whether the positive effect of Pre-date attractiveness rating of distractor picture on Reaction Time was robust within each level of Gender. We found that the effect was indeed robust for men (b_{men} = 1.87 [0.65], 89% CrI [0.80, 2.88], pd_+ = 1.00), but not for women (b_{women} = 1.04 [0.83], 89% CrI [-0.33, 2.34], pd_+ = .89). Thus, men responded slower to the probe by 1.87 ms when the attractiveness rating of the distractor picture was increased by 1, while no robust effect was found for women (see Figure 1 top panel).

Furthermore, we found a robust overall effect of Pre-date attractiveness rating of probe picture on Reaction time (b = -1.11 [0.55], 89% CrI [-1.97, -0.24], pd_- = .98), whereby participants responded faster by 1.11 ms when the attractiveness rating for the probe picture was increased by 1. In this case, however, the effect was modulated by Gender ($b_{women-men}$ = 2.83 [1.06], 89% CrI [1.12, 4.51], pd_+ = 1.00). Therefore, we further explored the slope per Gender. We found a robust negative effect of Pre-date attractiveness rating of probe picture for men (b_{men} = -2.51 [0.67], 89% CrI [-3.59, -1.48], pd_- = 1.00), indicating that men responded faster by 2.51 ms when the attractiveness rating of the probe picture was increased by 1. For women, on the other hand, we found no robust effect (b_{women} = 0.30 [0.85], 89% CrI [-1.03, 1.59], pd_+ = .64). Thus, men seemed to respond faster to the probe when they considered the image that was replaced by the probe highly attractive, while no robust effect was found for women (see Figure 1 lower panel).

We performed the same analysis with the Post-date attractiveness ratings as predictor. This analysis yielded the same results (Table S5).

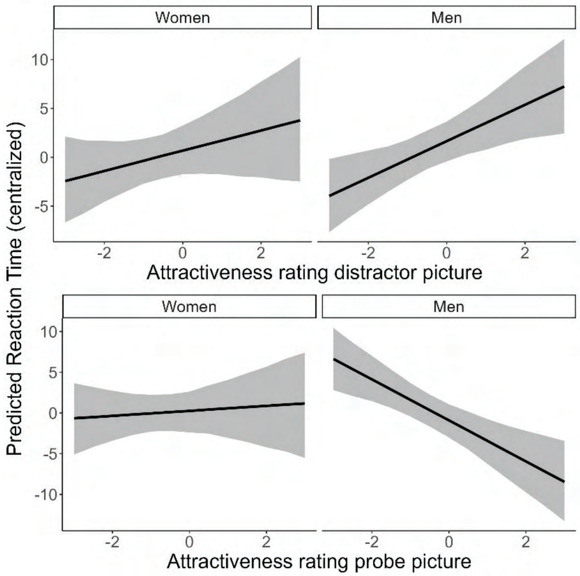

Figure 1. Conditional effect plot showing associations between Pre-date attractiveness rating and Reaction Time (RT) separate per Gender. The black line represents the median effect, while the grey ribbon represents the 95% credible interval.

Date outcome

Second, we investigated the association between Date outcome and Reaction Time using a Bayesian mixed model with a Gaussian distribution (Descriptives: Table S6-8; Model Table: Table S9). We found a robust effect of Date again distractor picture on Reaction time: participants were slower by 4.41 ms to respond to the probe if the distractor image depicted someone they later indicated as a successful date compared to when the distractor image depicted someone that they did not consider a successful date during their speed-dates (b_{no-yes} = -4.41 [1.96], 89% CrI [-7.51, -1.29], pd_{-} = .99), and this effect did not substantially differ per Gender ($b_{women-men}$ = -2.48 [3.93], 89% CrI [-10.30, 5.26], pd_{-} = .74; see Figure 2 top panel).

When investigating the effect of Date again probe picture on Reaction Time, we did not find a robust overall effect (b_{no-yes} = 1.68 [1.94], 89% CrI [-1.49, 4.70], pd_{+} = .81). However, we did find a robust interaction with Gender ($b_{women-men}$ = -9.33 [3.88], 89% CrI [-16.80, -1.60], pd_{-} = .99). Therefore, we explored the effect of Date again probe picture within each level of Gender. For women, we found no robust effect (b_{women} = -2.97 [3.06], 89% CrI [-8.96, 3.12], pd_{-} = 0.84). For men, on the other hand, we found that they responded faster to the probe by 6.33 ms when it replaced

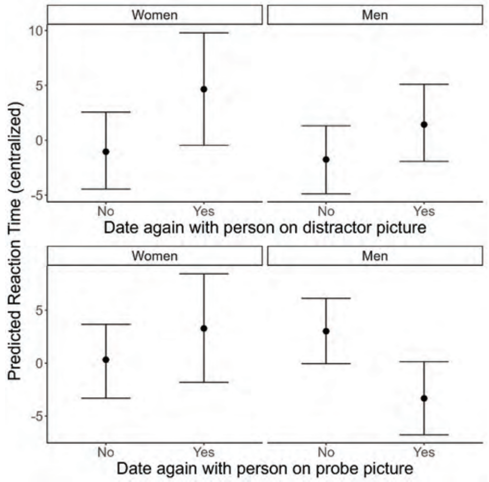

Figure 2. Conditional effect plot showing the effect of Date outcome on Reaction Time (RT) separate per Gender. Values are conditioned on the other predictor set to “No”. Error bars represent 95% Credible Intervals.

a picture of someone whom they later considered a successful date during their speed-dates (b_{men} = 6.33 [2.36], 89% CrI [1.75, 11.00], pd_+ = 1.00; see Figure 2 lower panel).

Voluntary attention (eye-tracking)

Pre-date attractiveness ratings

We first explored the association between Pre-date attractiveness rating and Looking time bias, using Bayesian zero-one inflated beta regression (Descriptives: Table S10-12; Model Table: Table S13). We found that attractiveness ratings had a robust effect on voluntary attention. More specifically, participant’s attractiveness ratings of the left picture correlated positively with proportion of time spent looking at the left picture (b = 0.087 [.0050], 89% CrI [0.079, 0.095], pd_+ = 1.00), while we found the opposite effect for the attractiveness rating of the right picture (b = -0.098 [.0041], 89% CrI [-0.106, -0.091], pd_- = 1.00). The results were similar for other values of Pre-date attractiveness rating: increased attractiveness ratings of the left picture were associated with an increased probability of looking at the left picture, while the opposite was true for the right picture (Table S14).

To see whether the effect was modulated by Gender, we compared the slopes for men and women. However, we found no robust interaction between Gender and Pre-date attractiveness rating for both the left picture ($b_{women-men}$ = -0.001 [.010], 89% CrI [-0.026; 0.007], pd_- = 0.83) and the

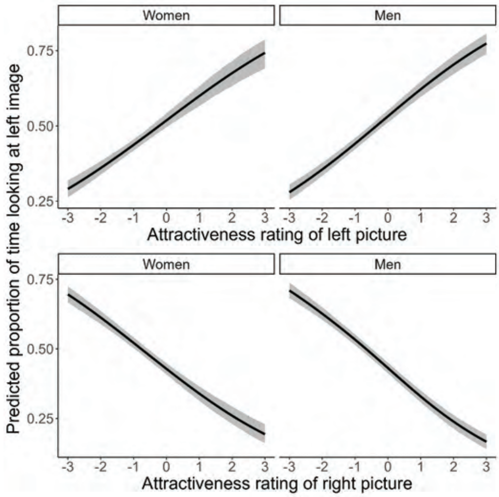

Figure 3. Effect plot showing associations between Pre-date attractiveness rating and Looking time bias separate per Gender. The black line represents the median effect, while the grey ribbon represents the 95% credible interval.

right picture ($b_{women-men} = 0.012$ [.010], 89% CrI [-0.006; 0.032], $pd_{+}= 0.91$). This pattern was similar for other values of Pre-date attractiveness rating: there was no robust difference in slope between men and women (Table S15).

We performed the same analysis with the Post-date attractiveness ratings as predictor. This analysis yielded the same results (Table S16). Altogether, the results show that participants indeed looked longer at faces that they rated as attractive. The results are visualized in Figure 3.

Date outcome

Second, we investigated the association between Date outcome and Look-ing time bias using Bayesian zero-one inflated beta regression (Descriptives: Table S17-19; Model Table: Table S20). We found that participants showed more attention towards pictures of people that they later indicated they would like to date again. More specifically, when the left picture depicted someone they wanted to date again, they spent on average 12.4 percentage points longer looking at the left picture than when the left picture depicted someone they did not want to date again (b_{no-yes} = -0.124 [.019], 89% CrI [-0.154, -0.095], $pd_{-}= 1.00$). When the right picture depicted someone they wanted to date again, they spent on average 15.8 percentage points less looking at the left picture than when the right picture depicted someone they did not want to date again ($b_{no-yes} = 0.158$ [.017], 89% CrI [0.131, 0.186], pd+ = 1.00).

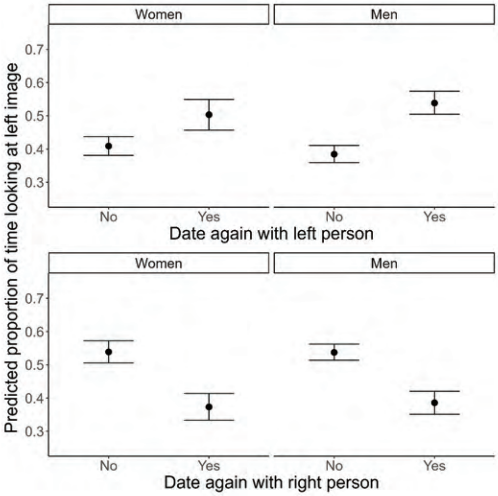

Figure 4. Plot showing the effect of Date outcome on Looking time bias separate per Gender. Error bars represent 95% Credible Intervals.

To see whether the effect was modulated by Gender, we investigated whether the effect for women and men was substantially different. However, we found no consistent gender differences (Left picture: $b_{\ women-men} = 0.060$ [.037], 89% CrI [0.002, 0.118], pd_{+}= 0.95; Right picture: $b_{\ women-men} = 0.014$ [.034], 89% CrI [-0.043, 0.066], pd_{+}= 0.66), although the pd suggested that the effect of Date outcome on Looking time bias was stronger for men for the left picture specifically.

Altogether, the results show that participants indeed looked longer at the faces of people that they later indicated they wanted to see again after their speed-date (Figure 4).

Model comparisons

Regarding the immediate attention analysis, we found no clear differences in predictive accuracy between the three models (Table S21-23). Although the model that included Pre-date attractiveness rating had the highest ex-pected log-predictive density, the differences with the models that included Post-date attractiveness rating (Δelpd$_{LOO}$ = 10.5 [9.6]) or Date outcome (Δelpd$_{LOO}$ = 14.0 [11.2]) as predictors was not robust due to the relatively high standard errors. Thus, while the model that incorporated Pre-date attractiveness rating as predictors had the highest predictive accuracy, there was no substantial difference in predictive accuracy with the two other models.

Regarding the voluntary attention analysis, we found robust differences in predictive accuracy between the three models (Table S24-26). Namely, the model that included Pre-date attractiveness rating had a substantially higher predictive accuracy than the models included Post-date attractiveness rating ($\Delta \text{elpd}_{\text{LOO}} = 100.1$ [17.4]) or Date outcome ($\Delta \text{elpd}_{\text{LOO}} = 133.5$ [17.9]) as predictors. Thus, the modal comparisons suggested that pre-date attractiveness ratings might be a better predictor of voluntary attention than post-date attractiveness ratings or date outcome.

Discussion

Here, we combined a naturalistic speed-date paradigm with cognitive tasks on attentional biases to investigate how physical attractiveness shaped processes of immediate and voluntary attention, using a dot-probe task and a preferential looking paradigm, respectively. First, consistent with previous literature, we found considerable variation in attractiveness ratings between subjects. With regard to immediate attention, we found that only men's attention was modulated by attractiveness, but we found no consistent association between date outcome and immediate attention. With regard to voluntary attention, we found that both men and women looked longer at faces that they rated as attractive before their date. Furthermore, participants showed more attention towards the faces of people that they later indicated they wanted to date, suggesting that voluntary attention can to some extent reflect mate choice for both men and women. However, model comparisons showed that pre-date attractiveness ratings were more predictive of immediate and voluntary attention than date outcome and post-date attractiveness, although the results are equivocal for immediate attention. Below, we discuss these findings and further address possible implications and limitations of our study.

Similar to previous work on (dis)agreements in attractiveness ratings, we found an ICC of approximately 0.4 for the pre-date attractiveness ratings (Hönekopp, 2006; Bronstad & Russell, 2007), reinforcing the idea that individual attractiveness preferences can vary and should be taken into account when studying cognitive aspects of mate choice. Consistent with this idea, we found that individual attractiveness ratings predicted immediate attention in men. This finding extends previous work (Roth et al., 2022) on immediate attention and attractiveness that showed a general attentional bias for faces that were predefined as attractive in a large community sample, but found no effect of sex on this bias. Crucially, this previous study did not account for relationship status. Given that motivation can influence immediate attention (Y. Ma et al., 2015, 2019; Maner, Gailliot, & DeWall, 2007), we only tested single participants who were interested in a relationship, and as mentioned above we used their individual attractiveness ratings as predictor instead of pre-defined categories. Thus, we can conclude that men immediately attended towards faces that they rated as attractive, but we did not find the same result for women. Future research should aim to disentangle and quantify the effects of general attractiveness and individual attractiveness preferences on attention. For example, a recent study on dating behavior (Baxter et al., 2022) showed that both general and individual preferences uniquely contribute to date outcome, but whether this is also the case for attentional processes remains unknown.

It is tempting to interpret our results on immediate attention as evidence for the notion that men are more attuned towards attractiveness than women, which has also been found in previous immediate attention studies (Maner, Gailliot, & DeWall, 2007; Zhang et al., 2017). However, in our exploratory analysis of the interaction between pre-date attractiveness rating and gender, we found a robust gender difference only for the effect of probe picture attractiveness on reaction time. While the effect of distractor picture attractiveness was robust only for men, the difference between men and women itself was not robust. Therefore, we refrain from interpreting the differences between men and women as clear evidence for a sex effect, as previous studies have described the pitfalls of interpreting differences in post-hoc effects as evidence for a robust interaction (Gelman & Stern, 2006; Nieuwenhuis, Forstmann, & Wagenmakers, 2011). With regard to the absence of a robust effect in women, in accordance with our findings, previous work has shown that the neural activity of men and women might differ in response to faces varying in attractiveness. Van Hooff and colleagues (2011) investigated the neural underpinnings of processing attractiveness. They found higher late positive event-related potential (ERP) amplitudes (250-600 ms post cue) in men than women. Crucially, this ERP has been linked to appraisal of facial attractiveness (Werheid, Schacht, & Sommer, 2007). This finding suggests that men might appraise attractiveness differently than women, which could translate into observable differences in processes involving immediate attention (van Hooff et al., 2011). Future research should further investigate the neural underpinnings of appraising attractiveness and how these translate to behavior.

Previous studies on immediate attention and attractiveness heavily relied on consensus attractiveness ratings (Roth et al., 2022; Y. Ma et al., 2015, 2019; Maner, Gailliot, & DeWall, 2007). Here, we examined whether taking the idiosyncratic preferences into account rather than general attractiveness ratings would increase the magnitude of the effect sizes found in the dot-probe task as compared to previous literature. We found that people in general responded 7 ms faster between the least and highest attractiveness rating. However, the difference between the two most extreme conditions (a very unattractive probe picture paired with a very attractive distractor picture, and the other way around) would be 15 ms. This effect size is similar to those that have been typically reported in dot-probe studies (van Rooijen et al., 2017). Regarding the effect of attractiveness on immediate attention, this effect is comparable to a previous study that did not take idiosyncratic preferences into account (Roth et al., 2022). In that study, people had an attentional bias of 9 ms to attractive faces when paired with neutral faces, but had a 6 ms attentional bias to neutral faces when these were paired with unattractive faces. Overall, this indirectly translates to an 15 ms attentional bias to attractive faces compared with unattractive faces. While it is important to note that this is an indirect comparison, and that the methods are slightly different, this effect size fits well with our current finding. In conclusion, contrary to our expectation, taking idiosyncratic preferences into account did not increase the magnitude of previously recorded effects of attractiveness on immediate attention. Instead, the size of the effect of consensus ratings and idiosyncratic ratings on immediate attention seem to be rather similar.

Our hypothesis regarding date outcome and immediate attention were partly supported. Specifically, we found an overall effect of the distractor picture on RT, and an effect of the probe picture for men but not for women. For men, these results are in line with our previously described effects of attractiveness on immediate attention. Given that we found a robust association between attractiveness and immediate attention for men, and that we know that date outcome is strongly associated with attractiveness (Roth, Samara, & Kret, 2021a; Luo & Zhang, 2009), it is not surprising that date outcome and immediate attention are associated as well. Of course, physical attractiveness rating does not perfectly predict date outcome; other processes such as physiological linkage (Prochazkova et al., 2022), nonverbal behavior (Hall, Xing, & Brooks, 2015), attachment styles (Schindler, Fagundes, & Murdock, 2010) and perceived similarity (Tidwell, Eastwick, & Finkel, 2013) all explain date outcome to some extent as well. Still, the association between attractiveness rating and date outcome might have been strong enough to explain the association between date outcome and RT in the immediate attention task.

In the preferential looking task, we found that both men and women divided their attention based on the attractiveness of the stimuli they were presented with. This is in line with previous work (Leder et al., 2016), but also contrasts with other work that found a gender difference, with men showing a stronger association between voluntary attention and attractiveness than women (Mitrovic et al., 2018). However, it is important to note that participants in our study were all interested in a relationship, i.e., they were motivated to find a partner, while other studies tested both single and committed participants (Mitrovic et al., 2018). As has been suggested, motives can substantially affect cognitive processes (Kenrick et al., 2010). On top of that, participants in our study were aware that they would later meet the people they saw during the tasks, possibly strengthening their motivation even further.

The preferential looking task consisted of trials with a prolonged exposure to the stimuli compared to the dot-probe task. Therefore, participants were able to freely look upon the stimuli and gather more relevant information from the stimuli compared to the dot-probe task. Given that women might need more contextual information in order to appraise a potential partner (Laan & Janssen, 2007), this could possibly also explain why we do not find any sex differences in the preferential looking task, while we do find some evidence for sex differences in the dot-probe task. Future research should further investigate the concordance between immediate and voluntary attention to attractiveness and their relationship to gender.

We also found that date outcome was substantially associated with voluntary attention: Participants indicated that they wanted to date again with people that they looked at for longer during the preferential looking task. This again highlights the strong association between attractiveness ratings and initial partner preferences: especially on first dates people seem to employ physical attractiveness as their main selection criterion (Roth et al., 2022; Luo & Zhang, 2009). Given the strong association between attractiveness rating and voluntary attention, it is not surprising that the association between date outcome and voluntary attention is also robust. An exploratory analysis showed that the associations were not modulated by gender: both men and women showed highly similar trajectories with regard to attractiveness-contingent voluntary attention. Importantly, we consider it unlikely that this effect is driven by uncertainty in the parameter estimates, given that the credible intervals for the interactions between attractiveness rating and gender were very narrow (see Figure 3). Despite the fact that this finding is somewhat inconsistent with evolutionary theories of human mate choice that emphasize sex differences in attractiveness appraisal (Buss & Barnes, 1986; N. P. Li & Meltzer, 2015), it is in line with previous speed-dating studies that failed to find gender differences in the appreciation of physical attractiveness (Roth et al., 2022; Eastwick & Finkel, 2008a; Luo & Zhang, 2009). Here, we have extended these findings by showing that both attractiveness ratings and date outcome are associated with voluntary visual attention in both men and women. Nonetheless, it should be noted that these analyses were exploratory in nature, and thus no strict inference can be drawn.

One could argue that it is not readily clear whether our findings (both in immediate and voluntary attention tasks) reflect long-term or short-term mate choice dynamics. Previous studies have questioned the ecological validity of speed-date paradigms to capture long-term mate choice processes (N. P. Li & Meltzer, 2015; N. P. Li et al., 2013). Specifically, Li et al. (2013) argue that speed-date designs might attract people that are not necessarily considering their interaction partners as long-term mates. Thus, they posit that the unique effects of short-term and long-term mate choice cannot be disentangled in speed-date designs, and that it is unclear whether such designs more closely resemble short-term or long-term mate choice contexts. However, it should be noted that almost all of our participants (except for 2) reported that they were interested in pursuing a long-term relationship and, in line with other speed-date events (Asendorpf et al., 2011; Luo & Zhang, 2009), still seemed to value physical attractiveness, although this is often specifically mentioned as a criterium for short-term mates (N. P. Li et al., 2013). Furthermore, previous work has shown that long-term partner ratings and physical attractiveness ratings highly correlate (Roth, Samara, & Kret, 2021a; Bressan, 2021; Wu, Chen, & Yu, 2022). In addition, it remains to be established whether there are specific contexts that emphasize long-term over short-term mate-choice considerations. In fact, a large-scale study showed no evidence that different initial meeting contexts (e.g., bars, church, online) influence divorce rates (Cacioppo, Cacioppo, Gonzaga, Ogburn, & VanderWeele, 2013). In a speed-date context, it has been shown that first impressions, which are asserted by some to reflect short-term mate choice processes, still predict long-term romantic interest (Baxter et al., 2022). In conclusion, our findings cannot be interpreted as the product of uniquely long- or short-term mate choice processes. Instead, our findings would be best interpreted in the context of a close-relationships tradition (Eastwick, Luchies, Finkel, & Hunt, 2014) that considers short-term and long-term contexts as closely related.

Finally, we attempted to disentangle the effects of attractiveness and date outcome on immediate and voluntary attention by means of Bayesian model comparisons (PSIS-LOO-CV, Vehtari et al., 2017). For immediate attention, these comparisons suggest that pre-date ratings of attractiveness are more predictive of reaction times than date outcome or post-date attractiveness, even though the differences were not robust. Thus, we cannot draw strict conclusions regarding the relative influence of attractiveness and date outcome on immediate attention. For voluntary attention, on the other hand, we found robust evidence in favor of the model that includes pre-date attractiveness ratings over the models that include date outcome and post-date attractiveness rating, respectively. This suggests that voluntary attention is specifically driven by physical attractiveness ratings, which is in line with previous work (Leder et al., 2016; Mitrovic et al., 2018, 2016). Consequently, the robust effect of date outcome on voluntary attention might have been the result of strong intercorrelation between attractiveness ratings and date outcome, as has been reported in many studies (Roth, Samara, & Kret, 2021a; Luo & Zhang, 2009). To address this limitation, we suggest that future studies could employ a pre-post-design, where participants engage in attention tasks before and after a speed-date session to study specifically how the experiences gained during the speed-dates alter attentional processes.

In conclusion, we investigated how attractiveness and date outcome were associated with immediate and voluntary attention in non-committed young adults. In line with previous studies, we found substantial inter-individual differences in attractiveness preferences. Furthermore, we found that immediate attention was modulated by attractiveness for men, but not for women, while no consistent relationship between immediate attention and date outcome was found. With regard to voluntary attention, we found that both men and women looked longer at pictures of people that they found attractive and that they wanted to date again. However, attractiveness ratings were more predictive of voluntary attention than date outcome. Our results therefore suggests that especially voluntary attention can provide information about individual preferences and possibly also mate choice of people who are motivated to find a partner.

Part II

Attraction modulates social cognition

Chapter 4

Investigating the functional projection hypothesis: A replication of Maner et al. (2005)

Abstract

It is well-known that emotions influence our social perception. In their seminal study, Maner et al. (2005) showed that activating specific motivational states, namely fear and romantic arousal, leads to corresponding changes in the social perception of specific social groups. Here, in two experiments, we conceptually replicated the study by Maner et al. (2005). Partly consistent with Maner et al. (2005), we found that men rated highly attractive White women as more sexually aroused than all other stimuli. However, this bias was independent of the induced motivational state. In contrast to Maner et al. (2005), we found that participants rated White men (as opposed to Black men) as angrier than White women, Black men, and Black women. The findings are discussed in the wider context of emotional states influencing social perception.

Based on:
Samara, I., Roth, T. S., Milica Nikolić, & Kret, M. E. (in preparation). Investigating the functional projection hypothesis: A replication of Maner et al. (2005)

All data, code, and materials that are associated with this paper and used to conduct the analyses will be accessible on the Leiden University archiving platform DataverseNL upon publication.

Introduction

Similar to physical states, like thirst (Van Boven & Loewenstein, 2003), emotions inform our actions, increasing the likelihood of emotion-relevant actions being performed (Carver & White, 1994). For example, fear makes us cower, indicating that a threat has been detected and increases the chance that the person will take protective action (Buck, 1999). Sexual and romantic arousal activate an approach tendency (Both, Everaerd, & Laan, 2003) and promote interpersonal contact (Stephan, Berscheid, & Walster, 1971). In a highly influential study, Maner et al. (2005) demonstrated that the emotions people experience not only influence their actions but crucially, how they perceive others (i.e., the functional projection hypothesis). However, whether this effect remains when using different stimulus materials and different samples has not yet been examined. Here, we aim to conceptually replicate Maner et al. (2005).

Emotional top-down states can influence social perception (P. Niedenthal & Halberstadt, 2003; P. M. Niedenthal, Halberstadt, & Innes-Ker, 1999; Maner et al., 2005). Maner et al. (2005) examined the effect of sexual arousal and fear on social perception. In their study, participants first watched a brief video clip (approx. 6 minutes) that was designed to induce a fearful, sexually arousing or neutral motivational state. Then participants performed an experimental task where they indicated for a series of target faces the level to which they perceived that person to be sexually aroused, angry, scared, or happy. The target faces exhibited in fact a neutral expression. The results showed that participants who had watched the fear-inducing film were more likely to indicate that Black male faces were angrier than White male faces compared with participants in the control group who watched a neutral video clip. Furthermore, male participants who had watched the sexually arousing film were more likely to indicate that White highly attractive female faces were more sexually aroused than White medium attractive and Black high and medium attractive female faces compared with participants that had watched the neutral clip. Below, we discuss these effects in detail.

Visual attractiveness is important in mate choice (Roth, Samara, & Kret, 2021a; Roth et al., 2022). Previous evidence suggests that men respond more strongly to sexually arousing stimuli compared to women (see Rupp & Wallen, 2008, for a review). This finding has often been suggested to be the cause of the sexual overperception bias (Haselton, 2003), the effect that men are more likely to misinterpret friendliness cues as flirting (Abbey, 1982; A. J. Lee et al., 2020; Samara et al., 2021). Since men can experience a state of arousal faster than women (Huberman, Dawson, & Chivers, 2017), it is more likely that men use their internal emotional state as a guide in judging women's emotions, leading to biased estimates of women's attraction. Therefore, the findings of Maner et al. (2005) regarding men judging highly attractive women but not medium attractive women as more sexually aroused is not surprising. The finding that only highly attractive White women were judged as sexually aroused and not highly attractive Black women could be explained by the fact that only data from White participants were analyzed in Maner et al.'s (2005) study. It has been shown that White participants rate White women as more attractive than Black women (Lewis, 2011), which might have blunted the effect for highly attractive Black target faces.

A widely discussed finding in Maner et al.'s (2005) study was that participants in the fear condition rated Black men as angrier than White men compared to participants in the control condition (e.g., see Haselton & Nettle, 2006). However, considering that the authors analyzed data only from White American participants it is unclear whether these findings would generalize to another non-US population.

There are several issues with the methods of Maner et al. (2005). First, it is not clear whether a validation study of the target faces was conducted, meaning that the suitability of the target faces cannot be assessed. Therefore, it is unclear whether the reported effects are due to the employed manipulation or other confounding factors. A straightforward solution to this issue would be to use stimuli from a validated database, for example, the Chicago Face Database (CFD; D. S. Ma et al., 2015). Also, the data (1-9 Likert scale responses) were analyzed using metric models (e.g., models underlying the t-test, ANOVA, etc.). Such models are not appropriate for ordinal data, as the often-poor model fit can result in inflated Type I or Type II errors, as well as effect inversions (see Liddell & Kruschke, 2018, for an extensive explanation). Furthermore, the effect reported regarding highly attractive White women being reported as more sexually aroused by men in the mate-search condition compared to control (and the other target stimuli) could be the result of the recency effect (Baddeley & Hitch, 1993; Broadbent & Broadbent, 1981). In other words, as the woman in the romantic video clip was White, it could be that men rated highly attractive White women as sexually aroused not because of the projection of their own emotional state, but because they had just observed the protagonist (a highly attractive White woman) being sexually aroused. The question is whether this result would remain consistent if the woman in the romantic clip was Black. In conclusion, whether the effects reported in Maner et al. (2005) result from these methodological decisions and whether they would replicate with different stimuli sets and different samples remains unclear.

Here, we aimed to conceptually replicate the study by Maner et al. (2005). We conducted two separate experiments for romantic arousal and fear. In addition to the romantic arousal video with a White female protagonist employed by Maner et al. (2005), we also included a romantic arousal video with a Black female protagonist. If the effects reported in Maner et al. (2005) were due to priming effects, then we should observe that men who viewed the romantically arousing video would be more likely to indicate White highly attractive female target faces as more sexually aroused than all other target faces as well as compared to participants that watched the control video. However, if the effect reported in Maner et al. (2005) was due to a recency effect (Baddeley & Hitch, 1993; Broadbent & Broadbent, 1981), we would expect participants to indicate Black highly attractive female target faces as more sexually aroused than all other target faces for participants that watched the video with the Black female protagonist compared to participants that watched the video with the White female protagonist. We used the same video to induce fear as in Maner et al. (2005) and expected that international participants who watched the fear-inducing video would rate Black men as angrier than all other target faces compared to participants that watched the control video.

Methods

Participants

Participants were recruited from the university student population pool and advertisements placed on social media. In both studies, all participants were between 18-30 years old and self-reported normal or corrected-to-normal vision, normal color vision, and hearing acuity, being fluent in English, and not currently undergoing psychological treatment. All participants provided informed consent, in accordance with the declaration of Helsinki.

Experiment 1

Sixty ($N = 60$) male participants were recruited. Two participants did not agree to the use of their data after being debriefed and were therefore excluded from further analyses. Thus, the final sample consisted of 58 male participants ($M_{age} = 21.83$, $SD = 2.71$). Participants were randomly assigned to the control ($n = 19$), Black-protagonist video ($n = 20$), or White-protagonist video condition ($n = 19$). The experimental protocol was approved by the Leiden University Ethics Committee (CEP: 2021-11-30-M.E. Kret-V1-3583). Participants were remunerated with course credits.

Experiment 2

Sixty ($N = 60$) participants (29 women; women $M_{age} = 20.80$, $SD = 2.39$; men $M_{age} = 22.50$, $SD = 2.52$) were recruited. Participants were randomly assigned to the control ($n = 30$; 15 women) or fear condition ($n = 30$; 14 women). The experimental protocol was approved by the Leiden University Ethics Committee (CEP: 2021-11-30-M.E. Kret-V1-3584). Participants were remunerated with course credits.

Video Stimuli

Experiment 1

We used the same videos as in Maner et al. (2005) with one addition. Specifically, we included another sexually arousing video depicting clips from the movie *Something New* (Hamri, 2006). This movie features an African-American heroine in the early stages of forming a romantic relationship with a White man. The other sexually arousing video depicted scenes from the movie *Things to Do in Denver When You're Dead* (Fleder, 1995). This video depicted a White heroine in the early stages of forming a romantic relationship with a White man. The clips selected from the movie *Something New* were matched as closely as possible with the clips from the movie *Things to Do in Denver When You're Dead* in terms of the scene content (i.e., number of romantic/explicit scenes). The control video featured clips from the movie *Koyaanisqatsi* (Reggio, 1982). Video clips were approximately between 6.5-7.5 minutes long.

Experiment 2

The fear-inducing video consisted of a scene from the movie *Silence of the Lambs* (Demme, 1991), in which an FBI agent tracks a serial killer through a dark basement. The control video was the same as in Experiment 1. Video clips were approximately between 6.5-7.5 minutes long.

Target Faces

For both Experiment 1 and Experiment 2, we used the same subset of 16 faces (8 female) from the Chicago Face Database (CFD; D. S. Ma et al., 2015, see Table 1). The target faces were matched closely for age and attractiveness. Only the female faces were used in Experiment 1.

Procedure

After signing the informed consent, participants were led to the experimental cabin. They were seated in front of a 19-inch monitor (1024 × 768 resolution; 60Hz refresh rate). Participants watched one of the sexual arousal clips or the control clip (6.5-7.5 minutes). Next, participants filled in the self-report affect questionnaire. Next, the researcher recited the instruction script as reported in Maner et al. (2005):

"Each person you will see was instructed to relive in their mind some very emotionally arousing event in their life, a time in their life that caused a strong emotional reaction. Once they were really feeling the emotions of that event again, we asked that they cover up their emotions by putting on a neutral facial expression. Then we took their picture. Remember though,

Table 1. Information (code, age, attractiveness ratings) regarding the target faces of the Chicago Face Database employed in the present study

CFD code	Skin Color	Gender	Age	Attractiveness
BF-223	Black	Female	26.86	High (4.46)
BF-247	Black	Female	25.48	High (4.48)
BM-227	Black	Male	22.52	High (4.11)
BM-215	Black	Male	22.42	High (4.11)
WF-207	White	Female	24.88	High (4.46)
WF-236	White	Female	26.38	High (4.58)
WM-242	White	Male	23.07	High (4.03)
WM-009	White	Male	23.70	High (4.08)
BF-021	Black	Female	26.41	Average (3.05)
BF-031	Black	Female	26.34	Average (3.02)
BM-028	Black	Male	24.36	Average (3.00)
BM-216	Black	Male	24.72	Average (3.00)
WF-036	White	Female	22.64	Average (2.90)
WF-005	White	Female	22.39	Average (3.03)
WM-040	White	Male	25.12	Average (3.05)
WM-026	White	Male	22.39	Average (3.03)

that research has shown that emotions, in general, can still be detected because people can subconsciously notice subtle microexpressions on people's faces. People are especially accurate when they make their judgments based on their immediate gut reaction about what the emotion is, so you should try to go with your gut reactions to the people in the photos." (p. 67)

Then, participants performed the experimental task. The task was presented using E-prime (Eprime version 3; Psychology Software Tools, Pittsburgh, PA). Each trial started with a centrally presented target stimulus shown for 1 s. Then, participants indicated how sexually aroused, fearful, happy, or angry they perceived the person depicted on a 9-point scale using the corresponding keyboard key. Participants performed 8 (Experiment 1) or 16 trials (Experiment 2) in total. After completing the task, participants filled in the revised Sociosexual Orientation Inventory (SOI-R; Penke & Asendorpf, 2008) and the Belief in a Dangerous World (BDW; Altemeyer, 1988) questionnaires to measure one's propensity to a) engage in casual relationships and b) perceive their surroundings as safe and secure, respectively. Finally, participants were debriefed about the aim of the study. The study lasted approximately 15 minutes.

Statistical Analyses

Sexual arousal (Experiment 1) and anger (Experiment 2) target face ratings were analyzed using Bayesian multilevel modeling (MLM). We opted for Bayesian MLMs so we could both account for the nested data and quantify the evidence in favor of the null or alternative hypothesis. For each experiment, we fitted two models: one Gaussian and one ordinal. In the first model, we replicated the analyses by Maner et al. (2005). We further conducted a Bayesian ordinal multilevel model (with cumulative family) to examine whether the ordinal model captured the dependent variable better (see Liddell & Kruschke, 2018). In all analyses, all our predictors were sum-coded (the Condition predictor was added to the model as two sum-coded dummy variables). In the Gaussian models, we included a Gaussian prior with a mean of 4.5 and *SD* of 2 for the intercept and a conservative Gaussian prior with a mean of 0 and *SD* of 1 for all coefficients. In all ordinal models, we set a conservative Gaussian prior with a mean of 0 and *SD* of 0.5 for all coefficients.

We report multiple estimates (e.g., see Martin, Ringen, Duda, & Jaeggi, 2020), namely, the median Odds Ratio (OR) with the Median Absolute Deviation (MAD), alongside the 95% Highest-Density Credible Intervals (HDI), which summarize a posterior distribution with the highest probability density (Kruschke, 2018). Effects with a 95% HDI spanning over 0, were not considered robust (Bürkner & Vuorre, 2019). Furthermore, we report the probability of direction (*pd*), the proportion of the probability that supports a putative effect (Makowski et al., 2019), and an approximation of Cohen's *d* based on Borenstein et al. (2009) for the ordinal models.

All multilevel models included *Participant* as a random intercept. Contrasts between posterior distributions were computed using the package *emmeans* (Lenth et al., 2021) and interpreted as robust if the estimated Highest Posterior Density (HPD) Interval did not contain 0. Since the intercepts in ordinal models simply reflect thresholds between categories (see Bürkner & Vuorre, 2019), they are not interpreted.

We used the guidelines outlined in the WAMBS checklist to examine model convergence (Depaoli & van de Schoot, 2017). For all models, Gelman-Rubin diagnostic values, and trace and density histograms of all posterior distributions were examined. Analyses were conducted with R (R Core Team, 2021) using the package *brms* (Bürkner, 2017, 2018; Bürkner & Vuorre, 2019).

Results

Experiment 1

Preliminary analyses

To examine whether the mood induction was successful in inducing sexual and romantic arousal, we conducted an ordinal model on romantic and sexual arousal ratings with Condition (control vs. White female protagonist vs. Black female protagonist) as a fixed effect. The results showed that the Black protagonist videos did not increase sexual arousal robustly compared to the control condition or the White protagonist video condition (OR = 1.18[0.35], 95% HDI [0.66, 2.14], pd = 71%, d = 0.09[0.16]; OR = 0.9[0.27], 95% HDI [-0.49, 1.62], pd = 64%, d = 0.06[0.17], for the control and White protagonist conditions, respectively). Regarding romantic arousal, men indicated higher romantic arousal in the Black protagonist video than the control video condition (OR = 0.25[0.07], 95% HDI [0.14, -0.45], pd = 100%, d = 0.76[0.16]) and the White protagonist video compared to the Black protagonist video condition (OR = 2.52[0.69], 95% HDI [1.46, 4.31], pd = 100%, d = 0.51[0.15]).

Main analyses

Regarding sexual arousal ratings, the results of the Bayesian multilevel model (see Table 2) showed that contrary to the findings of Maner et al. (2005), we did not find that participants rated highly attractive White females as more sexually aroused than medium attractive White and high and medium attractive Black women after watching the romantic video clip compared with participants who watched the neutral video (b = 0.07, 95% HDI [-0.16, 0.31], pd = 73%; b = -0.09, 95% HDI [-0.33, 0.15], pd = 77%; for Control and White protagonist conditions, respectively). Men that watched the Black-protagonist and White-protagonist videos did not differ in sexual arousal ratings from men that watched the control video (b = -0.10, 95% HDI [-0.50, 0.29], pd = 69%; b = 0.07, 95% HDI [-0.32, 0.46], pd = 63%; for Control and White protagonist condition, respectively). The interaction between Female Target Skin Color × Female Target Attractiveness was robust (b = -0.22, 95% HDI [-0.39, -0.05], pd = 99%), indicating that participants rated White highly attractive female targets as more sexually aroused than medium attractive female targets, highly attractive Black targets, and medium attractive Black targets (see Figure 1). The main effect of Female Target Attractiveness was robust, suggesting that men rated highly attractive female targets as more sexually aroused than medium attractive female targets (b = 0.74, 95% HDI [0.57, 091], pd = 100%). All other effects and interactions did not influence sexual arousal ratings.

The results of the Bayesian ordinal multilevel model supported the results of Model 1 (see Table 3).

Table 2. Overview of the Gaussian multilevel model predicting men's sexual arousal ratings as a function of Target Attractiveness, Target Skin Color, and Condition

Predictors	Median *b*	95% HDI	*pd*
Intercept	2.78	2.50 – 3.07	100%
Condition [Control]	-0.10	-0.50 – 0.29	69%
Condition [White Protagonist]	0.07	-0.32 – 0.46	63%
Skin Color [Black]	-0.22	-0.39 – -0.05	99%
Attractiveness [High]	0.74	0.57 – 0.91	100%
Condition [Control] × Skin Color [Black]	0.13	-0.11 – 0.37	85%
Condition [White Protagonist] × Skin Color [Black]	0.06	-0.18 – 0.30	68%
Condition [Control] × Attractiveness [High]	0.00	-0.23 – 0.25	51%
Condition [White Protagonist] × Attractiveness [High]	-0.04	-0.28 – 0.19	63%
Skin Color [Black] × Attractiveness [High]	-0.22	-0.39 – -0.05	99%
Condition [Control] × Skin Color [Black] × Attractiveness [High]	0.07	-0.16 – 0.31	73%
Condition [White Protagonist] × Skin Color [Black] × Attractiveness [High]	-0.09	-0.33 – 0.15	77%
Random Effects			
SD(Participant)	0.87		

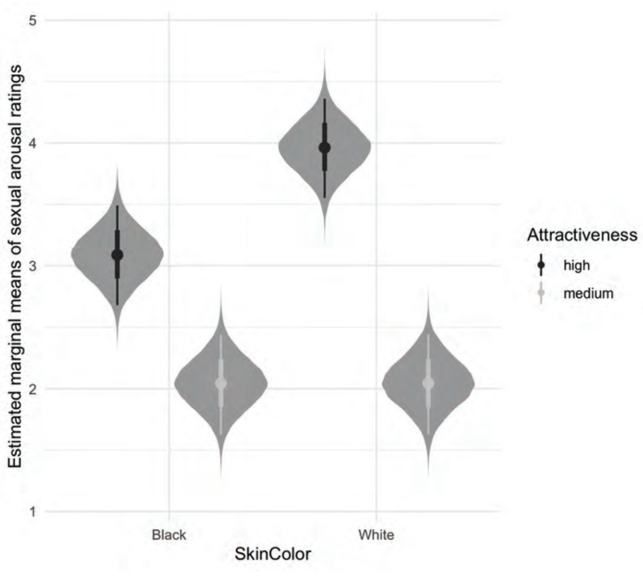

Figure 1. Estimated marginal means of the posterior distribution for sexual arousal ratings as a function of Skin Color (Black vs. White) and Target Attractiveness (High vs. Medium). The points reflect the median and the error bars the 66% to 95% Highest Density Interval (HDI).

Table 3. Overview of the ordinal cumulative multilevel model predicting men's sexual arousal ratings as a function of Target Attractiveness, Target Skin Color, and Condition

Predictors	Median OR	95% HDI	*pd*	*d*
Intercept[1]	0.71[0.12]	0.51–1.01	97%	0.19[0.09]
Intercept[2]	1.49[0.26]	1.05–2.08	99%	0.22[0.1]
Intercept[3]	2.91[0.52]	2.05–4.18	100%	0.59[0.1]
Intercept[4]	5.32[1.01]	3.67–7.85	100%	0.92[0.11]
Intercept[5]	8.31[1.69]	5.64–12.55	100%	1.17[0.11]
Intercept[6]	18.79[4.40]	11.94–30.27	100%	1.62[0.13]
Intercept[7]	40.58[11.36]	23.81–71.52	100%	2.04[0.16]
Intercept[8]	335.51[188.61]	112.17–1199.91	100%	3.21[0.33]
Condition[Control]	0.90[0.19]	0.58–1.35	69%	0.06[0.11]
Condition[White Protagonist]	1.09[0.22]	0.72–1.65	66%	0.05[0.11]
Skin Color[Black]	0.79[0.07]	0.66–0.94	100%	0.13[0.05]
Attractiveness[High]	2.10[0.20]	1.75–2.53	100%	0.41[0.05]
Condition[Control] × Skin Color[Black]	1.11[0.14]	0.87–1.42	79%	0.06 [0.07]
Condition[White Protagonist] × Skin Color[Black]	1.03[0.13]	0.80–1.30	59%	0.02[0.07]
Condition[Control] × Attractiveness[High]	1.06[0.13]	0.83–1.34	67%	0.03[0.07]
Condition[White Protagonist] × Attractiveness[High]	0.88[0.11]	0.69–1.12	84%	0.07[0.07]
Skin Color[Black] × Attractiveness[High]	0.87[0.08]	0.73–1.03	94%	0.08[0.05]
Condition[Control] × Skin Color[Black] × Attractiveness[High]	1.12[0.14]	0.88–1.43	82%	0.06[0.07]
Condition[White Protagonist] × Skin Color[Black] × Attractiveness[High]	0.92[0.11]	0.72–1.16	76%	0.05[0.07]
Random Effects				
SD(Participant)	1.05			

4

Experiment 2

Preliminary analyses

To examine whether the mood induction was successful in inducing fear, we conducted an ordinal model on fear ratings with Condition (control vs. fear) as a fixed effect. The model included a random intercept per participant. The results showed that participants that watched the fearful video indicated that they felt more fear than people who watched the control video (OR = 2.73[0.63], 95% HDI [1.72, 4.31], pd = 100%, d = 0.55[0.13]). This effect suggests that the manipulation was successful in eliciting fear.

Main analyses

Regarding anger ratings (see Table 4), the model showed that contrary to the findings of Maner et al. (2005), participants who watched the fearful video did not rate Black men as angrier than Black women, White men, and White women compared to participants that watched the control video (b = 0.06, 95% HDI [-0.07, 0.19], pd = 81%). The interaction between Target Skin Color × Target Gender was robust (b = 0.32, 95% HDI [0.19, 0.45], d = 100%, see Figure 2). Pairwise comparisons showed that participants rated Black female targets (M = 3.39, SD = 2.28) and White male targets (M = 4.06, SD = 2.60) as angrier than White female targets (M = 3.00, SD = 2.10; HPD: [-0.78, -0.05], HPD: [0.73, 1.46], respectively). Contrary to the findings of Maner et al. (2005), participants rated White male targets as angrier than Black male targets (M = 3.22, SD = 2.12; HPD: [0.48, 1.21]). Participants also rated White male targets as angrier than Black female targets (HPD: [0.31, 1.04]). There was no difference between mean anger responses for Black female and Black male targets (HPD: [-0.54, 0.19]), and White female and male Black targets (HPD: [-0.61, 0.11]).

Female targets were rated as less angry than male targets (b = -0.23, 95% HDI [-0.36, -0.10], pd = 100%), and participants who watched the control video rated targets as angrier than participants who watched the fear-inducing video, (b = 0.27, 95% HDI [0.02, 0.52], pd = 98%). All other main effects and interactions were not robust.

The ordinal model supported the findings of the metric model (see Table 5); indicating that the findings are more likely to be indeed reflective of a true effect on the population.

Table 4. Overview of the Gaussian multilevel model predicting anger ratings as a function of Target Gender, Target Skin Color, and Condition.

Predictors	Median *b*	95% HDI	pd
Intercept	3.41	3.15 – 3.66	100%
Condition [Control]	0.27	0.02 – 0.52	98%
Skin Color [Black]	-0.11	-0.24 – 0.02	95%
Target Gender [Female]	-0.23	-0.36 – -0.10	100%
Condition [Fear] × Skin Color [Black]	0.02	-0.11 – 0.15	60%
Condition [Fear] × Target Gender [Female]	0.00	-0.13 – 0.13	51%
Skin Color [Black] × Target Gender [Female]	0.32	0.19 – 0.45 100%	
Condition [Control] × Skin Color [Black] × Target Gender [Female]	0.06	-0.07 – 0.19	81%
Random Effects			
SD(Participant)	0.85		

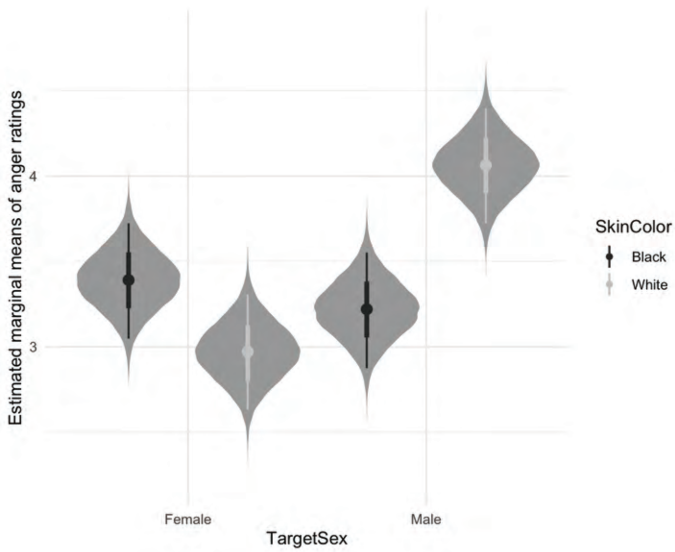

Figure 2. Estimated marginal means of the posterior distribution for anger ratings as a function of Target Sex (Female vs. Male) and Skin Color (Black vs. White). The points reflect the median and the error bars the 66% to 95% Highest Density Interval (HDI).

Discussion

In the present study, we examined the functional projection hypothesis by conceptually replicating the work by Maner et al. (2005). In contrast to Maner et al. (2005), we found that men rate highly attractive female targets

Table 5. Overview of the ordinal cumulative multilevel model predicting anger ratings as a function of Target Gender, Target Skin Color, and Condition.

Predictors	Median OR	95% HDI	*pd*	*d*
Intercept[1]	0.31[0.04]	0.24–0.40	100%	0.65[0.07]
Intercept[2]	0.83[0.10]	0.64–1.06	93%	0.11[0.07]
Intercept[3]	1.54[0.19]	1.19–1.98	100%	0.24[0.07]
Intercept[4]	2.66[0.35]	2.08–3.46	100%	0.54[0.07]
Intercept[5]	4.58[0.62]	3.49–5.99	100%	0.84[0.08]
Intercept[6]	9.32[1.39]	6.96–12.55	100%	1.23[0.08]
Intercept[7]	25.03[4.60]	17.64–36.60	100%	1.78[0.10]
Intercept[8]	61.09[14.90]	38.47–101.49	100%	2.27[0.14]
Condition[Control]	1.30[0.15]	1.02–1.63	98%	0.14[0.06]
Skin Color[Black]	0.92[0.05]	0.83–1.00	92%	0.05[0.03]
Target Gender[Female]	0.81[0.05]	0.73–0.91	100%	0.11[0.03]
Condition[Control] × Skin Color[Black]	1.01 [0.06]	1.11–1.14	58%	0.01[0.03]
Condition[Control] × Target Gender[Female]	0.99 [0.06]	0.89–1.12	57%	0.01[0.03]
Skin Color [Black] × Target Gender[Female]	1.28 [0.07]	1.14–1.43	100%	0.14[0.03]
Condition[Control] × Skin Color[Black] × Target Gender[Female]	1.05[0.06]	0.93–1.17	79%	0.03[0.03]
Random Effects				
SD(Participant)	0.83			

as more sexually aroused than medium attractive female targets independent of whether they watched the video with the White or Black female protagonist or the control video. Furthermore, contrary to Maner et al. (2005) we found that participants rated White men as angrier than Black men, White women, and Black women independent of whether they watched the fearful video or the control video. Below, we discuss these findings in detail.

The finding that men rated highly attractive White women as more sexually aroused is partly in line with Maner et al. (2005). However, in contrast with Maner et al. (2005), we did not find an effect of the video condition on the sexual arousal target ratings. Given that male participants in the control group also rated highly attractive White women as more sexually aroused than all other targets but rated themselves as less romantically aroused than participants in the other two conditions who watched sexually arousing videos, suggests that this response is not influenced by emotional state induced by the videos. Rather, this pattern likely emerged due to a transient arousal state induced by the highly attractive White female targets. This behavioral pattern, termed the sexual overperception bias, is well known (e.g., Abbey, 1982; Haselton, 2003; La France et al., 2009), and previous work has suggested that men are more likely to overinterpret attraction when they are interested in their partner compared to when they are not (Samara et al., 2021). Furthermore, contrary to our expectations we did not find support for the notion that men's rating of only highly attractive White women was due to a recency effect (Baddeley & Hitch, 1993; Broadbent & Broadbent, 1981) as the video clips used in the original study were with a White protagonist. Participants who watched the sexually arousing video clip with the Black female protagonist rated highly attractive White women as more sexually aroused than all other female targets, indicating that this effect is likely not due to priming. In conclusion, here we support previous findings by demonstrating that men overperceive attraction when confronted with highly attractive White women, and furthermore show that men's prior emotional state does not influence the sexual overperception bias.

In contrast to the findings of Maner et al. (2005), we found that participants rated White men as angrier than Black men, White women, and Black women in both the fear and control video condition. This finding goes against previous studies demonstrating that White participants rate Black target faces as more threatening than White target faces (Kenrick et al., 2010; Hugenberg & Bodenhausen, 2003). The discrepancy between our findings and the findings of Maner et al. (2005) could be due to the fact that we selected target stimuli from a standardized database (i.e., the CFD; D. S. Ma et al., 2015) and controlled for age and attractiveness, whereas the stimuli in Maner et al. (2005) were not standardized. Minor differences in appearance can influence emotional perception, for example, how red a person's face is, increases the likelihood that they are perceived as angry (S. G. Young, Thorstenson, & Pazda, 2018). Another potential reason for the discrepancy between our findings and Maner et al.'s (2005) could be that the original study was conducted with an American university student sample, whereas, in the present study, we recruited international students from a European university. Cultural and local differences between the European and American samples and different stigmatized minority groups (e.g., Moroccan in the Netherlands) might explain these discrepancies in our findings. Future research should further investigate whether and to what degree differences in target stimuli and cultural differences might influence social perception.

In conclusion, in the present study, we examined the functional projection hypothesis by (conceptually) replicating the study by Maner et al. (2005). Partly consistent with Maner et al. (2005) we found that men rate highly attractive White women as more sexually aroused but independently of which video they watched: a sexually arousing one with a White and Black female protagonist or a control video. Furthermore, in direct contrast with Maner et al. (2005), we found that participants rated White men as angrier than Black men independent of whether they watched a video meant to induce fear or a control video. Future research should investigate whether the use of standardized target stimuli and the cultural differences between samples may influence the functional projection hypothesis.

Chapter 5

The role of emotion projection, sexual desire, and self-rated attractiveness in the sexual overperception bias

Abstract

A consistent finding in the literature is that men overperceive sexual interest in women (i.e., sexual overperception bias). Several potential mechanisms have been proposed for this bias, including projecting one's own interest onto a given partner, sexual desire, and self-rated attractiveness. Here, we examined the influence of these factors in attraction detection accuracy during speed-dates. Sixty-seven participants (34 women) split in four groups went on a total of 10 speed-dates with all opposite-sex members of their group, resulting in 277 dates. The results showed that attraction detection accuracy was reliably predicted by projection of own interest in combination with participant sex. Specifically, men were more accurate than women in detecting attraction when they were not interested in their partner compared to when they were interested. These results are discussed in the wider context of arousal influencing detection of partner attraction.

Based on:
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All data, code, and materials that are associated with this paper and used to conduct the analyses are accessible on the Leiden University archiving platform DataverseNL.

Introduction

Almost half a century of research findings shows that men overperceive sexual interest in women (e.g., Abbey, 1982; Henningsen, 2004; Koeppel, Montagne-Miller, O'Hair, & Cody, 1993; Levesque, Nave, & Lowe, 2006; La France et al., 2009; Treat, Viken, & Summers, 2015), a finding aptly termed as the "sexual overperception bias" (Haselton & Buss, 2000; Haselton, 2003). It has been suggested that this bias might rely on i) projecting one's own interest onto a given partner and ii) on the set of behaviors employed in partner selection (i.e., mating strategy) (Howell et al., 2012; Koenig, Kirkpatrick, & Ketelaar, 2007). Recently, sex differences have been observed in these two factors, which revived the debate about the sexual overperception bias (A. J. Lee et al., 2020; Roth, Samara, & Kret, 2021b). Since this bias has been linked to the likelihood of sexual assault (Abbey, McAuslan, & Ross, 1998), examining the factors relating to this bias has not only theoretical implications, but is crucial in illustrating the underlying causes for miscommunication in interpersonal relationships.

While on a date, with uncertainty running high, people can make two types of errors: they can see attraction when there is none or miss it when it is there. These errors are the focus of the Error Management Theory (EMT; Haselton & Buss, 2000), an influential model explaining the sexual overperception bias. The EMT framework parallels statistical classification, in that inferring attraction when there is none (overperception) is a Type I error and missing attraction when attraction is indeed there (underperception) is a Type II error. Overperceiving attraction resembles a situation familiar to many chess players, in which a player is required to make a move even though any possible move would place her at a disadvantage ("Zugzwang"; Henningsen & Henningsen, 2010, p. 619). Similarly, a man believing that another is interested in him may feel bound to act; however, a move would place him at risk for social embarrassment. On the other hand, not noticing attraction when it is indeed present results in significant costs (i.e., a missed mating opportunity). Crucially, the costs associated with missing such a chance are asymmetrical across sexes (Haselton & Buss, 2000; Haselton, 2003). Men may suffer a greater cost if they miss a chance to reproduce (underperceive) than social embarrassment (overperceive). On the other hand, women expressing interest in a person not interested in a committed relationship may suffer costs due to missed paternal investment, according to the parental investment theory (Trivers, 1972). In conclusion, when detecting attraction, humans can either over- or under-perceive attraction and each error is associated with specific costs, which shape the resulting baseline rates for detecting attraction in others.

People are generally not accurate in predicting attraction during dates (Veenstra & Hung, 2011). For example, a recent speed-dating study showed that participants were 51% accurate in correctly inferring whether their partner would be interested in another date with them (Prochazkova et al., 2022). Interestingly, participants responded in a manner similar to their own emotional state: participants who were interested in their partner tended to indicate that their partner was also interested in them. This pattern, which we will refer to as the projection mechanism, has been suggested to drive the sexual overperception bias (Shotland & Craig, 1988) and has been supported by an emerging body of literature (Henningsen & Henningsen, 2010; Koenig et al., 2007; A. J. Lee et al., 2020). Crucially, men tend to have greater levels of sexual interest in a given partner than women (Henningsen, Henningsen, & Valde, 2006; Todd et al., 2007), which fits with the observed sex differences in sexual overperception. Nevertheless, despite the findings supporting the projection mechanism underlying the sexual overperception bias, it remains unclear whether men tend to project their own interest onto a given partner more than women (A. J. Lee et al., 2020; Roth, Samara, & Kret, 2021b).

Attraction does not emerge in a vacuum. Individual differences, such as sexual desire, and self-rated attractiveness, likely shape how the overperception bias arises during an interaction (e.g., Howell et al., 2012; Lemay & Wolf, 2016; Perilloux et al., 2012; A. J. Lee et al., 2020). The sexual overperception bias has been linked to men's higher sex drive (Baumeister, Catanese, & Vohs, 2001; Maner et al., 2005); suggesting arousal acts as a cue signaling that a mating opportunity should not be lost (Koenig et al., 2007). Indeed, emotional states have a significant impact on decision making (Damasio, 1996). Sexual arousal has been shown to increase the likelihood of risky sexual practices, likely indicating that inhibition is lowered during states of arousal (Ariely & Loewenstein, 2006; Skakoon-Sparling, Cramer, & Shuper, 2016; Skakoon-Sparling & Cramer, 2021). Another likely factor in the sexual overperception bias is self-rated attractiveness. Specifically, people with higher self-rated attractiveness are more likely to report that a given partner is interested in them (Kohl & Robertson, 2014; Lemay & Wolf, 2016). This bias could be due to expectancies that self-rated attractiveness should match with others' perception (Murray, Holmes, & Griffin, 2000). Crucially, men rate themselves as more attractive than women (Hayes, Crocker, & Kowalski, 1999), which might explain the sexual overperception bias. Thus, these findings suggest that sexual desire and self-rated attractiveness are likely to influence the sexual overperception bias.

Speed-dating paradigms have been widely used to test sex differences in mate-choice (e.g., A. J. Lee et al., 2020; Kurzban & Weeden, 2005). Speed-dating studies allow for the time- and cost-efficient investigation of the first moments of interaction (Finkel & Eastwick, 2008), as they create a space in which multiple people can have a brief date with multiple partners. Furthermore, speed-dates thus allow for the control of individual characteristics (e.g., mean attractiveness over many people, not a single data point). Importantly, speed-dating contexts create an ecologically valid setting to study sexual and romantic interactions, while maintaining a relatively controlled lab setting (Finkel et al., 2007; Eastwick & Finkel, 2008b).

In an exploratory study, we employed a naturalistic speed-dating paradigm to investigate the effects of sex, own interest, sexual desire, and self-rated attractiveness on accuracy in detecting attraction. Based on previous evidence, we would expect that men exhibit lower attraction detection accuracy than women and that projection of own interest decreases attraction detection accuracy. Furthermore, we explored whether self-rated attractiveness and sexual desire scores influenced accuracy in detecting attraction.

Methods

A total of 80 participants were recruited for a speed-dating event, 10 of which did not attend the experimental session. Furthermore, three participants (2 men) dropped out before the speed-dating started; resulting in a final sample of $N = 67$ (35 women; women: $M_{age} = 22.03$, $SD = 2.26$; men: $M_{age} = 22.61$, $SD = 1.75$). In total, 277 dates took place. All participants provided informed consent as according to the declaration of Helsinki. Participants were not compensated for their participation but received a complementary ticket to Apenheul Primate Park (Apeldoorn, the Netherlands). The procedure and methods were approved by the Leiden University Ethics Committee (CEP: 2020-02-20-M.E. Kret-V1-2169).

Procedure

Participants first filled in questionnaires regarding demographic information; the 7-level Kinsey scale (Kinsey, Pomeroy, & Martin, 1948); self-rated attractiveness (7-point scale); and the Sexual Desire Inventory (SDI, Elaut et al., 2010). Next, participants completed a battery of cognitive tasks (see Supplementary Material of Chapter 3 for an overview of all tasks used; pre-registered using the AsPredicted database [Reference number #36,394]). Following completion of the tasks, participants went on 10 speed-dates (cf. Perilloux et al., 2012; A. J. Lee et al., 2020). Men and women sat at opposite sides of a table in a 2 × 2 fashion. Barriers were used to block the view of the opposite-sex participants. At the start of each date, participants were instructed to turn the barriers perpendicularly to separate each couple. Next, a bell rang, indicating the start of the date. After 5 minutes, the participants were asked to turn the barriers in a parallel fashion and indicate a) how attractive they found their partner (7-point scale); b) how attractive they considered them as a long-term mate (7-point scale); c) whether they would be interested in going on another date with them (yes/no); d) whether their partner would like to go on another date with them (yes/no); and e) whether they knew each other (yes/no). The choice of asking participants to indicate whether they would like to go on another date with their partner (see also Overbeek, Nelemans, Karremans, & Engels, 2013; Asendorpf et al., 2011; Todd et al., 2007), instead of indicating sexual interest (as in, Perilloux et al., 2012; A. J. Lee et al., 2020) was opted for given that it is more ecologically valid procedure. Participants were given 1 minute to fill in the questionnaires. Male participants rotated from one partner to the next. After all opposite-sex couples had had a date, participants were thanked and debriefed.

Statistical Analyses

To examine accuracy in detecting attraction, we calculated accuracy scores by comparing participants' predictions regarding whether their partner would be interested in another date with them to the responses of their partners (0 = incorrect; 1 = correct). These accuracy scores were analyzed using Bayesian logistic multilevel modeling (MLM). The use of Bayesian MLM allowed us to account for the nested nature of the data, as well as examine the support for either the null or alternative hypothesis.

In total, we conducted 3 separate accuracy models. All models included accuracy scores as dependent variable and the fixed effect of Sex. In the first model, we examined whether sex and own interest influence accuracy scores by including the fixed effect of Own Interest, and its interaction with Sex. In the second model, we examined whether sex and sexual desire influence accuracy scores by including the fixed effect of Sexual Desire and its interaction with Sex. In the third model, we examined whether sex and self-rated attractiveness influence accuracy scores by including the fixed effect of Self-Rated Attractiveness and its interaction with Sex. All our binary predictors were sum coded (-1 vs. 1); whereas all other predictors were scaled to obtain a mean of 0 and a standard deviation (*SD*) of 1.

An important benefit of Bayesian analyses is that they allowed us to place a prior on our assumptions, thus incorporating prior knowledge in the parameter estimation (Jeffreys, 1961; M. D. Lee & Wagenmakers, 2013). Given that uniform priors are considered improper in logistic models since they can bias the posterior distribution of the estimate (McInturff, Johnson, Cowling, & Gardner, 2004; Seaman, Seaman, & Stamey, 2012), we opted for a Student's *t* prior distribution with 7 degrees of freedom centered at 0 with an *SD* of 1 (except for the intercept which had an *SD* of 10; Ghosh, Li, & Mitra, 2018; Gelman, Jakulin, Pittau, & Su, 2008). The use of Student's *t* priors with 7 degrees of freedom has been recommended as opposed to other distributions, as it produces reliable estimates and reduces likelihood of computational estimation problems (i.e., "slow mixing Gibbs samplers") even under conditions of separation (Ghosh et al., 2018, p. 362). Furthermore, an exponential prior with an *SD* of 1 was set for all error terms.

To facilitate the interpretation of the model coefficients, all estimates were exponentiated to obtain the odds ratio (OR). Effects were interpreted using the OR 95% Highest Density Intervals (HDI), which summarize 95% of the posterior parameter distribution (Kruschke, 2018). If the 95% HDI spanned over 1, then the effect was not considered robust; given that this would suggest that accuracy spanned over 0.5 (i.e., chance level accuracy). To examine the reliability of interactions, we performed model comparisons to calculate Bayes Factors (*BF*). As recommended, more than the default 1000 iterations per chain (1500) were set to allow for the efficient calculation of *BF*s. To test differences in interactions, we calculated a *BF* using the Savage-Dickey method (see Wagenmakers, Lodewyckx, Kuriyal, & Grasman, 2010).

To further examine the direction of the errors associated with detecting attraction, we calculated a parameter estimation by subtracting the participants' decision from their partners' decision (see also Perilloux et al., 2012). This led to a parameter that took the values of 0 if the participants were accurate, 1 if they overestimated attraction, and -1 if they underestimated attraction. We then modeled this variable as a function of Sex and Own Interest (i.e., whether the participant was interested in going on another date with his or her partner) and their interaction in an ordinal model. We opted for adjacent category models (ACM) with category-specific effects, which allowed us to detect differences between each category level (e.g., man vs. woman) for each of the potential outcomes. We set a prior of Student's t with 7 degrees of freedom, scaled at 0 and with an *SD* of 2.

For all models, we followed the procedure outlined in the WAMBS checklist (Depaoli & van de Schoot, 2017). Trace and autocorrelation plots, as well as posterior density histograms were examined. All analyses were conducted in R Studio (version 3.6.2; R Core Team, 2019) using the *brms* package (Bürkner, 2017, 2018; Bürkner & Vuorre, 2019).

Results

A Bayesian chi-square test showed that men indicated more often than women that they were interested in going on another date with their dating partner ($BF_{10} > 10$; see Table 1), consistent with previous findings. Bayesian independent t-tests showed that there was no difference between men and women in sexual desire (women: $M = 50.71$, $SD = 12.19$; men: $M = 56.48$, $SD = 15.76$; $BF_{10} = 0.83$) and self-rated attractiveness (women: $M = 4.68$, $SD = 0.73$; men: $M = 5.03$, $SD = 0.68$; $BF_{10} = 1.46$), contrary to previous findings (A. J. Lee et al., 2020; Perilloux et al., 2012).

Accuracy

In the first model, we examined whether Sex and Own Interest influenced attraction detection accuracy (Table 2; Model 1). The results showed that

Table 1. Percentage of men and women's dating choice.

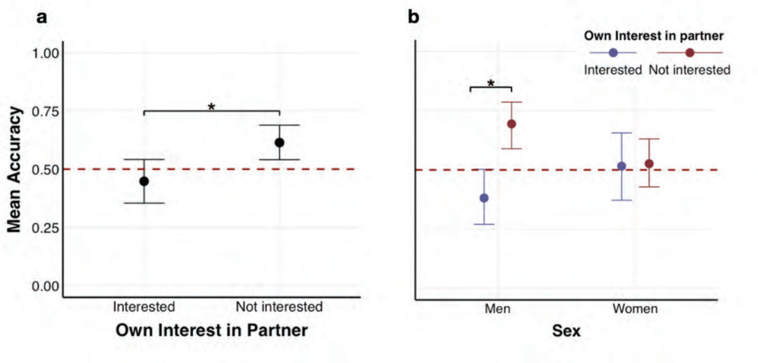
	Women	*Men*
Yes	26%	44%
No	74%	56%

Table 2. Overview of all accuracy predicting models (1–3).

Predictors	**Accuracy (Median odds ratios with 95% highest density intervals)**					
	Model 1		**Model 2**		**Model 3**	
Intercept	1.14	[.86–1.52]	1.22	1.22	1.16	[.88–1.53]
Sex	1.04	[.79–1.38]	1.03	[.78–1.36]	1.13	[.85–1.48]
Own interest	**.71**	**[.57–.88]**				
Sexual desire			1.23	[.96–1.58]		
Self-rated attractiveness					.82	[.64–1.05]
Sex × own interest	**.73**	**[.59–.90]**				
Sex × sexual desire			.84	[.66–1.07]		
Self-rated attractiveness × sex					1.09	[.86–1.39]
Random Effects						
Var(Participant)	.37		.32		.33	
Var(Partner)	.26		.31		.31	

Reliable effects (95% HDIs not containing 0) are presented in bold

overall participants were not able to reliably detect attraction. Own Interest decreased accuracy (see Figure 1a). Sex did not reliably predict attraction detection accuracy. We further examined whether the interaction between Sex × Own Interest was reliable by comparing the more complex model (i.e., including the interaction) with a more parsimonious model (i.e., excluding the interaction). The calculated Bayes Factor showed moderate evidence in favor of the complex model ($BF_{10} = 7.39$); indicating that the interaction was reliable. The interaction indicated that men were more accurate in detecting attraction when they were not interested compared to when they were interested in their partner (see Figure 1b); whereas, there was no difference in accuracy for women when they were interested in their partner compared to when they were not.



5

Figure 1. (a) Mean participant accuracy as a function of interest in their partner (interested vs. not interested). The figure shows that participants were less accurate when they were attracted to their partner than when they were not. (b) Interaction graph between Sex and Own Interest. The figure illustrates that men were less accurate in detecting attraction in their partner when they were interested in the partner compared to when they were not interested. All error bars reflect 95% CrI and the red line denotes chance accuracy level (0.5).

To further examine whether the reduced accuracy observed in men was driven by over- or underperceiving attraction when they were interested in their partner, we modeled the estimation variable as a function of Sex × Own Interest. The model (Table 3; Model 1) showed that participants were more likely to accurately detect than underperceive attraction when they were interested in their partner compared to when they were not, consistent with the projection hypothesis. The coefficient for the interaction between Sex × Own Interest spanned over 0, therefore, was not reliable.

Regarding overperception, the coefficient of Sex was not reliable. Participants were more likely to overperceive than accurately detect attraction when they were interested in their partner than when they were not. The interaction between Sex × Own Interest was not robust (see Figure 2). However, since our aim was to explore the difference between sexes in overperception of attraction, we conducted further point-null tests, which revealed that men were more likely than women to overperceive than accurately detect attraction when interested in their partner ($BF_{10} > 10$), whereas there was no difference between men and women when they were not interested in their partner ($BF_{10} = 0.95$).

Table 3. Overview of estimation predicting model as a function of sex and own interest.

Predictors	Estimation (median estimates with 95% HDIs) Model 1	
Intercept [under-accurate]	**-1.63**	**[-2.10 to -1.18]**
Intercept [over-accurate]	**1.39**	**[.79–1.38]**
Sex [under-accurate]	.44	[.02 – .87]
Sex [over-accurate]	.27	[-.14 to .65]
Own interest [under-accurate]	.57	[.26–.90]
Own interest [over-accurate]	**1.03**	**[.75–1.31]**
Sex × own interest [under-accurate]	- .09	[− .40 to .25]
Sex × own interest [over-accurate]	.28	[.01 − .58]
Random Effects		
Var(Participant)	1.06	
Var(Partner)	.59	

Reliable effects (95% HDIs not containing 0) are presented in bold

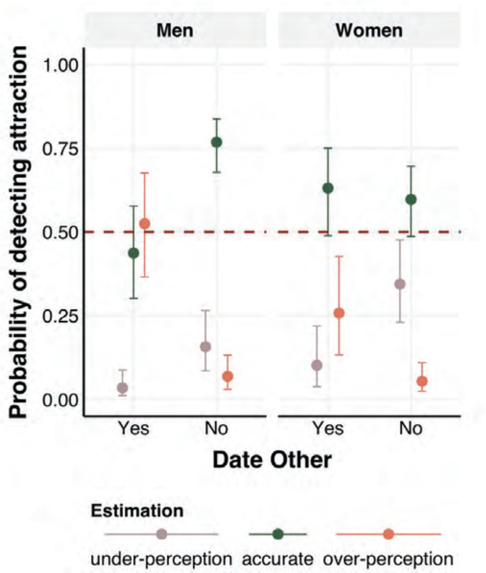


Figure 2. Interaction graph between sex and own interest showing the probability of each response category (i.e., underperception, accurate response, and overperception) for each factor level combination. The graph illustrates that men were more likely to overperceive attraction when they were interested in their partner compared to women and that men were more likely to accurately detect attraction than overperceive when they were not interested in their partner compared to women. Error bars reflect 95% CrI, and the red line denotes chance level (.5)

In the second accuracy model, we examined the effect of trait sexual desire (i.e., sexual desire scores) and its interaction with Sex. All coefficients spanned over 1, therefore, were not robust. In the third model, we examined the effect of self-rated attractiveness and its interaction with Sex. All coefficients spanned over 1, therefore, were not robust.

Baseline Differences Accounting for Accuracy Differences

In the previous analyses, we observed that men were more likely to accurately detect attraction in their partner if they were not interested in their partner, which could be due to differences in state arousal levels influencing their decision making. An alternative explanation, however, could be that men guessed their partner's response, and given that women overall tend to respond more often in the negative, it coincidentally ended up matching, leading to increased accuracy.

To examine this, we conducted a Bayesian binomial test using the *BayesianFirstAid* package (Bååth, 2014). The number of successes in detecting attraction was calculated only for instances where male participants were not interested in their partner and indicated that their partners were not interested in them. If men were indeed guessing when they were not interested in their partners, then the probability of success (i.e., a correct response) should be approximately close to 0.5 accuracy (i.e., chancel level). The results of the Bayesian binomial test showed that men were more likely to correctly indicate that their partners were interested in them (relative success frequency: 0.74, 95% HDI [0.66, 0.81]). It should be noted that if men had prior knowledge of the average positive response rates for women (e.g., because of prior dating experience), they would be able to accurately guess their responses 61% of the time ($0.26 \times 0.26 + (1–0.26) \times (1–0.26) = 0.61$; see also Place et al., 2009, for a similar approach). Since 0.61 was outside of the 95% HDI range, it can be inferred that men indeed were more likely to accurately detect attraction in their partner rather than guessing.

Discussion

The present study explored the effects of sex, own interest, sexual desire, and self-rated attractiveness in the overperception bias using a naturalistic speed-dating paradigm. Overall, we found that men were more willing to go out with their partner as compared to women. Importantly, our findings illustrate that projection of own interest influences attraction detection, particularly in men. Specifically, men were more accurate in detecting attraction if they were not interested in their partner compared to when they were. Furthermore, when men were interested in their partner, they overperceived interest more than women. However, there was no difference between sexes when participants were not interested in their partner. Women were approximately 50% accurate in detecting attraction, independent of whether they were interested in their partner or not. Sexual desire and self-rated attractiveness did not influence accuracy in detecting attraction. In the section below, we discuss these results in more detail.

First, we found that men were more likely to indicate that they were interested in going out with their partner again compared to women. This is in line with previous literature across different countries and target samples (i.e., university students and general population) showing a consistent pattern in terms of reduced male selectivity (e.g., Asendorpf et al., 2011; Fisman, Iyengar, Kamenica, & Simonson, 2006; Kurzban & Weeden, 2005; Lenton & Francesconi, 2010; McClure, Lydon, Baccus, & Baldwin, 2010; Overbeek et al., 2013; Todd et al., 2007). An explanation could be that men wanted to maximize the number of dates that they could get, consistent with EMT (Haselton & Buss, 2000) which suggests that missing a dating opportunity could be more costly for men than for women. Also, the low likelihood of women indicating that they would like to meet their partner again supports previous findings showing that women are typically choosier than men (Todd et al., 2007; Trivers, 1972). In conclusion, we show that men were more likely than women to decide that they would like to go on another date with their partner supporting the notion that men are slightly less picky regarding dating.

It might be argued that the increased tendency of men to respond positively after a date can be explained by the fact that only men had to rotate between partners in our study. This effect was described by Finkel and Eastwick (2009), who showed that the reduced selectivity is nullified when female participants also rotate between partners. However, a recent meta-analysis showed that the female choosiness effect is robust across studies, and that the rotation effect did not moderate female choosiness (Fletcher, Kerr, Li, & Valentine, 2014), nor has been replicated (e.g., Overbeek et al., 2013). It is therefore unlikely that the partner-rotation effect can explain our findings. Nonetheless, future research should examine whether the sex-rotation-setup modulates the relationship between sex and the sexual overperception bias.

Interestingly, we found that men were more accurate when they were not interested in their partner compared to when they were, whereas women were approximately at 50% independent of their interest in their partner. An explanation for this interaction between sex and the projection of own interest might be because of a link between choice biases and physiological arousal. Previous research has shown that men can detect changes in genital arousal that indicate sexual arousal within five minutes, and importantly, the correlation between genital arousal and subjective sexual arousal is reliable for men, but not for women (Kukkonen, Binik, Amsel, & Carrier, 2007; Dekker & Everaerd, 1988). Physiological arousal influences our affective state, which can in turn bias our decisions (Damasio, 1996; Storbeck & Clore, 2008). For example, men that were shown sexually arousing stimuli were more likely to indicate that attractive women were sexually aroused than not (Maner et al., 2005) and sexually aroused participants are more likely to engage in risky sexual practices (Ariely & Loewenstein, 2006; Skakoon-Sparling & Cramer, 2021; Skakoon-Sparling et al., 2016). Thus, our findings might suggest that in situations where men were not interested in their partner, this biasing emotional state was not present, thus allowing them to accurately detect that their partner is not interested in them. Indeed, previous research has suggested that cues signaling disinterest might be easier to detect than cues signaling interest, especially in zero-order acquaintance settings (Hall et al., 2015). Given that the concordance between bodily and subjective arousal is not as robust in women, it is not surprising that women were not necessarily biased as much as men in terms of detecting attraction. In conclusion, our findings extend previous evidence showing that accuracy does not only depend on sex or projecting one's own emotion on a partner, but accuracy is in fact dependent on an interplay between these two factors.

The estimation model complemented the results of the accuracy models. Interestingly, we found that both men and women were likely to overperceive attraction when they were interested in their partner compared to when they were not. Crucially, when men were interested in a partner, they overperceived interest more than women, which likely explains the decreased accuracy exhibited in men. These findings are partially consistent with EMT (Haselton & Buss, 2000). EMT predicts that men would be more likely to overperceive attraction than women. However, our findings highlight that perhaps the effect of being attracted to a given partner should be incorporated as an additional parameter in EMT (A. J. Lee et al., 2020), because if men are not interested, they are in fact very likely to be accurate regarding attraction. Thus, our findings support and further extend the EMT framework by showing that the addition of interest in a given partner might be crucial in predicting overperception.

Curiously, we found no effect of sexual desire on attraction detection accuracy. Our results are inconsistent with previous findings (A. J. Lee et al., 2020; Perilloux et al., 2012). One reason for this discrepancy could be that previous studies focused on short-term mating strategies, whereas we examined overall sexual desire. It is well known that sociosexuality—the inclination to form short-term relationships (Kinsey et al., 1948)—differs between men and women (Clark, 1989). Importantly, given that sexual desire and sociosexuality are highly correlated (O'Connor et al., 2014), we expected to observe similar findings as Lee et al. (2020). However, in our dataset we found no difference in sexual desire between sexes, whereas in Lee et al. (2020) sociosexuality was significantly higher for men than women (see also Roth, Samara, & Kret, 2021b). Either due to the differences in instruments or the differences in sample characteristics, we did not find an effect of sexual desire on attraction detection accuracy. Future research should investigate the effect of sexual desire and its association with sociosexuality and sex on attraction detection accuracy.

In addition, we found no effect of self-rated attractiveness on accuracy, in contrast with previous research (A. J. Lee et al., 2020; Perilloux et al., 2012). A potential explanation for this finding could be that in the present study, we examined physical attractiveness exclusively. We could therefore only speculate that our sample was similar to previous research in terms of other factors that can constitute attractiveness (e.g., personality). Nevertheless, previous research has shown that personality has negligible effects on both men and women's desirability (Kurzban & Weeden, 2005). Furthermore, self-rated attractiveness has been found to play a role in overperception together with short-term mating styles (Howell et al., 2012; A. J. Lee et al., 2020; Perilloux et al., 2012). However, in our sample, most participants indicated they were searching for a long-term relationship. Thus, this pronounced long-term relationship focus might have prevented the interplay between self-attractiveness and mating strategy to emerge.

One crucial point that cannot be disentangled in the context of the present study is whether women and men interpreted the question regarding the wish to go on another date with their partner similarly. Specifically, in previous studies, participants were asked to indicate how sexually interested they were in their partner (A. J. Lee et al., 2020; Perilloux et al., 2012). However, in the present study, participants were asked to indicate whether they would like to go on another date with their partner (see also Asendorpf et al., 2011; Overbeek et al., 2013; Todd et al., 2007, for similar setups). It could be argued that this question led female participants to respond to the perceived question of "Are you romantically interested in your partner?" and male participants to respond to the question of "Are you sexually interested in your partner?" Even though this cannot be tested in the present study, it is quite likely that the response pattern would have remained the same. Previous research has shown that romantic interest and sexual interest follow the same sex differences, where women are choosier than men (Fletcher et al., 2014). Crucially, asking about the wish to go on another date rather than sexual interest is a strength of the current study, as it increases its ecological validity, given that it resembles real-life situations more closely (e.g., online dating sites; Kurzban & Weeden, 2005).

It should be noted that in the present study, we examined only heterosexual participants; therefore, our findings cannot be directly generalizable to non-heterosexual populations. Furthermore, our sample consisted predominantly of university students. University students offer a prime target sample for sexuality research given the greater interaction frequency with opposite-sex partners and the increased necessity to infer sexual interest (Perilloux et al., 2012) and are commonly the primary target for such studies (e.g., A. J. Lee et al., 2020). Importantly, most participants in our study were interested in a committed relationship (only 2 participants were not), which limited our ability to investigate whether different mating strategies might influence attraction detection accuracy (e.g., A. J. Lee et al., 2020; Perilloux et al., 2012). Crucially, a limitation that stems from the use of a speed-dating setup is that we cannot assess whether the personality characteristics and social skills of our sample are representative of a wider population (Finkel & Eastwick, 2008). Future research should investigate more heterogeneous samples in terms of educational background and age.

The current study shed light on several factors that underlie the sexual overperception bias. Given that this bias is linked to the likelihood of assault (Abbey et al., 1998), the study's findings are crucial in elucidating and reducing miscommunication between the sexes in dating contexts (Perilloux et al., 2012). Crucially, we showed that sex and projection of own interest are intertwined and should not be seen as competing, but rather as complementary explanations. Importantly, our findings cast doubt on previous research suggesting that one's own interest, sexual desire, and self-rated attractiveness might fully explain the sexual overperception bias (A. J. Lee et al., 2020; Roth, Samara, & Kret, 2021b). Therefore, our results not only support the EMT framework, but further suggest that the incorporation of sex differences in projection of own interest might be a useful addition to the EMT framework.

Chapter 6

Can third-party observers detect attraction in others based on subtle nonverbal cues?

Abstract

In a series of three studies, we examined whether third-party observers can detect attraction in others based on subtle nonverbal cues. We employed video segments of dates collected from a speed-date experiment, in which daters went on a brief (aprox. 4 min) blind-date and indicated whether they would like to go on another date with their brief interaction partner or not. We asked participants to view these stimuli and indicate whether or not each couple member is attracted to their partner. Our results show that participants could not reliably detect attraction, and this ability was not influenced by the age of the observer, video segment location (beginning or middle of the date), video duration, or general emotion recognition capacity. Contrary to previous research findings, our findings suggest that third-party observers cannot reliably detect attraction in others. However, there was one exeption: Recognition rose above chance level when the daters were both interested in their partners compared to when they were not interested.

Based on:
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All data, code, and materials that are associated with this paper and used to conduct the analyses are accessible on the Leiden University archiving platform DataverseNL.

Introduction

Humans swiftly produce and infer emotional states through facial or bodily expressions in everyday life. Even though some emotional states might be easier to recognize than others (e.g., happiness Camras & Allison, 1985), humans can efficiently communicate their emotional state using nonverbal cues even in as little as 3 s (Melzer, Shafir, & Tsachor, 2019). A crucial emotional state regarding mate choice, yet commonly misinterpreted, is *attraction* (e.g., Farris, Treat, Viken, & McFall, 2008; Haselton & Buss, 2000)). Observing and decoding subtle nonverbal cues, such as blushing or a faint smile, might facilitate answering whether a person would be interested in seeing another again; however, such nonverbal cues can be accurately detected as efficiently as other emotions has not yet been examined. In the present study, we investigated whether third-party observers could detect attraction between strangers during a speed-date using thin video slices.

6

Attraction is a powerful emotion. It can guide our behaviour during social interactions, pulling us towards people we find attractive or interesting (Montoya & Horton, 2020). Like other emotions (e.g., anger or fear), attraction influences others' behavior (e.g., Ekman, 1992; Montoya et al., 2018; Russell, 2003). Notably, the experience of attraction is linked to heightened arousal, which previous research has demonstrated by measuring these psychophysiological processes via heart rate and electrodermal conductance (Foster, Witcher, Campbell, & Green, 1998; Prochazkova et al., 2022). These physiological processes can act as somatic markers (Damasio, 1996) and are used in efficiently interpreting an ambiguous situation, such as a first romantic encounter. Interestingly, previous research has shown that people on a speed date can indicate whether they would like to meet their partner again only after 3 s of looking at their partner, and their judgment remains (mostly) consistent throughout the speed date (Prochazkova et al., 2022). Thus, these findings illustrate that attraction can emerge quickly, linked to specific physiological processes, and guide behaviour during social interactions.

Humans might often hide their feelings or convey the opposite to steer social interactions in the desired direction (Kret, 2015). However, despite our best efforts to control our emotional expressions, there are specific cues over which we have no control (Grammer, Kruck, Juette, & Fink, 2000; Prochazkova & Kret, 2017). For example, upon viewing someone that interests us, our pupils might dilate, and a distinctive blush might appear on our face (Eibl-Eiblsfeldt, 1989; Keltner & Buswell, 1997). Indeed, nonverbal cues primarily communicate attraction (Givens, 1978). The vast repertoire of expressions encapsulating attraction and how they are expressed have prompted the term "courtship dance" (Birdwhistell, 1970). Multiple signals reflecting attraction have been catalogued, even if the senders might not always be aware of producing them (Grammer, Kruck, & Magnusson, 1998; McCormick & Jones, 1989; M. M. Moore, 2010). Coy smiles, genuine smiling, blushing, hair flipping, leaning forward, roling the pelvis, and head tilting are a few of the signals listed in previous research (Argyle, 1988; Eibl-Eiblsfeldt, 1989; Givens, 1978; Grammer et al., 2000; M. M. Moore, 1985, 2010). Therefore, even if there is no clear-cut expression, there are subtle nonverbal signals that, when expressed, indicate interest and availability.

Emotional expressions are not only sent to others, however, but they also need to be efficiently interpreted for them to be informative and useful. However, a given signal can often be ambiguous. This ambiguity is similar to a verbal exchange, where one statement can be interpreted in multiple ways by the perceiver, who is tasked with inferring the statement's message (for a comprehensive review, see Vangelisti, 2015). It is important to note that it might be easier to detect attraction in a later phase of a speed date than during a first impression (e.g., Place et al., 2009). This is not surprising, given that beginning of dates is typically more stilted than later during the interaction. During a first impression, it is typical that people are more reserved and do not display as many nonverbal behaviours as they typically would, perhaps to reduce the likelihood of rejection or to adhere to social norms (Kunkel, Wilson, Olufowote, & Robson, 2003). This might translate into people being better able to detect the absence of attraction rather than its precense, as shown in a recent study (Hall et al., 2015). In that study, participants watched six one-minute videos of people on a date (only one person from the couple; 3 men and 3 women). Participants indicated, amongst other items, whether the person depicted was flirting with their partner (yes/no). Accuracy was coded as a match between the participants' and the daters' responses. The results showed that participants were more accurate in detecting (the absence of) attraction when the daters were not flirting than the presence of attraction when the daters were flirting. The authors argued that since base rates of flirting behaviours in zero-order acquaintance settings are low, people might lack knowledge of cues reflecting attraction to detect and interpret them efficiently. These findings suggest that it is challenging to detect attraction in others during first impressions since behaviours signaling attraction are not typically displayed.

Notably, previous research typically utilized videos of dates as stimuli and asked third-party observers to indicate whether the people involved in the date were attracted to each other or not (e.g., Hall et al., 2015; Place et al., 2009). However, factors such as the angle and distance of the camera from the people might have made it challenging to observe minute emotional expressions (for instance, a faint or coy smile), which would have facilitated gauging the others' interest. In contrast, in other previous work (Prochazkova et al., 2022), participants were filmed in close range, so subtle spontaneous emotional reactions are easy to detect. Therefore, an uninvolved third-party observer might be able to decode attraction cues better than the persons in the date themselves if the date allowed for less stilted behaviours and if subtle expressions were expressed and visible. Furthermore, despite previous research showing both daters simultaneously (e.g., Hall et al., 2015; Place et al., 2009, 2012), the effect of synchronous behaviour between the daters has not been directly examined. Indeed, mimicry has been shown to increase the chance of liking and affiliation with others (Chartrand & Bargh, 1999; Cheng & Chartrand, 2003; Lakin & Chartrand, 2003; Roth, Samara, Tan, et al., 2021; Roth, Samara, & Kret, 2021a). Therefore, if synchronous behaviour between two daters facilitates the detection of attraction (i.e., dater A smiles and dater B reciprocates that smile), then the presentation of randomly shuffled videos would impair accuracy in detecting attraction. Thus, two factors that might influence accuracy in detecting attraction in others, namely subtle expressions and synchronous behaviour, have not been disentangled in previous research.

Many factors might influence detecting attraction in others (Place et al., 2009). Place et al. (2009) examined the possible effects of age on attraction accuracy. In their adult sample, they found no evidence that age mattered. However, the age range of their sample was limited to young adults (18-27 years old). Thus, whether age influences accuracy in detecting attraction when including a wider age range remains unclear. Nevertheless, there is a reason to assume that age may influence detecting attraction. First, young individuals, specifically children, will have less relationship experience than adults. Given that such experience is essential for detecting and interpreting emotions according to the Perception-Action Model of Empathy (PAM; de Waal & Preston, 2017), adults, who are more experienced with romantic attraction, should detect attraction in others considerably better than children. Second, brain areas important for emotion expression processing are still under development in children (Thomas, De Bellis, Graham, & LaBar, 2007). Thus, younger children have more difficulties recognizing emotions than older children and adults, especially when the emotions are complex (Pons & Harris, 2005) or social and subtle (Thomas et al., 2007). Third, attraction may not be evolutionary relevant for young children before they enter puberty and become interested in sexuality (Baams, Dubas, Overbeek, & van Aken, 2015). It is, thus, more likely that children become better at detecting attraction with age.

Here, in a series of three experiments, we examined whether third-party observers could detect attraction between strangers on a date after observing only thin slices of that interaction (i.e., 3-9 s). Specifically, we examined whether this is influenced by a) age (Experiment 1 and Experiment 2) or the interaction phase (i.e., first impression or middle of the date) and stimulus presentation duration (Experiment 3); and b) when the person observed is indeed interested in their partner than when not. To investigate these hypotheses, we asked participants to indicate whether the daters would like to go on another date with their partner, which was considered a proxy for attraction. Previous evidence has shown a moderate correlation between physical attraction and the likelihood of wanting to meet a partner again (Veenstra & Hung, 2011). We expected that third-party observers would be significantly more accurate than chance level in detecting attraction, given the plethora of subtle expressions visible in the video segments. Based on previous findings (Hall et al., 2015), we also aimed to examine whether detecting attraction is facilitated as a function of whether the person depicted is interested in their partner or not. Hall et al. (2015) found that lack of attraction is easier to detect. However, if people were interested in their partner, they might produce more salient and interpretable cues than not, resulting in increased attraction detection accuracy.

General methods

Stimuli

Stimuli consisted of muted video fragments collected during a blind date study conducted at the Lowlands festival (Lowlands, the Netherlands) (Prochazkova et al., 2022). In that study, participants were seated at opposite ends of a table with a barrier blocking their partner from view (see Figure 1). Participants were informed that they would have three separate interactions with their partner: a first impression phase (FI; 3 s), an eye contact phase (EC; 2 min), and a verbal interaction phase (VI; 2 min). The EC and VI phases were counterbalanced across couples. During the FI phase, the barrier was lifted, and participants saw each other in a flash of 3 s and were not allowed to speak. The barrier was then lowered, obscuring the partners from view. During the VI phase, the barrier was lifted, and participants were allowed to communicate with each other for 2 min. During the EC phase, the barrier was lifted, and participants were not allowed to communicate with each. The barrier was lowered again between the VI and EC phases. Video was recorded using the Tobii wearable eye-tracker glasses (Tobii Sweden), meaning that the video of each participant reflects the first-person perspective of their partner. In our study, all stimuli started as soon as the barrier was lifted and continued for 3, 6, or 9 s. Only stimuli from the FI (Study 1, Study 2, Study 3) and VI (Study 3) were used in the present study. All stimuli were shown against a grey background. Out of the 32 videos used, 16 depicted individuals (10 men and 6 women) that indicated that they were interested in their partner (50% base rate across all individuals). As a manipulation check, we examined differences in frequency and duration of behaviors signaling attraction between daters attracted to their partner compared to daters that were not attracted to their partner for FI and 9s VI stimuli. The results showed that in 9s VI stimuli, participants interested in their partner showed a greater duration of such behaviors, such as coyness, than participants who were not interested in their partner (see Supplemental Material).

Figure 1. Experimental setup of Prochazkova et al. (2022). Reprinted with permission.

(Current) experimental task

The experimental task was controlled by a script written in E-Prime (Version 2; Psychology Software Tools, Pittsburgh, PA). Figure 2 illustrates the progression of a typical trial in the task. Each trial started with a screen showing the trial number (1.5 s), followed by the presentation of the videos either in a side-by-side (woman left) or one-by-one fashion (3 s). Participants were instructed to attend to the video presented, with no specific instructions regarding which video they should attend to specifically. Another screen followed on which participants were asked to indicate whether the person(s) they viewed would like to go on another date with their partner (separately for the male and female couple member displayed: "Does he want to go on another date with her?" "Does she want to go on another date with him?") and remained on the screen until an answer was provided (in Experiment 1, responses were provided using a pen and paper questionnaire). Finally, a screen appeared on which participants were required to indicate their degree of certainty regarding the previous response, which also remained on the screen until an answer was provided.

Statistical analyses

We computed accuracy scores by comparing the participants' responses (0 = no; 1 = yes) with the actual responses of the members of the dating cou-ples. These accuracy scores (0 = incorrect; 1 = correct) were analyzed using Bayesian logistic multilevel modeling (MLM). Bayesian MLM's use allowed us to both account for the dependence in our data and quantify the support for either the null or alternative hypothesis present in our data (Jeffreys, 1961; M. D. Lee & Wagenmakers, 2013; van Doorn et al., 2019). All our analyses consisted of three models, each testing a separate hypothesis. We conducted

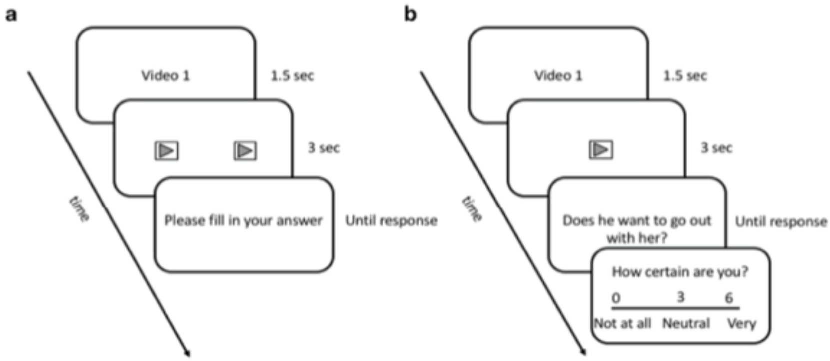

Figure 2. Progression of a typical trial in the experimental task for Experiment 1 (a) in which both members of a couple were presented simultaneously, and responses were logged using pen and paper and Experiment 2 (b), where only one member of the couple was displayed. The question in figure b is an example for only the male couple member presented, the questions were formed depending on the couple member's gender.

an intercept-only model to examine whether people can accurately detect attraction. In the second model, we examined whether accuracy differs as a function of age or the video segments properties by including the fixed effect of Group or Video Condition for Experiments 1-2 and Experiment 3, respectively. In the third model, we examined whether the accuracy of the uninvolved third-party observers was enhanced when the daters themselves were attracted to their partner by including the fixed effect of Attraction to Partner. Additionally, in Experiment 1, we examined whether synchronous behaviour between the daters influences accuracy by including the fixed effect of Shuffled condition. All our models included a random effect of Participant. The minor adjustments due to the factors present in each experiment are further explained in the corresponding statistical analyses section.

There has been a long-standing debate about optimal priors for logistic models (e.g., Christensen, 2011; Gelman, Jakulin, Su, & Pittau, 2007). Uniform priors can exert undue influence on the posterior distribution of the underlying parameter (McInturff et al., 2004) and therefore, weakly informative priors are better suited (Seaman et al., 2012). We have opted to use a normal distribution for all input values despite previous literature pointing towards Cauchy priors (Gelman et al., 2007; Ghosh et al., 2018). All priors were centered to 0 and had a standard deviation of 1 for all coefficients except the constant ($SD = 0.8$). We further included an exponential prior ($SD = 1$) to all error terms. Finally, binary inputs were sum-coded (-1 vs. 1).

The interpretation of Bayesian logistic MLM estimates might not be intuitive. Therefore, we report multiple estimates to illustrate the robustness and uncertainty of an effect (e.g., see Martin et al., 2020). The median estimate coefficient is reported together with the 95% Highest-Density Credible Intervals (*HDI*), which summarize the posterior parameter values with the highest probability density (Kruschke, 2018). Furthermore, we report the probability of direction (*pd*), the proportion of the probability in support of a hypothesized positive or negative effect (Makowski et al., 2019). To examine the robustness of interactions, we performed model comparisons to calculate Bayes Factors (*BF*). *BF*s are interpreted following the scheme of Jeffreys (1961), who suggested *BF* values of 0-3 to be considered anecdotal evidence, 3-10 moderate, and greater than ten strong evidence in favour of either the alternative (BF_{10}) or null (BF_{01}) hypothesis.

Model convergence was examined using the guidelines detailed in the WAMBS checklist (Depaoli & van de Schoot, 2017). Specifically, for every model, we examined the Gelman-Rubin diagnostic values (a value close to 1 indicates convergence), as well as trace, autocorrelation plots, and density histograms for all posterior distributions. Analyses were conducted in R (version 3.6.1; R Core Team, 2019) using the *brms* package (Bürkner, 2017, 2018).

Experiment 1

Methods

Participants

Sixty-one adults ($n = 61$; age range = 18-54; *M* age: 26.13, $SD = 6.40$; 42 female) and 60 children (2 excluded for inattentiveness, final $n = 58$, age range: 8-14; *M* age: 10.00, $SD = 1.63$; 25 female) were recruited during a science festival (Rotterdam, the Netherlands). The sample size was determined by the number of people that wanted to participate during this event and is comparable to the studies by Place et al. (2009). All participants provided informed consent and were informed that they could withdraw their participation with no adverse consequences as according to the Declaration of Helsinki. For children younger than 12 year old, consent was provided by their parents, whereas for children older than 12 years old, consent was provided by both the parents and the children. The study was approved by the Leiden University Psychology Ethics Committee (CEP19-0424/290). Participants were not remunerated for their participation.

Stimuli

Stimuli consisted of videos of the couple members during the first impression (FI) presented side by side on the display for 3 s (see Figure 3). The 3 s videos were selected as in the original study, participants could report within 3 s

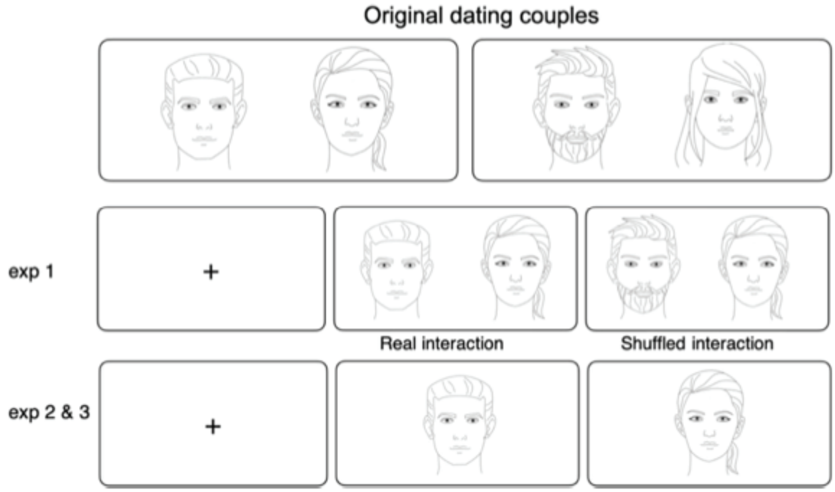

Figure 3. Stimuli and stimulus progression.

whether they were interested in their partner, and crucially, their responses remained relatively consistent throughout the speed date (Prochazkova et al., 2022). The original videos (i.e., with background) were displayed. To examine the effect of synchrony on the detection of romantic interest, we manipulated the presentation of interactions in the couples (i.e., Shuffled condition). Specifically, half of the couples ($n = 8$) were not shuffled and were presented as collected (henceforth known as *real* interaction). In contrast, the rest of the videos were randomly shuffled and presented to create fake interactions that actually never took place (e.g., see Figure 3: bearded man dated the woman wearing her hair down but was presented in the Shuffled condition next to the woman wearing her hair in a ponytail). This factor was implemented as a control to ensure that it is specific cues of the person not necessarily the interaction between the couple that influenced the participants' response.

Procedure

Participants were asked to provide informed consent. Next, they were seated in front of a computer monitor (25-inch, 1680 ×1050 resolution; 60 Hz refresh rate). Participants filled in their answers for each trial in a paper questionnaire. The task consisted of 16 trials and lasted approximately 5 min. After the end of the task, participants were debriefed and thanked for their participation.

Table 1. Overview of all accuracy predicting models (1–3) for Experiment 1.

Predictors	Accuracy (Median β with 95% HDIs)		
	Model 1	**Model 2**	**Model 3**
	β(95% HDI)	β(95% HDI)	β(95% HDI)
Intercept	-0.06 [-0.15, 0.02]	-0.06 [-0.13, 0.01]	-0.06 [-0.13, 0.01]
Age Group		-0.14 [-0.21, -0.07]	-0.15 [-0.22, -0.07]
Shuffled		-0.01 [-0.07, 0.06]	-0.01 [-0.07, 0.05]
Attracted to Partner			0.36 [0.29, 0.42]
Age Group × Shuffled		0.04 [-0.02, 0.10]	
Age Group × Attracted to Partner			0.14 [0.07, 0.20]
Shuffled × Attracted to Partner			0.08 [0.02, 0.15]
Age Group × Shuffled × Attracted to Partner			-0.01 [-0.08, 0.05]
Random Effects			
Var(Group ID)	0.02	0.00	0.01
Var(Participant)	0.00	0.00	0.00

Statistical Analyses

We performed all analyses as detailed in the Statistical Analyses [General Methods section] with the following adjustments: To account for the fact that the videos were shuffled, we included the fixed effect of Shuffled and its interaction with Age Group and Attraction to Partner in Models 2 and 3, respectively. Furthermore, given that participants performed the study in the presence of other participants, we recorded their subgroups (*GroupID*) and included a random intercept per Participant nested in *GroupID*.

Results

All models are presented in Table 1. Contrary to our hypothesis, we did not find robust evidence that participants could detect attraction overall (β = -0.06; 95% HDI [-0.15, 0.02]; $p_{-} = 93.62\%$). Our hypothesis that age would influence the detection of attraction was confirmed: the model showed that children performed worse than adults (β = -0.14, 95% HDI [-0.21, -0.07], $p_{-} = 99.99\%$); however, adults did not substantially differ from chance level (i.e., 0.5; see Figure 4a). There was no substantial difference in accuracy as a function of Shuffled (β = -0.01, 95% HDI [-0.07, 0.06], $p_{+} = 60.64\%$) or an interaction between Shuffled and Age Group (β = 0.04, 95% HDI [-0.02, 0.10], $p_{+} = 90.76\%$; $BF_{01} = 12.59$) indicating that synchrony did not influence accuracy in detecting attraction.

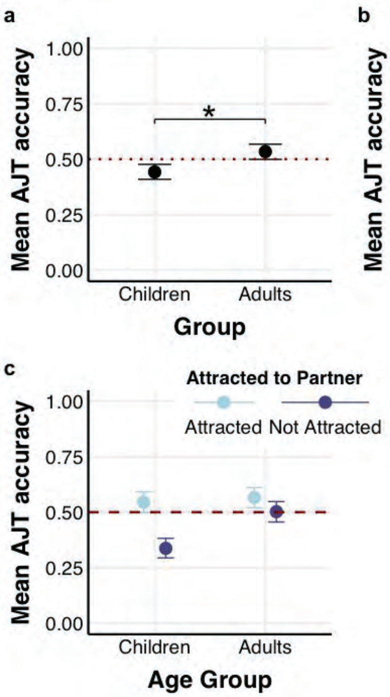

Figure 4. (a) Mean accuracy in the Attraction Judgment Task (AJT) as a function of Group (Children vs. Adults). The graph shows that children performed below chance level (0.5), whereas adults did not differ from chance level; (b) Accuracy as a function of Attraction to Partner (Attracted vs. Not attracted). The graph shows that participants performed above chance level (0.5) when the person depicted was attracted to their partner compared to when they were not. (c) Accuracy as a function of Attraction to Partner (Attracted vs. Not attracted) and Age Group (Children vs. Adults). The graph shows that children performed worse when the person depicted was not attracted to their partner. The red line denotes chance level (0.5) and all error bars reflect 95% Credible Intervals (CrI).

To examine whether participants can detect the presence of attraction, we included the fixed effect of Attraction to Partner and its interaction with Age Group and Shuffled. The model showed that participants were more accurate when the person in the video indeed was attracted to their partner than when they were not (see Figure 4b; β = 0.36; 95% HDI [0.29, 0.42], p_+ = 100%). Children performed worse than adults (β = -0.15, 95% HDI [-0.22, -0.07], p_- = 100%). There was no substantial difference between real and shuffled videos (Table 1, Model 2; β = -0.01, 95% HDI [-0.07, 0.05]; p_+ = 59.55%), or an interaction between Shuffled *by* Age Group (β

= 0.04, 95% HDI [-0.02, 0.11], p_+ = 89.80%; $BF_{01} > 10$). The interaction between Group and Attraction to Partner was reliable (see Figure 4c; β = 0.14, 95% HDI [0.07, 0.20], p_+ = 100%; $BF_{10} > 10$); indicating that children performed worse when the daters depicted were not attracted to their partner compared to when they were attracted to their partner. The interaction between Shuffled and Attraction to Partner was not reliable (β = 0.08, 95% HDI [0.02, 0.15], p_+ = 99.22%; $BF_{10} = 0.68$), as well as the interaction between Shuffled, Attraction to Partner, and Age Group (β = -0.01, 95% HDI [-0.08, 0.05], p_- = 66.25%; $BF_{01} > 10$). For that reason, these interactions are not interpreted.

Discussion Experiment 1

In Experiment 1, we aimed to examine if a) people accurately detect attraction; b) whether this ability is influenced Age Group (as an index of experience); c) synchrony between daters; and d) whether accuracy is enhanced when the daters themselves were interested in their partner. The results of Experiment 1 showed that participants overall did not detect attraction or the absence of it better than chance level (0.5). Regarding our second hypothesis, we found that children performed below chance level. Crucially, we found that videos in which couple members were attracted to their partner were detected more accurately than ones in which they were not. Synchrony between daters did not seem to influence the ability to accurately detect attraction in others.

A possible explanation for the low accuracy observed could be that attending to the videos required dividing attention over two separate video streams (one for the male and one for the female). This division of attention combined with the brief duration of the video segments (3 s) might have impaired efficient processing of our stimuli. Indeed, previous research has shown that dividing attention has a negative effect on decision making (e.g., McCrink & Hubbard, 2017, for operational momentum). Therefore, in Experiment 2, we simplified our experimental procedure by presenting stimuli one-by-one.

Experiment 2

The results of Experiment 1 showed that synchrony does not influence the accuracy of participants in detecting whether daters were attracted to their partner or not. Therefore, in this experiment, we presented the same stimuli as in Study 1, with the sole difference that only one couple member was presented in every trial so as to reduce cognitive load. This adjustment allowed us to examine whether reduced cognitive load would enhance accuracy in detecting attraction. Furthermore, participants performed the experimental task on a personal laptop.

6

Methods

Participants

Thirty-eight adults (age range: 18-66; *M* age: 40.40, $SD = 15.30$; 21 female) and 26 children (age range: 8-12; *M* age: 9.80, $SD = 1.40$; 12 female) were recruited during the Afternoon and Night of Discoveries events (Leiden, the Netherlands), respectively. All participants provided informed consent and were informed that they could withdraw their participation with no adverse consequences as according to the Declaration of Helsinki. The study was approved by the Leiden University Psychology Ethics Committee (CEP19-0722/418). Participants were not remunerated for their participation. Differences in participants' age and gender between Experiment 1 and Experiment 2 are reported in the Supplementary Material.

Procedure

After participants provided informed consent, they were invited into the experimental cabin and seated in front of a Dell laptop (15-inch display; 60 Hz refresh rate). Instructions were presented on the display and also explained by a researcher. Participants were informed that they would view a series of videos and indicate whether the person depicted would like to go on another date with their partner or not and their level of certainty regarding their judgment. Participants were instructed to respond as fast and accurately as possible. To limit distraction, participants wore noise-reduction earmuffs throughout the task.

Participants were prompted to indicate whether the person would like to go on another date with their partner by pressing the corresponding keyboard key (*j*/*y* for ja or yes, and *n* for no); followed by their certainty regarding their decision from 0 (*not at all*) to 6 (*very*) with 3 indicating neutral level of certainty. The task consisted of 32 trials in total and lasted approximately 5 min.

Statistical Analyses

Trials with RTs < 200 ms were excluded (0.25% adults' dataset; 0.24% children's data; Whelan, 2008). We followed the same modeling steps as in Experiment 1 with the only difference that the random intercept per participant was not nested in GroupID (since there was no such factor in the current design).

Results

First, we did not find substantial evidence that participants could reliably detect attraction (β = -0.01; 95% HDI [-0.10, 0.08], p_{-} = 56.62%). To examine our second hypothesis, we included the fixed effect of Age Group.

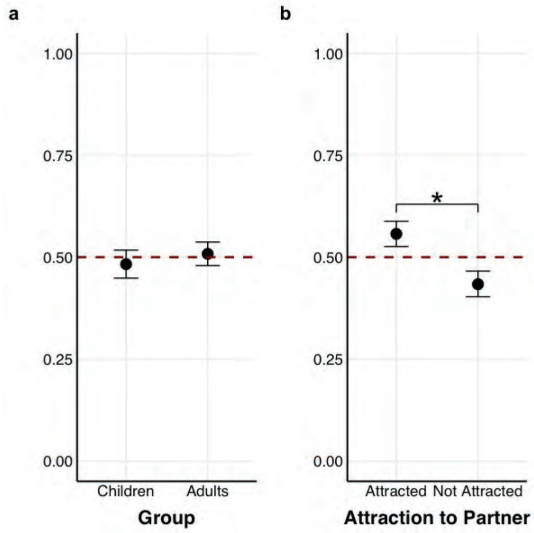

Figure 5. (a) Accuracy as a function of Group (Children vs. Adults). The graph depicts that both children and adults performed at chancel level (0.5); (b) Accuracy as a function of Attraction to Partner (Attracted vs. Not attracted). The graph depicts that participants performed above chance level (0.5) when the person depicted was attracted to their partner compared to when they were not. The red line denotes the chance level, and all error bars reflect 95% Credible Intervals (CrI).

The model showed that accuracy did not substantially differ as a function of Group (β = -0.05; 95% HDI [-0.14, 0.04]; p_{-} = 85.70%). Next, we modeled participants' accuracy by including the fixed effect of Attraction to Partner and its interaction with Age Group. As in Experiment 1, the model showed that participants were more accurate when the person in the video indeed was attracted to their partner than not (β = 0.25; 95% HDI [0.16, 0.34]; p_{+} = 100%; see Figure 5; Table 2, Model 3). Accuracy did not differ as a function of Age Group (β = -0.05; 95% HDI [-0.14, 0.04]; p_{-} = 86.25%). The interaction between Age Group and Attraction was not reliable (β = 0.09; 95% HDI [0.00, 0.18]; p_{+} = 97.09%; BF_{01} = 3.45). For that reason, the interaction is not interpreted.

Discussion Experiment 2

The goal of Experiment 2 was to assess whether the low accuracy observed in Experiment 1 was the result of the simultaneous video stream used in Experiment 1. Our results are straightforward. First, we found no difference between children's and adults' accuracy. Further, we replicate the finding

Table 2. Overview of all accuracy predicting models (1–3) for Experiment 2.

Predictors	Accuracy (Median estimate of the coefficient with 95% HDI)		
	Model 1	**Model 2**	**Model 3**
	β(95% HDI)	β(95% HDI)	β(95% HDI)
Intercept	-0.01 [-0.10, 0.08]	-0.02 [-0.11, 0.07]	-0.02 [-0.11–0.07]
Age Group		-0.05 [-0.14, 0.04]	-0.05 [-0.15, -0.04]
Attracted to Partner			0.25 [0.16, 0.34]
Age Group × Attracted to Partner			0.09 [0.00, 0.18]
Random Effects			
Var(Participant)	0.00	0.00	0.00

participants could not reliably detect attraction or its absence in the dating videos. Interestingly, we also replicate the effect that participants detected attraction somewhat more accurately (56%) when the person depicted was attracted to their partner than not (44%).

Experiment 3

In Experiment 3, we manipulated the phase and length of the presented video segment. We used muted videos from the Verbal Interaction (VI) phase of Prochazkova et al.'s study (2022) and varied their lengths (i.e., 3, 6, and 9 s). Furthermore, to probe whether the observed accuracy was due to a general low emotion recognition accuracy, we included an additional Emotion Recognition Task (ERT). Low scores in the ERT would indicate that participants could not detect basic emotional expressions and might explain the low accuracy in our task of primary interest (AJT). Also, to ensure that the low accuracy was not due to potential individual differences that might influence emotion detection accuracy, we collected information using the Autism-Spectrum Quotient (AQ; Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001) and Beck-Depression Inventory (BDI-II; Beck, Steer, & Brown, 2011). Participants also indicated whether they were in a relationship or not and its duration. Because in Study 2 there were no differences between children and adults in the accuracy of detecting attraction, for feasibility, we decided to recruit adults only.

Methods

Due to the restrictions because of the COVID-19 pandemic, data collection took place online using the Gorilla platform (Anwyl-Irvine, Massonnié, Flitton, Kirkham, & Evershed, 2020).

Participants

One hundred and seventy-six ($N = 176$) adults were recruited using social media platforms and the university psychology student pool, 13 of whom did not complete the study. Therefore, the final sample consisted of 163 participants (age range: 18–66; M age: 27.69, $SD = 13.20$; 95 female). All participants provided informed consent and were informed that they could withdraw their participation with no adverse consequences as according to the Declaration of Helsinki. Participants were not remunerated for their participation except for course credits. The study was approved by the Leiden University Psychology Ethics Committee (CEP 2020–02-27-M.E. Kret-V2-2192). Differences in participants' age and gender between Experiment 1, Experiment 2, and Experiment 3 are reported in the Supplementary Material. Participants' emotion recognition was good (75% correct) and in line with previous studies (e.g., Akdag, 2020).

Stimuli

Regarding the Attraction Judgment Task (AJT), to examine whether the overall low mean accuracy observed in Experiment 1 and Experiment 2 was due to either the brief duration of the stimuli or the interaction phase employed (i.e., first-impression phase; FI), in Experiment 3, we manipulated the video segment in two ways: length and interaction phase. Specifically, we used the following segments: a) 3-s FI segments (as in Experiment 1 and Experiment 2); b) 3-s; c) 6-s; and d) 9-s segments from the verbal interaction (VI) phase.

Experimental Task

The AJT was the same as in Experiment 2. Participants were assigned in the stimulus condition in a counterbalanced order.

Procedure

After participants provided informed consent, they were asked to provide demographic information (i.e., age, gender, sexual orientation, nationality, and educational level). Next, participants were informed that they would view a series of videos and, they should indicate whether the person depicted would like to go on another date with their partner and their level of certainty regarding their judgement. Participants were instructed to respond as fast and accurately as possible. Participants were prompted to indicate whether the person would like to go on another date with their partner by pressing the corresponding keyboard key (y yes, and n for no); followed by their certainty regarding their decision from 0 (*not at all*) to 6 (*very*) with

3 indicating a neutral level of certainty. Participants were prompted to take a break after 16 trials. The task consisted of 32 trials in total.

Following the AJT, participants performed the ERT (for a description of the stimuli, see Supplemental Material). Each trial started with a centrally presented fixation cross for 1000 ms, followed by the video stimulus. Then, six buttons displaying all possible emotional expressions (i.e., happy, sad, surprised, fearful, angry, neutral) were displayed and remained visible until a response was provided. Participants first practiced the task (5 trials) and then completed the task (60 trials in total). Participants were not provided feedback for their responses and were prompted to take a break after 30 trials.

After completion of the ERT, participants filled in the AQ and BDI-II and indicated if they were in a relationship, and if so its duration and qualitative status (e.g., married, dating, cohabitating). The study lasted approximately 25 min. After finishing the study, participants were debriefed and thanked for their participation.

Statistical Analyses

Regarding the AJT, we excluded trials with RTs $<$ 200 ms (0.04% across all conditions). Trials on which there were technical issues, for instance regarding the presentation of the videos, were also excluded (0.16%). After applying our exclusion criteria, we were left with 99.80% of the data. Regarding the ERT, practice trials and trials with RTs faster than 200 ms were excluded (0.01%).

To model accuracy, we followed the procedure as detailed in Statistical Analyses [see General Methods section]. We coded the predictor Video Condition using a sum-contrasting scheme. All models included a random intercept per Participant. Our analyses were pre-registered on the AsPredicted database (Reference number: #37,849).

Results

First, we found no substantial evidence that participants could reliably detect attraction ($\beta = 0.01$, 95% HDI [-0.04, 0.07], $p_{+} = 69.39\%$). After adding the fixed effect of Video Condition, there was no substantial difference in accuracy between conditions (see Figure 6a; Table 3 Model 2); therefore, longer video segments did not influence participants' ability to detect attraction in others.

Table 3. Overview of all accuracy predicting models (1–3) for Experiment 3.

Predictors	Accuracy (Median estimate of the coefficient with 95% HDI)		
	Model 1	**Model 2**	**Model 3**
	β(95% HDI)	β(95% HDI)	β(95% HDI)
Intercept	0.01 [-0.04, 0.07]	0.01 [-0.04, 0.07]	0.01 [-0.04, 0.07]
VI3		0.03 [-0.07, 0.12]	0.03 [-0.07, 0.12]
VI6		0.03 [-0.07, 0.12]	0.03 [-0.07, 0.13]
VI9		0.05 [-0.04, 0.14]	0.05 [-0.04, 0.15]
Attracted to Partner			0.17 [0.12, 0.23]
VI3 × Attracted to Partner			-0.15 [-0.25, -0.06]
VI6 × Attracted to Partner			0.04 [-0.05, 0.14]
VI9 × Attracted to Partner			0.15 [0.05, 0.24]
Random Effects			
Var(Participant)	0.00	0.00	0.00

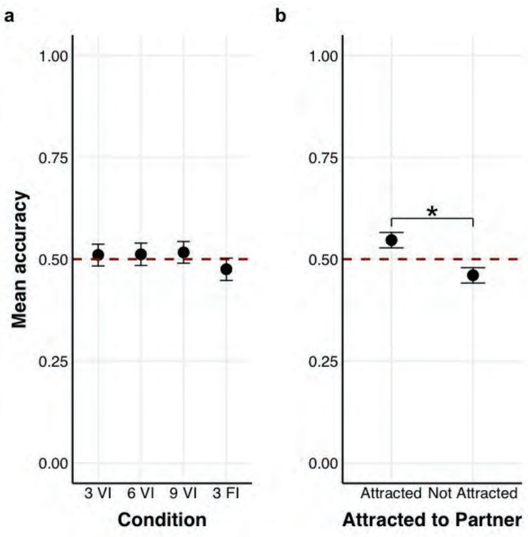

Figure 6. (a) Accuracy as a function of Video Condition (VI = Verbal Interaction; FI = First Impression (videos were muted in both conditions). Values 3, 6, 9 indicate the duration of the video segments in sec. The graph shows that people could not reliably detect attraction; (b) Accuracy as a function of whether the person depicted wanted to date their partner or not. For all graphs, the red dotted line denotes the chance level (0.5) and errors bars reflect 95% Credible Intervals (CrI).

To examine whether participants can detect the presence of attraction, we added the fixed effect of Attraction to Partner and its interaction with

Video Condition (Table 3, Model 3). The model showed that participants were more accurate when the person depicted wanted to date their partner than when they did not ($\beta = 0.17$, 95% HDI [0.12, 0.23], $p_+ = 100\%$; see Figure 6b). Furthermore, we examined whether the interaction between Attraction to Partner and Video Condition was reliable by comparing this model to a more parsimonious model (i.e., excluding the interaction). The resulting Bayes Factor revealed that the more parsimonious model was moderately preferred over the more complex mode ($BF_{01} = 6.11$). Therefore, the interaction between Attraction to Partner $\times$Video Condition is not interpreted.

Control analyses: performance in the Emotion Recognition task

We examined accuracy in the ERT task using an intercept-only Bayesian logistic mixed model on accuracy scores. The model showed that participants were reliably more accurate than chance level ($\beta = 1.13$, 95% HDI [1.06, 1.19], $p_+ = 100\%$); indicating that participants were attentive during the task and could reliably detect basic emotional expressions. Only one participant exhibited a mean accuracy below 0.5 ($M = 0.47$); excluding this participant did not change the results of our main analyses ($\beta = 1.13$, 95% HDI [1.06, 1.20], $p_+ = 100\%$). Thus, they were not excluded from the dataset.

Discussion experiment 3

Our main question was whether people could accurately detect attraction. Interestingly, even when using more prolonged and more informative video segments taken from later phases of the interaction, participants were not reliably better than the chance level in detecting whether the daters were attracted to their partner or not. We also replicated the finding from experiments 1 and 2 that participants were more accurate when the person depicted was attracted to their partner than when they were not.

General discussion

In a series of three experiments, we found no strong evidence supporting the notion that people can reliably detect attraction or its absence in thin video slices of people on a date based on nonverbal subtle emotional cues. However, we found that accuracy was increased based on whether the person presented in the video was attracted to their partner. Specifically, we found that the third-party observers were more accurate in detecting attraction when the daters were attracted to their partners than detecting the absence of attraction when the daters indicated not being attracted to their partner.

In addition, recognizing attraction was not influenced by age or length of the stimuli presented.

In accordance with previous findings (e.g., Place et al., 2009), we found that people cannot reliably detect attraction from initial interactions. Given that previous findings have emphasized the importance of subtle nonverbal cues in communicating attraction (e.g., Eibl-Eiblsfeldt, 1989; Keltner & Buswell, 1997), one might question whether the observed low accuracy in detecting attraction might be the result of a low frequency of occurrence of behaviours associated with attraction. In other words, was there sufficient information present in the stimuli themselves that the participants might have picked up? Indeed, we only found minor numerical differences in behaviours associated with attraction (e.g., coyness, genuine smiles) in the First Impression 3-s videos (see Supplemental Material). Thus, the observed low accuracy might result from the low frequency of behaviour occurrence. Nonetheless, our findings replicate previous research (e.g., Place et al., 2009) further support the notion that people cannot reliably detect attraction when viewing others in the initial phases of their interaction.

Our findings do not provide support for the notion that third-party observers can detect attraction when viewing segments from later phases of a date, which contrasts with previous research (Place et al., 2009). In all experiments, participants performed near chance level independent of the length of the segment (3, 6, or 9 s) or the phase of the interaction (first impression or verbal interaction). Our analyses (see Supplemental Material) of the coded behaviours illustrate that daters that were attracted to their partner exhibited behaviours associated with attraction for a longer duration compared to daters that were not interested in their partner (in videos taken from the middle of the speed date). This finding suggests that the observed low accuracy is not due to the low frequency of behaviour occurrence. Instead, it might be more probable that people cannot detect attraction as third-party observers using thin video slices even when the signs of attraction are there.

It may be advantageous for humans to mask what they feel in certain situations, and they often use their cognitive resources to do so (Kret, 2015). This masking might render interpreting nonverbal cues more complex and thus, lead to confusion and awkward social encounters (Abbey, 1982; Abbey & Melby, 1986) when the expressions of the sender are misinterpreted (Burgoon et al., 2002; Grammer, 1990). These factors may be a source of error in people involved in a one-on-one interaction (i.e., a date), given that the high-intensity motivational environment might decrease accurate emotion detection (Maner et al., 2005; Prochazkova et al., 2022).

It has been speculated that the ability to detect attraction in others has an adaptive function, allowing people to collect more information to guide their mating choices (see Simao & Todd, 2002). However, a more parsimonious explanation would be that the ability to detect attraction as a third-party observer is merely a by-product of detecting attraction when faced with a potential mate, which would undoubtedly be a beneficial quality for anyone navigating their romantic environment. However, previous research consistently demonstrates that people cannot detect attraction in others and instead project their interest to a given partner (A. J. Lee et al., 2020; Samara et al., 2021; Prochazkova et al., 2022). Thus, it remains possible that people cannot detect attraction above chance level.

Emotions can be efficiently detected from facial expressions (Ekman, 1992). Previous research has shown that basic emotions, such as disgust, fear, and happiness, can be recognized in scenes within 200 ms (Righart & De Gelder, 2008). This effect suggests that detection and recognition of emotional expressions likely rely on quick facial expression processing (see also Meeren, van Heijnsbergen, & de Gelder, 2005), for similar findings on the interaction between facial expressions and body language). Here, we examined whether attraction can be detected as efficiently as other emotions. Given our null findings, we cannot conclude whether indeed attraction can be detected as efficiently as other emotions based on three experiments. Future research should help elucidate how easily and accurately complex emotions like attraction are perceived and processed.

In all experiments, we consistently found that people are likely to detect attraction when the person observed is indeed exhibiting such signals. Indeed, even though attraction cannot be expressed with a single behaviour (M. M. Moore, 1985), people likely have experience in decoding such cues and are thus more likely to detect them efficiently. This is further corroborated by our consistent replication of this effect in initial encounters as well as later in the interactions irrespective of video length (3, 6, and 9 s). Date members that were attracted to their partner likely illustrated affiliation more clearly (e.g., see Grammer, Honda, Juette, & Schmitt, 1999). In contrast, disinterested partners might have opted to display rejection more subtly (or perhaps not at all), making it more challenging to interpret. However, it should be noted that we did not find robust differences in attraction cues between daters that were interested in their partner compared to daters that were not in the 3-s stimuli, even though a robust difference was found for coy smiles in the 9-s stimuli. An alternative explanation for this finding is that participants had a general propensity to respond positively rather than negatively (see Supplemental Material). This could be due to expectancy effects, given that participants were informed that these video segments are from a blind date study. Future research should further investigate the role of expectancy effects in the ability of third-party observers to detect attraction.

This finding directly contradicts previous research (Hall et al., 2015, Experiment 2). In their study, the authors asked participants to view 1min segments of others on a date and indicate whether they thought the person on the video was flirting with their partner. Given that the people who report feeling attracted to their partner are also more likely to report flirting (Hall et al., 2015, Experiment 1), this is a reliable indicator of detecting attraction. Furthermore, their results suggest that participants were more accurate in detecting attraction when the person depicted was not flirting than when they were flirting. The authors suggest that these findings could be due to a) the implicit risk of openly displaying interest in another, which would have rendered any flirting difficult to decode, and b) that the probability of flirting in zero-acquaintance settings is relatively low (e.g., Abbey, 1982; Saal, Johnson, & Weber, 1989); therefore, people might not be familiar with flirting expressions in such settings. We disagree with both of these interpretations. Flirting, in general, is quite ambiguous, as flirting cues are also easily confused with friendliness (Farris et al., 2008; M. M. Moore, 2010). Furthermore, previous research has documented several flirting signals in first time-encounters, such as self-grooming (McCormick & Jones, 1989), suggesting that these are signals typically exhibited in such situations. Crucially, in a previous study (Prochazkova et al., 2022), it was found that almost half (44%) of the participants reported that they would be interested in going on another date with their partner rendering the reduced-likelihood interpretation unlikely. In short, we consistently show that attraction is detected above the chance level when it is indeed there.

Based on the Perception–Action Model of Empathy (PAM; Preston & de Waal, 2002), we expected that participants with more experience with romantic interactions (i.e., adults) would be more accurate in detecting attraction than participants with less experience with romantic interactions (i.e., children). However, in Experiment 2, we found no substantial differences between adults and children, suggesting that children's lower accuracy in detecting attraction in Experiment 1 was likely due to cognitive overload.

One limitation that should be discussed is the fact that our responses were coded in a binary way. This approach was necessary to calculate accuracy based on the responses of the study conducted by Prochazkova et al. (2021), where responses were also coded binary. It could be argued that this approach reduced the variation that would otherwise be shown if responses were coded in a continuous way. This is indeed possible, even though it should be noted that using a scale for attraction and a binary response for another date has been shown to correlate highly (Roth, Samara, & Kret, 2021a; Roth, Samara, Tan, et al., 2021). Nonetheless, future studies using speed-dating paradigms could also employ a continuous response regarding attraction and willingness to go on another date, which can then be used in studies employing third-party observers.

In conclusion, here we demonstrate that people might not reliably detect when others are attracted to their partner and when not. Furthermore, we showed that the overall accuracy in detecting attraction is not influenced by age, or the phase of the interaction observed. The only factor that reliably influenced accuracy is whether attraction is indeed present.

Chapter 7

Ultimate and proximate factors underlying sexual overperception bias: A reply to Lee et al. (2020)

Based on:
Roth, T. S., Samara, I., & Kret, M. E. (2021). Ultimate and proximate factors underlying sexual overperception bias: A reply to Lee et al. (2020). *Evolution and Human Behavior, 42*(1), 73-75. https://doi.org/10.1016/j.evolhumbehav.2020.06.002

Why do men often overestimate the chances of women feeling attracted to them? This landmark question, known as the "sexual overperception bias", has been subject of numerous investigations (e.g., Abbey, 1982; Shotland & Craig, 1988). Recently, Lee et al. (2020) showed that initial differences between sexes in the perception of sexual interest disappeared when controlling for two mediating factors: sociosexual orientation (i.e., willingness to engage in uncommitted sex) and projection of own interest onto the partner. Without questioning the importance of these factors in the perception of sexual attraction, we argue that apart from these proximate explanations, the crucial difference between proximate and ultimate explanation has remained overseen in their manuscript. As a consequence, the authors' conclusion that sex differences disappear after controlling for mediating variables, is unwarranted. In the remainder of this reply, we clarify our argument that Lee et al. seem to describe a mechanism through which sex differences in overperception can arise, and thus do not question the ultimate explanation offered by Error Management Theory (Haselton & Buss, 2000; Haselton, 2003; Haselton & Galperin, 2013). This theory suggests that, from an evolutionary perspective, men benefit more than women from overperceiving sexual interest.

While a proximate explanation focuses on how a certain phenomenon works (mechanistically), an ultimate explanation addresses the question of why the phenomenon exists from an evolutionary point of view (Tinbergen, 1963). These explanations are distinct and of equal merit, crystallized in the "proximate ultimate distinction" (Tinbergen, 1963; Mayr, 1963). Crucially, these explanations are complementary, so one does not negate the other. For example, consider the following statements: male birds sing (1) due to an increase in circulating testosterone; or (2) to attract mates. Both statements could be correct. The first describes the responsible mechanism; whereas, the latter addresses the adaptive value (MacDougall-Shackleton, 2011). So let us consider the following question: in the case where we find that differences in circulating testosterone explain singing of male birds, would we be justified in concluding that male birds do not sing to attract mates? This example demonstrates the problem that we see in the conclusion of Lee et al.

Lee et al. provide a proximate explanation for the sexual overperception bias and cast doubt on the validity of previously described sex differences in sexual overperception bias. In their study, the authors conducted statistical analyses with sociosexual orientation and self-interest projection as mediators. Their results showed that when accounting for these, the overperception effect disappears, prompting the authors to conclude that "the sex difference [in the sexual overperception bias] can be completely explained by the mediators [...] ." We believe that this strong claim is not justified. It is

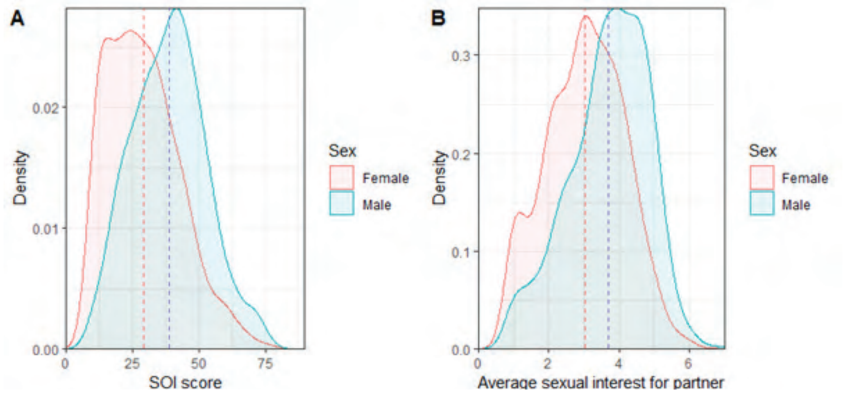

Figure 1. Distribution of (A) sociosexual orientation scores and (B) average interest in partners for men and women in the dataset of Lee et al. Dashed lines show the mean SOI (left) and sexual interest (right) per sex.

well known that men have higher sociosexuality scores than women (Penke & Asendorpf, 2008), a pattern replicated in Lee et al.'s data (publicly available here https://osf.io/je4h7/). Specifically, when conducting a Welch *t*-test on their impressive sample of 1184 participants comparing the two sexes, we found that men reported higher sociosexuality scores than women (Figure 1A; $t(1170) = -12.03$, $p < .001$, $d = 0.70$). In similar vein, self-reported attraction towards the partner was higher in men than in women (Figure 1B; $t(1199) = -10.31$, $p < .001$, $d = 0.59$). It is not surprising that sex differences in the overperception bias disappeared when adding these mediating variables, as the sex differences in the mediators are confounding their main analysis.

What Lee et al. did illustrate is that sex differences in the sexual overperception effect possibly arise due to sex differences in sociosexual orientation and attraction to the partner. Therefore, these mediating factors could be interpreted as a potential mechanism through which sex differences in sexual overperception bias arise. Indeed, this is in line with previous work by Howell et al. (2012), that clearly distinguished mechanism from function, suggesting that sociosexual orientation is likely a mechanism through which sex differences predicted by Error Management Theory (Haselton & Buss, 2000; Haselton, 2003) arise. Given our re-analysis of Lee et al.'s data we agree with the mechanistic interpretation of similar findings as given by Howell et al. (2012), and believe that the results do not challenge the adaptive value of the sex differences in sexual overperception bias as posited by Error Management Theory.

Returning to our earlier hypothetical question, if male bird song and testosterone are associated, does this imply that there is no relationship between singing and reproductive success? In short, no. To challenge an ultimate explanation, it is necessary to offer an alternative ultimate explanation and not a proximal one. In the case of sexual overperception, different selection pressures might have translated into higher sexual desire and interest in partners for men than for women. Importantly, if these variables explained overperception, as Lee et al. suggest, this would solely provide the how in observed sex differences in the sexual overperception effect, but does not offer any intuition regarding the mechanisms' ultimate function. In fact, the increased sociosexuality and interest in men compared to women are predicted by Error Management Theory (see also Sexual Strategies Theory: Buss & Schmitt, 1993). Therefore, we argue that Lee et al. provided evidence of a potential mechanism for Error Management Theory's ultimate theory of sexual overperception bias (Haselton & Buss, 2000). According to Error Management Theory, since male reproductive success is limited by the number of sexual partners, it is less costly to misjudge sexual interest when there is none, than to miss an opportunity. From an evolutionary perspective, one of these is costlier than the other. As a consequence, natural selection favoured mechanisms leading to the overperception of sexual desire in men (Haselton, 2003; Kokko, Brooks, Jennions, & Morley, 2003). As we have argued, higher sexual desire in men could very well be one of these mechanisms, which shows that the results of Lee et al. are perfectly in line with the ultimate explanation offered by Error Management Theory (Haselton & Galperin, 2013).

To their merit, Lee et al. discuss the fact that their mediating variables may be proximate explanations for sex differences in overperception, but they end up rejecting this view. However, we find their reasoning difficult to follow. The authors seem to argue that EMT predicts a domain-specific sex difference at the proximal level, which would then result in sex differences in perception of sexual interest. While we agree that this is an implausible explanation, we disagree that this proximate explanation could be drawn from the EMT framework. Instead, EMT is primarily concerned with the ultimate causes of behavior, and remains “virtually silent” about the proximate causes (Haselton & Galperin, 2013, p. 249). As a more plausible explanation, Lee et al. suggest that sex differences in perception of sexual interest could be the result of sex-specific selection on variation in (a) sociosexuality and (b) attraction to partners. These two factors would in turn result in sex differences in perception of sexual interest. It is our contention that the authors might be referring to sexual dimorphism when suggesting that domain-specific differences are predicted by EMT. However, sex differences can be defined as average differences between men and women on a continuous scale (McCarthy, Arnold, Ball, Blaustein, & De Vries, 2012), rendering the need for a domain-specific difference unmerited. Thus, it would still be possible that both of the mediators, which exhibit sex differences, are proximate explanations for sex differences in the perception of sexual interest that are expected under EMT.

In addition, the authors posit a more parsimonious explanation for projection of one's own interest onto potential partners. Specifically, they state that projection would lead to increased mating success regardless of sex. However, this contrasts with two important points. First, it does not account for the general sex difference in interest in potential partners: men tend to be attracted more often to a potential partner than women (e.g., Kurzban & Weeden, 2005). Second, this argument disregards the fact that women suffer higher reproductive costs, such as losing paternal support, if they choose a suboptimal partner, as opposed to men. Crucially, this discrepancy is central to EMT (Haselton & Buss, 2000), and has been demonstrated in women of reproductive age compared to post-menopausal women (Cyrus, Schwarz, & Hassebrauck, 2011). Thus, we are not fully convinced that this alternative explanation is warranted.

To conclude this commentary, we want to emphasize that distinguishing proximate and ultimate explanations in psychology remains crucial. Unfortunately, conflating evolutionary function with mechanism is an often encountered yet crucial mishap. To understand and explain behavior, we need to answer both the proximate and the ultimate questions (MacDougall-Shackleton, 2011). Therefore, researchers would benefit by acknowledging the distinction between these two explanations: they are two sides of the same coin, yet fundamentally different. As Scott-Phillips and colleagues (2011, p. 45) pointedly stated "[Scientific] progress will be quicker and more efficiently achieved if the underlying theory, including the proximate–ultimate distinction, is properly applied."

Part III

Attraction and inter-individual coordination

Chapter 8

A comparative framework of inter-individual coordination and pair-bonding

Abstract

Inter-individual coordination (IIC) at the behavioral and physiological level, and its association with courtship and pair-bond maintenance, have been receiving increased attention in the scientific literature in recent years. However, there is no integrative framework combining the plethora of findings in humans and nonhuman species yet that addresses the evolutionary origins of IIC. Here, we take a comparative approach and review findings on the link between IIC and pair-bond formation, maintenance, and bi-parental care. Our review suggests that across socially monogamous species, IIC – at a behavioral and physiological level – is correlated with the likelihood of forming and retaining a pair-bond, and with reproductive success. We expand on the pair-bonding hypothesis by stating that higher levels of IIC might be beneficial for relationship quality and bi-parental care and, as a result, might also become a preferred trait in the formation and maintenance of a pair-bond. We further discuss the key questions to disentangle the evolution of IIC based on this hypothesis.

Based on:
Samara, I., Roth, T. S., Tan, J., Prochazkova, E., & Kret, M. E. (2021). A comparative framework of inter-individual coordination and pair-bonding. *Current Opinion in Behavioral Sciences, 39*, 98-105. https://doi.org/10.1016/j.cobeha.2021.03.005

Introduction

Human pair-bonding is characterized by a deeply emotional long-term bond [3]. Spending time with a significant other is associated with feelings of happiness (Flood & Genadek, 2016), especially in committed relationships (Hudson, Lucas, & Donnellan, 2020). Such positive affect is an important characteristic of romantic bonds in humans, as it likely promotes the ultimate function of such bonds: motivating both parents to jointly care for their offspring (Finkel & Eastwick, 2015). However, the characteristics of a successful pair-bond and the fundamental prerequisites for successfully raising offspring remain not well understood. Nonetheless, the ultimate challenges faced by all species exhibiting bi-parental care are similar: raising and caring for their offspring, and crucially, dividing the tasks necessary for this goal. In this review, we outline a mechanism that might underlie successful relationship initiation, maintenance, and bi-parental care, namely inter-individual coordination (IIC). We present evidence suggesting that relationships that are or have the potential to be long-lasting might be characterized by IIC at both behavioral and physiological level, and that this pattern might extend to non-human species as well.

IIC refers to the behavioral and physiological linkage between two or more individuals (Mayo & Gordon, 2020), and encompasses mimicry, synchrony (Prochazkova & Kret, 2017), and complementary action (Skewes, Skewes, Michael, & Konvalinka, 2015)[4]. Thus, while behavioral linkage mostly manifests itself externally (e.g., body posture), physiological linkage is mostly associated with co-activation and regulation of internal processes (e.g., autonomic nervous system responses). In this review, we define IIC as the co-variation of behavioral and physiological responses between two individuals that share a common goal. For example, while on a first date we feel nervous yet see our potential partner smiling, we might smile back and experience a decrease in nervousness and increase in happiness. In other words, we might coordinate with the person opposite of us both on a behavioral and physiological level. Figure 1 depicts how IIC is associated with different aspects of pair-bonding. For example, IIC facilitates bond formation in humans (Launay, Tarr, & Dunbar, 2016), and results in effective cooperation (Behrens et al., 2020; Duranton & Gaunet, 2016), a relevant component of bi-parental care. Accordingly, human courtship is strongly associated with IIC (Grammer et al., 1998) and IIC has been implicated in

[3]Here pair-bonding is not restricted to an exclusive assortment between one male and one female (e.g., social monogamy in cross-species research or monogamous marriage arrangement in human societies). Pair-bonds can refer to any lasting reproductive relationship between two individuals, including those in polyandrous and polygynous relationships (Rooker & Gavrilets, 2021)

[4]it should be noted that physiology and behavior are not independent, but rather embedded in a continuous feedback loop, where one level informs the other (Mayo & Gordon, 2020)

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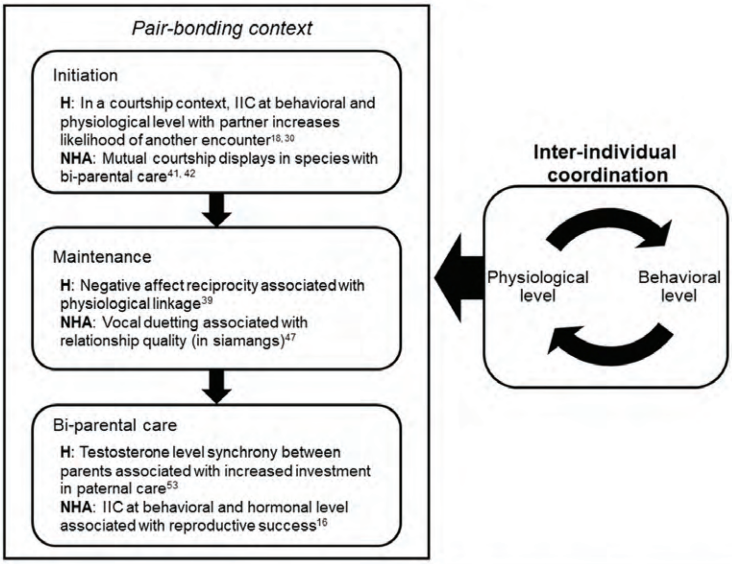

Figure 1 - Schematic representation of the effect of inter-individual coordination (IIC) on different stages of the pair-bonding process. Each stage contains an example from humans (**H**) and non-human animals (**NHA**).

relationship maintenance (Levenson & Gottman, 1983). Thus, IIC might be a crucial element for successful bond formation and maintenance, and consequently, bi-parental care.

Non-human animals also show IIC (Duranton & Gaunet, 2016), as can for example be observed in turn-taking (Pika, Wilkinson, Kendrick, & Vernes, 2018) or facial mimicry (Palagi, Celeghin, Tamietto, Winkielman, & Norscia, 2020). Specifically, species with bi-parental care, such as many bird species, might be suitable models to study the role of IIC in relationship initiation and maintenance. Indeed, species with bi-parental care display IIC in mutual courtship behaviors, such as vocal duetting (Haimoff, 1986), and parental care (Griffith, 2019) (Figure 1). In this review, we outline evidence suggesting that IIC is prevalent in pair-bonding species and, from an adaptationist point of view, might confer reproductive benefits, such as more offspring or higher offspring survival. We set out to answer two main questions. First, how is IIC reflected in different components of pair-bonding (i.e., initiation, maintenance, and bi-parental care)? Second, how is IIC manifested on a behavioral and physiological level? Our goal is to integrate findings from psychology and ethology and create an inter-disciplinary framework for studying the role of IIC in pair-bonding.

Humans

Behavioral level

It is difficult to envision romantic interactions without coordination with a partner. Indeed, as outlined below, evidence shows that humans exhibit substantial IIC in the context of romantic love. In particular, patterns of behavioral coordination during first romantic encounters have been referred to as the human courtship dance (Birdwhistell, 1970). For example, Grammer and colleagues (1998) describe a pattern of synchrony between couple members, where women, when interested in their partner, synchronize their movements with their partner. Moreover, in a recent study (Birnbaum et al., 2019), participants were more interested in meeting a stranger again after engaging in synchronized activity together compared to a non-synchronized activity. Given that IIC is associated with shared intentionality (Kurtz, Rennebohm, Teal, Charleson, & Thoburn, 2019), these findings suggest that IIC enables bond formation perhaps by facilitating the establishment of a common motivational framework.

IIC is also crucial in the maintenance of a pair bond. Recently, Sharon-David and colleagues (2019) demonstrated that participants who imagined having a synchronous interaction with their partner reported higher levels of intimacy in their relationship, while this was not the case for imagined out-of-sync interactions. Even more convincingly, Maister and Tsakiris (2016) asked participants to perform one of two behaviors: either open or close their mouths. Simultaneously, participants were presented with pictures of their romantic partner or friends (as a control group) performing the same expression or not. Their results showed that participants imitated their romantic partner more often and faster than a platonic friend; suggesting that specifically romantic affiliation is more contingent on IIC. Crucially, similar evidence supports these findings based on real-life interactions satisfied couples exhibited more movement coordination compared to dissatisfied couples (Julien, Brault, Chartrand, & Bégin, 2000). It is likely that these findings might also extend to emotional contagion, which is more prevalent amongst affiliated individuals (Preston & de Waal, 2002). For example, new parents that report higher relationship satisfaction are also more empathic towards each other (Rosen, Mooney, & Muise, 2017). Altogether, these findings suggest that IIC plays an important role in relationship maintenance.

Studies investigating bi-parental care and IIC in humans are at present limited. Two main patterns become apparent in the literature. First, marital satisfaction affects coordination within couples, and disruptions in coordination might consequently reduce paternal investment (Belsky, Youngblade, Rovine, & Volling, 1991; Kitzmann, 2000). Second, decreases in paternal investment might reduce parental reciprocity (Feldman, 2007), meaning that parental behaviors are more authoritative and less responsive to the infant's needs. Additionally, contexts where one parent undermines or does not support the other during parent-infant interactions might increase the likelihood of fearful temperament in the infant (Metz, Majdandžić, & Bögels, 2018). Thus, despite the limited number of studies and the complex triadic relationships, this preliminary evidence suggests that IIC affects bi-parental care, either directly or indirectly through marital satisfaction.

Physiological level

While behavioral IIC has received ample attention over the last decades, recent years have revealed a dramatic increase interest for physiological synchrony. Physiological synchrony is the co-activation and regulation of physiological processes, such as the autonomic nervous system and the endocrine system (Mayo & Gordon, 2020; Palumbo et al., 2017). In humans, physiological synchrony might be beneficial in facilitating pair-bond formation, as it might blur the boundaries between the self and the other and aid in establishing a shared perspective. Despite limited evidence regarding physiological linkage in couples over time, recent research (Prochazkova, Sjak-Shie, Behrens, Lindh, & Kret, 2019) has shown that heart rate (HR) and electrodermal activity (EDA) synchrony might be associated with increased attraction to an opposite-sex stranger. In conclusion, preliminary evidence suggests that physiological synchrony during courtship might influence its future prospects. However, more research is needed to investigate this complex relationship, especially the causality.

What do we know about physiological synchrony in couples? The different methodological and statistical approaches make this topic difficult to examine (Timmons, Margolin, & Saxbe, 2015). The level of physiological synchrony exhibited in a couple might be influenced by physical and emotional closeness (Freihart & Meston, 2019; Helm, Sbarra, & Ferrer, 2012). Therefore, it would be logical to assume that more linkage occurs in a long-term relationship. However, whether this increased physiological synchrony is beneficial for a long-term relationship remains heavily debated. Previous research has shown that perspective taking ability and physiological synchrony are positively associated (Schoebi, 2008); which might support the notion that synchrony is beneficial in communication and consequently maintenance of a romantic bond.

Accordingly, emotional responses seem to align in couples over time (Anderson, Keltner, & John, 2003). This pattern, however, is complex and requires further empirical investigation (Sels et al., 2020). This is also reflected in studies on physiological synchrony. Studies focusing on the sympathetic nervous system (SNS), a measure of arousal, during conflicts have shown counterintuitive results. In their study, Levenson and Gottman (1983) showed that couples exhibiting more SNS synchrony during conflicts reported lower marital satisfaction. Similarly, a recent study demonstrated that SNS linkage is related to a greater degree of demand-withdraw behavior during conflict (Reed, Randall, Post, & Butler, 2013). These findings suggest that synchrony in negative contexts is detrimental to relationship maintenance. However, this assumption might be premature. Research has demonstrated that a 'regulatory linkage' strategy, whereby when one partner is negatively aroused the other down-regulates their physiological response, might be more beneficial in de-escalating and resolving conflicts than a positive co-activation of the SNS (Liu, Rovine, Cousino Klein, & Almeida, 2013; Reed et al., 2013; Wilson et al., 2018). These findings reflect the complexity of investigating physiological synchrony and relationship maintenance.

Non-human animals

Behavioral level

There are many examples of IIC that highlight its link with the formation or maintenance of pair-bonds, such as courtship displays in birds. Specifically, recent evidence demonstrates that familiar dyads of zebra finches (*Taeniopygia guttata*) that had been briefly separated showed stronger IIC after being reunited than novel dyads (Prior, Smith, Dooling, & Ball, 2020). There are similar examples illustrating the importance of mutual courtship displays for initiation or maintenance of the pair-bond (Dahlin & Benedict, 2014; Ota, Gahr, & Soma, 2015; Soma & Iwama, 2017). Crucially, successful coordination has been linked to pair-bonding and fitness (Griffith, 2019). For example, well-coordinated pairs might be more successful in territorial defense and reduce offspring predation risk by synchronizing nest visits. A clear example of the importance of behavioral compatibility is provided by Ihle and colleagues (2015), who found that zebra finch couples that showed a mutual mate preference had a 37% higher reproductive success than experimentally "forced" pairs. Crucially, individuals of mutually chosen pairs were staying closer together and showed more synchronous behavior. Importantly, this design allowed the authors to isolate the effect of parental care while controlling for genetic quality of offspring and parents, thereby convincingly demonstrating the importance of IIC in bi-parental care. Corroborating evidence comes from graylag geese (*Anser anser*), where reproductively unsuccessful pairs lacked coordination (Nedelec & Beaver, 2014). Also, blue-footed boobies (*Sula nebouxii*) that have been together for a longer time produce more fledglings, even when controlling for experience (Sánchez-Macouzet, Rodríguez, & Drummond, 2014). Importantly, the authors suggest that increased within-pair coordination over time could be the mechanism underlying this difference in reproductive success. Altogether, these examples illustrate that IIC can enhance reproductive output in birds.

In the past century, similar evidence has been shown for non-human primates. In general, coordination is more apparent in affiliated individuals (Palagi et al., 2020; Pika et al., 2018). Many primate species with bi-parental care are characterized by their duetting behavior, a clear example of IIC. Importantly, such duets seem to be restricted to pair-bonding primate species (Haimoff, 1986). A famous example concerns siamangs (*Symphalangus syndactylus*), where duration and intensity of duetting correlated with relationship quality (Geissmann & Orgeldinger, 2000); suggesting that the stronger the relationship, the smoother the song. Recently, these findings were extended to facial mimicry in gibbons: pairs with strong facial mimicry had a greater relationship quality (Florkiewicz, Skollar, & Reichard, 2018). Importantly, the direction of causality is not clear yet. It is likely that IIC and pair-bond strength are embedded in a feedback loop; however, further research is needed to examine this notion.

Physiological level

Few studies have investigated physiological synchrony in non-human animals, and data in pair-bonding contexts are especially rare. This also applies to studies investigating physiological synchrony on a moment-to-moment basis (Kret, Tomonaga, & Matsuzawa, 2014), mainly due to methodological challenges. The few studies that investigated pair-bonding species and physiological synchrony have established that pairs synchronize on a hormonal level. For example, dyadic bond strength is associated with oxytocin synchrony in common marmosets (*Callithrix jacchus*) (Finkenwirth, van Schaik, Ziegler, & Burkart, 2015), and concentrations of hormones correlate in pairs of multiple bird species (Griffith, 2019). Hormonal synchrony is crucial during mating periods because the hormonal state of one partner might induce courtship behavior, consequently changing the hormonal state and behavior of the other (M. C. Moore, 1982; Hirschenhauser, 2012). Comparable patterns have been found in humans, where men whose testosterone levels correlate with their partner's during pregnancy are more involved in raising their child and maintaining their relationship (Saxbe et al., 2017). Thus, this preliminary evidence suggests that hormonal synchronization is relevant to establish a successful pair-bond and successfully care for offspring across species.

The pair-bonding hypothesis

Here, we have reviewed the literature on pair-bonding and IIC in humans and non-human animals. Our brief review suggests that IIC between partners might be a fundamental prerequisite for pair-bonding initiation, maintenance, and most likely, bi-parental care. Crucially, this prerequisite seems to be deeply rooted and extends beyond humans. Similar to humans, some animal species are faced with ultimate challenges relating to bi-parental care and relationship maintenance, such as producing, defending, and providing for their offspring together. All these challenges are easier to address when behavior is well-coordinated. Thus, when investigating the origin of partner bond-related behavior in humans, we should not overlook data from species facing similar challenges, namely raising offspring while relying on another individual. Therefore, we posit that a comparative framework integrating IIC and pair-bonding provides exciting opportunities to study the adaptive value of IIC in romantic relationships.

Here, we re-introduce and build upon the pair-bonding hypothesis. This hypothesis suggests that in species with bi-parental care, pair-bond strength is crucial for successful breeding (Rasmussen, 1981). While Rasmussen (1981) refers to only the relationship between pair-bond strength and reproductive output, we specifically suggest that IIC could be the underlying mechanism. First, IIC and pair-bond strength might form a positive feedback loop, so that coordination between individuals increases and the pair-bond can stand the test of time. Increased IIC might in turn improve reproductive output because of improved offspring care; however, sustaining the existing pair-bond in itself might also be beneficial. Indeed, divorcing may bear reproductive consequences, such as the need to search for a new partner. Second, IIC might mainly function to set a high baseline pair-bond strength during initial stages of bonding, so that only well-coordinated couples will be established. Although not mutually exclusive, the first explanation is well-supported by literature showing that reproductive success and IIC increase over time (Griggio & Hoi, 2011; Sánchez-Macouzet et al., 2014).

The idea that IIC plays a pivotal role in pair-bonding and reproductive success of a pair results in three main predictions. First, in species with bi-parental care, IIC should be apparent during courtship, because high amounts of IIC are necessary to successfully raise offspring. Second, well-coordinated pairs that perform coordinated displays should have a stronger and more durable pair-bond than other pairs. Third, well-coordinated pairs should have higher reproductive fitness (reflected in either more offspring or higher survival rate) than less coordinated pairs. These predictions can for example be studied using cross-over designs (Rutstein, Gilbert, & Tomkins, 2005). In Table 1, we outline a few options to investigate these questions in humans and non-human animals. For example, pair-bond strength can be quantified by incorporating measures of proximity and grooming or allopreening (Kenny, Birkhead, & Green, 2017; Silk, Cheney, & Seyfarth, 2013). Consequently, their relationship with coordination (e.g., synchrony, Nedelec & Beaver, 2014) can be investigated to understand whether between-pair variation in pair-bond strength is associated with between-pair variation in IIC. A comparative framework provides clear advantages to test these predictions. Importantly, for humans and non-human animals it remains to be established at what level the coordination will be present: behavioral, physiological, or both.

The link between IIC and pair-bonding is a natural extension of previous work that links specific behavioral phenomena to pair-bonding. For example, Julian Huxley already reported on the function of courtship rituals in 1914. Huxley extensively studied courtship displays in Great Crested Grebes (*Podiceps cristatus*) and argued that coordinated actions and the resulting emotional synchrony functioned to strengthen their pair-bond (Huxley, 1914, p. 516): "I believe that the courtship ceremonies serve to keep the two birds of a pair together, and to keep them constant to each other". Thus, Huxley explicitly proposed IIC as a mechanism for pair-bonding. A similar approach was taken to explain vocal duetting in birds (Wickler, 1980). The bottom line of these models is that performing coordinated displays helps the initiation of a new pair-bond, strengthens an existing pair-bond and in turn, improving the quality of bi-parental care. Thus, we have integrated both the notion that pair-bond strength is essential for reproductive fitness, and the notion that IIC is crucial for establishing and maintaining such a pair bond. Furthermore, we illustrate that IIC itself might play a role in reproductive fitness.

Conclusion and future directions

To delineate whether and when IIC is adaptive in pair bonding, it is crucial to compare humans to other animals. Therefore, interdisciplinary studies by biologists and psychologists are essential. Recent theoretical models integrating findings from non-human animals and humans (Prochazkova & Kret, 2017; de Waal & Preston, 2017) have highlighted the importance of IIC for affiliation. However, the challenges inherent to such research (e.g., subtlety of emotional cues, Kret, 2015) illustrate the need to focus on other measures, such as responses of the autonomic nervous system. Autonomic responses (e.g., pupil size change, blushing, sweating) are linked to emotions and are not under voluntary control (Prochazkova & Kret, 2017). Previous research has shown that pupil size (Kret et al., 2014) and facial temperature (Kano, Hirata, Deschner, Behringer, & Call, 2016) can be effectively used in research with non-human primates. These methods provide exciting opportunities to study physiological synchrony in non-human animals.

In the present review, we provided a comparative overview of the relationship between IIC and pair-bonding. We have outlined the relationship of IIC and pair-bonding, as well as bi-parental care. However, we did not find sufficient evidence to delineate the direction of causality. In other words, does IIC actually cause a stronger pair-bond, or do individuals that are compatible just show better coordinated behavior? An explicitly compar-

Table 1. Overview of research designs suitable for each pair-bonding stage for humans and non-human primates

Stage of pair-bond	Humans	Non-human animals
Initiation	*Speed-date paradigms* During speed dates, the daters' behavioral and physiological linkage can be measured and used to predict date outcomes	*Mate-choice arenas* In a mate-choice arena, one individual is confronted with multiple potential mates. Behavioral and physiological linkage can be measured and used to predict mate preference.
Maintenance	*Correlational studies* In a longitudinal setup, the behavioral and physiological linkage of couples can be measured (e.g., from the start of the relationship) and correlated with indicators of relationship satisfaction.	*Correlational studies* In a correlational setup, variation in relationship quality can be linked to variation in IIC, such as vocal duetting or mutual courtship displays.
Bi-parental care	*Correlational studies* In a longitudinal or cross-sectional setup, the behavioral and physiological linkage of couples can be measured (e.g., from the start of the relationship) and correlated with investment in bi-parental care and relevant measures of reproductive fitness (e.g., health or developmental measures).	*Cross-foster studies** In cross-foster studies, some eggs are removed from the nest of their biological parents and raised by surrogates. This allows one to study the effect of IIC while controlling for genetic quality of the offspring. Thus, the effect of parental IIC on parental care can be examined in isolation. For an example, see Ihle et al., 2015; Riesche et al., 2018.
		*Cross-over/serial breeding studies*** In cross-over designs, individuals can be sequentially paired with partners with whom they vary in IIC. This within-subject design allows the study of the effect of parental IIC on parental care while controlling for individual quality of the parents. For an example, see Rutstein et al., 2005. *Correlational studies* In a longitudinal or cross-sectional setup, the behavioral and physiological linkage of pairs can be measured (e.g., from the start of the pair-bond) and correlated with investment in bi-parental care and relevant reproductive fitness measures (e.g., offspring quantity and/or offspring survival).

* in birds and some primate species (e.g., marmosets)
** in serially monogamous birds or primates

ative approach (e.g., as in voles: L. J. Young, Winslow, Nilsen, & Insel, 1997) can be fruitful in answering this and many other questions such as, do closely related species that differ with regards to bi-parental care and pair bonding also differ in the amount and contexts in which IIC is occurs? Further development of comparative theoretical will allow us to explain IIC findings in humans and other animals and advance the understanding of this multi-faceted relationship.

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Chapter 9

The subtle art of seduction: Mimicry of coy smiles enhances interpersonal attraction

Abstract

Choosing our partner is one of the most important decisions in our life. However, the specific mechanism(s) underlying partner selection are not well understood. Previous research has suggested that mimicry between people facilitates social bond formation. However, whether the production and mimicry of specific expressions associated with flirting are predictive of attraction has recently been debated. Here, we conducted a real-life speed-dating study and micro-coded behaviours in 49 couples, half of which indicated mutual attraction and half not. We coded behaviours associated with attraction, specifically coy smiles, eyebrow flushes, as well as genuine smiles and polite smiles and tested whether they predict attraction to a partner. As expected, we found that mimicry of coy smiles predicted attraction. Interestingly, we found that genuine smiles predicted decreased attraction to a partner. Our findings suggest that mimicry of specific cues that reflect attraction is associated with dating success.

Based on:
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Introduction

Choosing our partner is one of the most important decisions in our life. Happily married individuals live longer than unhappily married or single individuals (Lawrence, Rogers, Zajacova, & Wadsworth, 2019) and seem to enjoy other physical benefits, such as recovering faster from illnesses (Umberson, Williams, Powers, Liu, & Needham, 2006). People often believe that they choose their partner based on certain criteria, such as physical appearance or personality, yet their actual dating decisions do not reflect that (Eastwick & Finkel, 2008a). When on a date, we collect information from many different sources about our potential partner. We might focus on their facial characteristics, voice, or body language. But ultimately, people tend to base their decisions on whether they feel a "spark" with their partner, a property known as chemistry (Reis, Regan, & Lyubomirsky, 2022; Roth, Samara, Tan, et al., 2021). This chemistry might be reflected or facilitated by mimicry, the automatic imitation of another's facial and postural expressions (Hess & Fischer, 2014). Here, we conducted a speed-dating study to examine whether mimicry of subtle nonverbal cues or so-called "flirting behaviors" (M. M. Moore, 2010) predict attraction.

Mimicry is defined as imitating the expressions and posture of people we interact with (Hess, Philippot, & Blairy, 1999). A consistent finding in the literature is that mimicry is crucial in forming interpersonal bonds (Bernieri, Rosenthal, Feldman, & Rimé, 1991; Chartrand & Bargh, 1999; Lafrance & Broadbent, 1976; Lakin et al., 2003; Yabar & Hess, 2007). This is not only the case for humans (Hess & Fischer, 2013), but also for many non-human animals (Griffith, 2019; Ota et al., 2015). Mimicking or imitating another's expressions during an interaction occurs automatically (Hess & Fischer, 2014) and has been suggested to result in motivational alignment (Kurtz et al., 2019). Importantly, mimicry mostly occurs when there is affiliative motivation (Stel & Vonk, 2010; Tiedens & Fragale, 2003), and mimicking another may be used to nonverbally indicate preferred physical proximity to another (Farley, 2014). Regarding the role of mimicry in pair bonding, a recent meta-analysis (Montoya et al., 2018) showed that attraction is closely associated with mimicking others. Indeed, this is also predicted by the pair-bonding hypothesis (Rasmussen, 1981; Roth, Samara, Tan, et al., 2021)—high levels of mimicry between potential partners increase the likelihood of a romantic bond. Although previous studies have examined the role of mimicry in romantic interactions (e.g., Prochazkova et al., 2022), whether the mimicry of subtle nonverbal expressions or so-called "flirting behaviors" influences pair bonding remains relatively unexamined.

People frequently try not to show their emotions during interactions (Kret, 2015). However, there are several cues associated with attraction that are not under our voluntary control or are performed unconsciously (Grammer et al., 2000). For example, when we see someone we are at-

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tracted to, we might blush, smile, and unconsciously look away, and our pupils might dilate (Eibl-Eiblsfeldt, 1989; Keltner & Buswell, 1997). It is widely recognized that attraction is primarily communicated through subtle nonverbal cues (Givens, 1978), which has led to coining the term "courtship dance" to express how humans signal attraction (Birdwhistell, 1970). These subtle expressions are crucial, as they allow for ambiguity and flexibility, protecting both parties involved in the exchange of romantic or sexual cues if such interest is not reciprocated (Gersick & Kurzban, 2014). Researchers have identified numerous cues indicating attraction that are produced unconsciously, such as coy smiles—looking away briefly while smiling —, eyebrow raises, and lip licking or biting—expressions commonly labelled "flirting behaviors" (Argyle, 1988; Eibl-Eiblsfeldt, 1989; Givens, 1978; Grammer, 1990; Guerrero & Wiedmaier, 2013; Hall et al., 2015; McCormick & Jones, 1989; M. M. Moore, 1985, 2010). Although it is well-known that mimicry facilitates the formation of romantic bonds (Roth, Samara, Tan, et al., 2021), whether the mimicry of such subtle nonverbal expressions plays a role in the initiation of pair bonding remains to be examined.

A recent speed-dating study (Prochazkova et al., 2022) suggested that physiological synchrony, rather than the mimicry of nonverbal facial expressions, is important in predicting attraction. The authors argued that this might be because facial expressions, unlike physiological activity, can be regulated by top-down control. Thus, they can be easily controlled or faked (de Gelder et al., 2010). However, although this study investigated emotional facial expressions such as smiles and laughter, it did not look into subtle nonverbal expressions, which may be less regulated by top-down control and which are typically associated with attraction. Prior theoretical literature on attraction has shown that subtle nonverbal expressions or so-called "flirting behaviors," such as coy smiles, eyebrow raises, and lip licking or biting, are related to attraction (Argyle, 1988; Eibl-Eiblsfeldt, 1989; Givens, 1978; Grammer, 1990; Guerrero & Wiedmaier, 2013; M. M. Moore, 2010). Crucially, it has been suggested that only coy smiles (and not any kind of smile, such as genuine or polite smiles) have been associated with attraction (Guerrero & Wiedmaier, 2013). This might explain why the previous study on the mimicry of nonverbal facial expressions in attraction (Prochazkova et al., 2022) failed to find that the mimicry of nonverbal facial expressions is informative for predicting attraction. It might be more likely that the mimicry of subtle nonverbal expressions typically found in attraction, rather than more general nonverbal behaviours that this study investigated (i.e., smiles—including and combining all types of smiles, laughter, and eye-gaze) matter for attraction.

Here, we examined whether mimicking subtle nonverbal expressions or so-called "flirting behaviours" predicts mutual attraction in a speed-dating paradigm. These experimental paradigms offer an opportunity to examine the initial stages of social interaction (Finkel & Eastwick, 2008) efficiently and economically. By employing a controlled laboratory environment, we thus allow for a space where multiple individuals can engage in brief dates with several potential partners, allowing for a structured and standardized data collection (Eastwick & Finkel, 2008b; Finkel et al., 2007; Finkel & Eastwick, 2008). Thus, speed-dating paradigms provide an ecologically valid way to study human mate choice (e.g., see Roth, Samara, & Kret, 2021a; Samara et al., 2021). We expected that when both couple members were interested in their partner, they would mimic more subtle expressions indicating attraction (i.e., coy smiles and eyebrow flushes). We also explored whether the mimicry of nonverbal expressions indicating positive affect (i.e., smiles, such as genuine smiles and polite smiles) predict attraction.

Methods

Participants

Given that we opted for a Bayesian analysis framework, which offers more flexibility with optional stopping during data collection, we did not conduct an a-priori power calculation (van Doorn et al., 2021). Eighty (N = 80) Dutch heterosexual participants between the ages of 18-30 were recruited via online platforms (e.g., Sona Systems, https://www.sona-systems.com) and on-campus advertisements for a speed-dating experiment. Ten participants failed to attend the experimental sessions, and three participants (2 men) withdrew from the study prior to the speed dating sessions. Therefore, the final sample consisted of 67 participants (N = 67; 35 women; M_{age} = 22.03, SD = 2.26; men: M_{age} = 22.61, SD = 1.75). Participants registered via a Qualtrics form, where they were provided with an information letter and criteria questions to participate in the experiment. Only participants who met the criteria (i.e., heterosexual, fluent in Dutch, 18-30 years old, with normal or corrected-to-normal vision and normal colour vision, normal hearing acuity, and no psychological disorders) were allowed to register for the experimental session. Participants were further instructed not to wear jewelry, heavy make-up, perfume, and revealing clothes during the testing sessions. As compensation for their participation, participants were provided with a ticket to Apenheul Primate Park located in Apeldoorn, the Netherlands. The study received approval from the Leiden University Ethics Committee (CEP: 2020-02-20-M.E. Kret-V1-2169).

Speed-dates

Participants were divided into groups of 20 (10 men) and were asked to complete a series of cognitive tasks (for a full description of the methods, see Roth et al., 2021). Following the tasks, the participants took part in a maximum of 10 speed dates with all opposite-sex participants, which resulted

Table 1. Description of coded behaviours including Event Type and Description

Variable	Event Type	Description
Coyness	State	A smile (lip corners raised) with gaze aversion or head-tilt
Genuine smile	State	Lip corners up with cheeks raised and eye contact
Polite smile	State	Lip corners up without cheeks raised and eye-contact
Eyebrow flush	Event	Eyebrows raised

in 277 dates. Each speed date lasted 4 minutes, after which, participants indicated their interest on meeting their partner for another date.

Videos

We selected only couples in which both partners indicated that they would like to go on another date with their partner (mutually attracted) or that they would not like to go on another date with their partner (mutually not attracted), which resulted in 62 dates being selected for this study. Thirteen dates were excluded because of technical difficulties (9 couples because the partner's video was not recorded and four because the starting bell was not recorded or because their partner obscured the view of one dater). This resulted in 49 couples that were coded and included in the analysis for the present study. In twenty-five of these dates ($n = 25$) both partners indicated that they were attracted to their partner, whereas in twenty-four couples, both partners indicated that they were not attracted to their partner.

All videos were coded offline using the Observer XT 15 event-logging software (Noldus Information Technology Inc., Wageningen, The Netherlands). We used a coding scheme including multiple composite and single-unit behaviors associated with a positive experience and attraction during romantic interactions. Specifically, we coded the following expressions: a) coyness; b) genuine smiles; c) polite smiles; d) eyebrow flushes (see Table 1; see also Samara et al., 2022, for a similar approach). The videos were coded by two independent coders following extensive training who were also blind to the outcome of the speed dates. Inter-rater reliability between the coders was calculated using 12 videos. The inter-rater reliability was good (Cohen's κ $>$ .60 for all behaviors; (see Table 1; Bakeman, 2000); therefore, all coded behaviors were included in the analyses.

Data preprocessing and analyses

The durations and frequencies of all behaviours were extracted and preprocessed using a custom MATLAB script to measure mimicry between daters. For each participant in a couple and for each behavior, we counted as mimicry of behaviour each instance where a partner responded to a dater's expression (with the same expression in return) within a range of 5 seconds (see also Prochazkova et al., 2022). The resulting data were analyzed in R Studio (version 4.2.2; Team, 2022) using the *brms* package (Bürkner, 2017, 2018).

We present the median estimate along with the 95% Highest Density Intervals (HDI), which account for 95% of the posterior parameter distribution (Kruschke, 2018). To determine whether an effect was robust, we considered whether the 95% HDI spanned over 0, as it would suggest that couples were 50% likely to go on another date (i.e., at chance level). Additionally, we report the probability of direction (*pd*), which reflects the proportion of probability in support of a predicted positive or negative effect (Makowski et al., 2019).

To examine whether the mimicry of subtle expressions predicts attraction while accounting for the individual differences in producing these expressions, we conducted a Bayesian binary logistic regression on date outcome with the counts of mimicked coy, genuine, polite smiles, eyebrow flushes, as well as the counts of expressed coy, genuine, polite smiles, and eyebrow flushes per participant as fixed effects as a control. All predictors were scaled to obtain a mean of 0 and an *SD* of 1. We opted for a Gaussian prior distribution with a mean of 0 and an *SD* of 1 for all effects.

Results

The results of the binary logistic regression predicting date outcome (mutual attraction vs. not) by the mimicry of coy, genuine, and polite smiles, and eyebrow flushes, and controlling for the number of these expressions of each partner, showed that a higher mimicry of coy smiles predicted an increase in attraction to partner (β = 1.94, 95% HDI: [1.06, 2.91], pd_+ = 100%; see Table 3; see Figure 1A and Table 2 for descriptives). Surprisingly, mimicry of genuine smiles predicted decreased attraction to a partner (β = -0.98, 95% HDI: [-1.77, -0.19], pd_- = 99.5%; see Table 3; see Figure 1B and Table 2 for descriptives). All other effects were not robust.

Discussion

Even though it is well-known that mimicry facilitates the formation of social bonds (e.g., Lakin et al., 2003), whether the mimicry of subtle nonverbal facial expressions influences attraction has been debated. Here, we examined whether mimicking subtle nonverbal facial expressions predicts mutual attraction in a real-life speed-dating setting. Our results showed that mimicking coy smiles—smiles with gaze or head aversions previously linked to flirting and attraction— predicts mutual attraction.

Table 2. Mean and *SD* of behavior expression and mimicry for each behavior and as a function of attraction to partner summed across two partners in a date.

Variable	**Attraction to Partner**	
	Attracted	**Not Attracted**
Coy smile expression	94.00 (53.98)	62.80 (33.10)
Genuine smile expression	24.04 (15.18)	21.75 (12.84)
Polite smile expression	29.49 (19.61)	26.11 (16.88)
Eyebrow flush expression	36.12 (22.78)	23.14 (15.07)
Coy smile mimicry	32.08 (14.21)	17.80 (8.82)
Genuine smile mimicry	7.62 (5.36)	7.29 (5.91)
Polite smile mimicry	9.87 (7.50)	8.26 (6.18)
Eyebrow flush mimicry	10.82 (8.27)	6.78 (4.59)

Table 3. Overview of the Model Predicting Date Outcome

Predictors	Date outcome (Median estimate of the coefficient with 95% HDI)	
	β (95% HDI)	pd_+
Intercept	0.31 (-0.21, 0.86)	87.7%
Coy smile mimicry	**1.94 (1.06, 2.91)**	**100%**
Coy smile expression	0.23 (-0.79, 1.20)	66.8%
Genuine smile mimicry	**-0.98 (-1.77, -0.19)**	**99.5%**
Genuine smile expression	-0.37 (-1.21, 0.55)	79.8%
Polite smile mimicry	0.00 (-0.76, 0.78)	50.4%
Polite smile expression	0.04 (-0.82, 0.92)	53.6%
Eyebrow flush mimicry	0.16 (-0.63, 0.94)	64.8%
Eyebrow flush expression	0.75 (-0.01, 1.52)	97.5%

Note: Robust effects are depicted in bold.

As expected, we found that mimicking subtle facial expressions, specifically coy smiles, predicts attraction. This finding supports the idea that mimicry promotes the formation of romantic bonds (Roth, Samara, Tan, et al., 2021; Rasmussen, 1981). It is also in line with the literature suggesting that subtle nonverbal facial expressions or so-called flirting behaviors are relevant for attraction (Argyle, 1988; Eibl-Eiblsfeldt, 1989; Guerrero & Wiedmaier, 2013; Givens, 1978; Grammer, 1990; Hall et al., 2015; McCormick & Jones, 1989; M. M. Moore, 1985, 2010). Of note, we did not find the same results for other types of smiles, including genuine and polite smiles, as neither genuine nor polite smiles were related to attraction. These findings are consistent with the findings of (Prochazkova et al., 2022) who demonstrated that smile mimicry did not predict attraction in a speed-dating context. Importantly, not every type of smile, but only the mimicry of coy-smile seems to be relevant for attraction.

Surprisingly, we found that mimicking genuine smiles decreased the like-

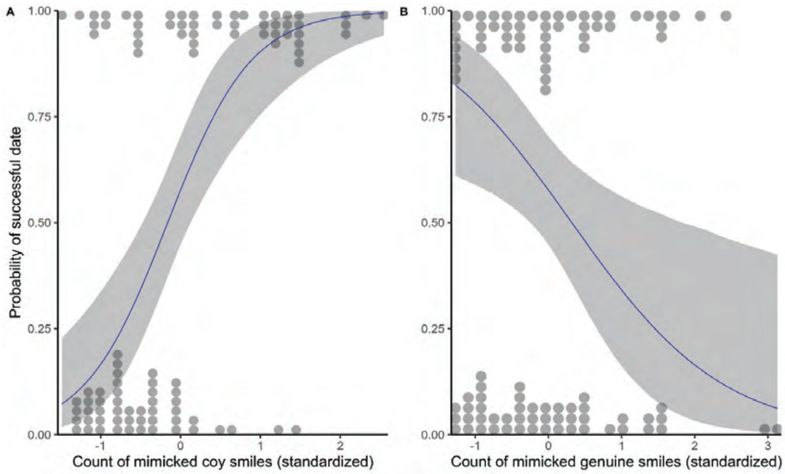

Figure 1. Probability of being attracted to a partner as a function of coy smile mimicry (counts, scaled for mean 0 and $SD = 1$). (B) Probability of being attracted to a partner as a function of genuine smile mimicry (counts, scaled for mean 0 and $SD = 1$).

lihood that two people would go on another date. This finding is unexpected, considering that previous research suggested that genuine smiles reflect positive affect and a willingness to affiliate (Ekman, Davidson, & Friesen, 1990; Hess & Fischer, 2022). However, our findings might suggest that, although genuine smiles might reflect general positive affect, they do not indicate romantic interest specifically. Although it has been argued that the Duchenne (genuine) smile (and not other types of smiles, such as polite smiles that do not include the orbicularis oculi and that are thought of as forced/voluntary smiles) indicates enjoyment and reflects positive affect (Ekman et al., 1990; Frank & Ekman, 1993), this position has been recently debated. Recent studies have suggested that Duchenne smiles are frequently observed in intentional contexts, thus, may not be an indication of positive affect exclusively (Girard, Cohn, Yin, & Morency, 2021; Krumhuber & Manstead, 2009). Future research should further examine whether or not the expression and mimicry of genuine smiles indicate attraction in a blind-date setting.

Our findings, albeit providing an insight into the dynamics of expressions exhibited during first dates using an ecologically valid paradigm and precise coding of (subtle) behaviors, should be interpreted with caution. First of all, the scope of the present study was limited to only heterosexual participants and was mostly comprised of university students, which is a common practice in speed-dating studies (A. J. Lee et al., 2020; Perilloux et al., 2012). Furthermore, the social skills of our sample might differ from those of a wider population, meaning that people more likely to attend speed-dating events might have stronger or weaker social skills (Finkel & Eastwick, 2008). To increase the generalizability of such findings, it is recommended that future research includes a more diverse range of participants with respect to age, educational background, and sexual orientation. Finally, our study was not experimental and, thus, the causal influence of the mimicry of coy-smiles on attraction cannot be inferred. Future studies may try to manipulate mimicry to test the causal effect of mimicry in attraction in real life settings.

In conclusion, our study examined whether mimicry of subtle flirting expressions predicts attraction in a real-life speed-dating paradigm. Our findings demonstrate that mimicry of specific expressions associated with attraction, namely coy smiles, predicts attraction in a speed-date paradigm. Surprisingly, we found that mimicry of genuine smiles reduces attraction to a partner. The results of this study further extend previous work on attraction and bond formation by highlighting the importance of mimicking subtle unconscious expressions in ecologically real-life dating paradigms. Future research should expand upon these findings to further disentangle the interplay between mimicry and attraction in real-life dating scenarios.

Chapter 10

General Discussion

In order to navigate our romantic environment, we have to be able to express attraction, detect it in others, and adjust our behavior so that we maximize our chances of forming romantic bonds. We notice an attractive potential partner faster, and our attention lingers on them more than on a less attractive partner. We tend to judge attractive people more favorably than others, an effect that in the literature is known as "what is beautiful is good" (Dion et al., 1972). This cognitive bias likely increases the likelihood that we approach attractive potential partners. Finally, when we approach our romantic interest, we are more likely to imitate them, which might increase our chances of establishing a romantic bond.

In the present dissertation, I examined, in a series of studies, the effects of attraction on social cognition. Specifically, I examined how attraction influences our attention and judging others' intentions, and how inter-individual coordination (IIC) might facilitate the formation of romantic bonds. Figure 1 displays an overview of the topics examined in each chapter. In the final chapter, I attempt to integrate the key chapter findings and discuss theoretical implications. Crucially, I also highlight potential new directions for future research.

Summary of key findings

In **Chapter 2** (Figure 1; red arrow), we examined how attractive faces modulate attention and social cognition. In Experiment 1, using the dot-probe task, participants were presented with attractive or unattractive faces paired with an intermediate-attractive face. The results showed that participants responded faster to the probe when presented at the same location as an attractive face. In contrast, participants responded slower when the probe was presented at the same location as an unattractive face. In Experiment 2, we examined whether a similar effect can be found when the stimuli used are symmetrical (an index of attractiveness) compared to asymmetrical or original portraits (without a symmetry manipulation). We found no effect of symmetry on reaction times, indicating that symmetry did not modulate attention. In Experiment 3, we investigated whether attractiveness modulates social gaze cueing using a modified Posner task (Deaner et al., 2007). The results showed that attractiveness did not manipulate gaze cueing; however, attractive faces did overall enhance reaction time, indicating that people responded faster to attractive than unattractive faces. However, this finding could be due to the longer stimulus presentation (300ms) compared to previous studies (e.g., B. C. Jones et al., 2010, where 200 ms but not 400 ms produced an effect). This suggests that attractiveness effects on attention might be best captured by paradigms designed to influence bottom-up attention, rather than allowing top-down effects to emerge. The findings of this study illustrate that attractiveness modulates attention and

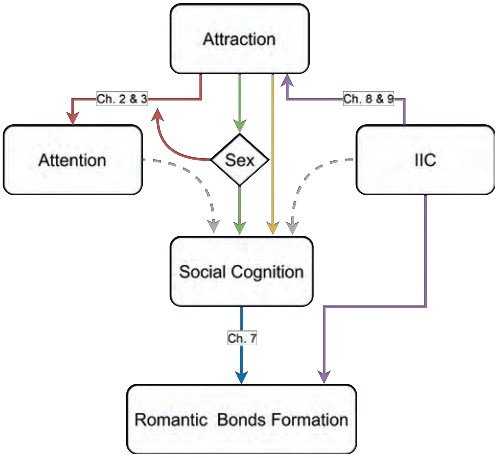

Figure 1. Graphical illustration of the topic of each chapter. Chapters 2 and 3 examined the influence of attraction on attention. Chapters 4 and 5 investigated how sex moderates the relationship between attraction and social cognition (specifically, the sexual overperception bias). Chapter 7 provided a theoretical overview of this relationship and extended it to the formation of romantic bonds. Chapter 6 examined whether people that are not involved in a date are able to detect attraction in others. Chapters 8 and 9 examined whether inter-individual coordination (IIC) is associated with attraction and facilitates the formation of romantic bonds. The gray dashed lines connecting Attention to Social Cognition and IIC to Social Cognition reflect suggestions for future studies elaborated on in the *Methodological considerations and future directions* section.

that traditional metrics of attractiveness (i.e., symmetry) might not be as important as previously thought, but other parameters such as averageness, might be more important in judging a face as attractive (e.g., see A. Jones & Jaeger, 2019). Importantly, we did not find evidence that attractiveness also modulates gaze cueing, even though this might be due to the stimulus presentation duration.

In **Chapter 3** (Figure 1; red arrow), we examined the relationship between attention and attractiveness, and willingness to date a potential partner. We used a manual reaction time task (i.e., dot-probe task) and a preferential-looking task (incl. eye tracking) to obtain a more fine-tuned understanding of the automatic or voluntary processes underlying this relationship. Regarding the dot-probe task, we found that men were more likely to be distracted by and attend to images of women they found attractive. Interestingly, even though both men and women were distracted by images of people with whom they would like to go on another date, only men responded faster to images of women with whom they would like to go on another date. In the preferential-looking task, the results showed that men and women tend to look more at an image of a partner they found attractive and with whom they would like to go on another date.

In **Chapter 4** (Figure 1; green arrow), I zoomed in on how people's emotional state affects their interpretation of others' emotional state in order to better understand how attraction may arise. This functional projection hypothesis was initially posed in the seminal work by Maner et al. (2005), which I replicated in this chapter. In Experiment 1, male participants viewed either a romantic video segment depicting a White heroine or a Black heroine or a neutral video segment. Then, participants were presented with a series of female White and African American neutral faces that were rated as high or average in attractiveness. They were asked to indicate whether the people they viewed were sexually aroused, afraid, happy, or angry. The results showed that independent of the video condition, men indicated highly attractive White women as more sexually aroused than all other faces (also called the sexual overperception bias). In the original study, Maner et al. (2005) found that men that had watched a romantic film were more likely to interpret the expressions of highly attractive White women as sexually aroused than men that had watched a neutral film, and compared to medium-attractive White women, highly-attractive Black women, and medium-attractive Black women. Therefore, our results partially replicated the findings of Maner et al. (2005) and furthermore show that the sexual overperception bias might also arise due to a transient arousal state. In Experiment 2, male and female participants watched a fearful or neutral video segment and were presented with a series of male and female White and African American neutral faces. In contrast with Maner et al. (2005), who found that Black men were rated as angrier compared to all other stimuli, we found that independent of the video condition, participants were more likely to indicate that White men were angrier than all other stimuli. This discrepancy between our findings and the findings by Maner et al. (2005) could be due to the fact that we used a different stimulus set, did not control for participants' ethnicity, and, importantly, the different ethnicity of the samples in our and the original study, as our study was conducted in the Netherlands. In contrast, the original study was conducted in the US.

In **Chapter 5** (Figure 1; green arrow), I investigated the factors underlying the sexual overperception bias. Using responses from a large speed-dating study, where people went on a maximum of 10 dates with a member of the opposite sex, I examined whether people were more likely to overperceive attraction in their potential partners as a function of sex, projection of their own interest, self-rated attractiveness, or trait sexual desire. The results showed that men were more likely to indicate that their partner was interested in another date only when they themselves felt attracted to their partner. Men detected their partners' interest more accurately when they were not attracted to them. On the other hand, women were approximately 50% (i.e., chance level) accurate in detecting their partners' attraction. These findings suggest that projection might be the mechanism by which the sexual overperception bias is manifested. In other words, the sexual overperception bias might occur because men tend to project their own sexual interest onto women they are interested in, leading them to misperceive the level of sexual interest in a potential partner. In contrast to previous literature (e.g., A. J. Lee et al., 2020; Perilloux et al., 2012), self-rated attractiveness and trait sexual desire did not influence overperception. However, this could be due to the fact that previous studies measured sociosexual orientation instead of specifically sexual desire. Furthermore, previous studies measured different aspects of attractiveness (e.g., physical and personality), whereas we only examined self-rated physical attractiveness.

The previous study showed that men are accurate in inferring whether their partner is attracted to them but only when they are not interested in that partner. This suggests that people may be more accurate in detecting attraction when they are neutral observers. In **Chapter 6** (Figure 1; yellow arrow), I examined whether third-party observers could detect attractions in others. In Experiment 1, I presented adults and children with two brief videos (3 sec) of people on a date and asked them to indicate whether each person was interested in their partner. Unbeknownst to the participants, half of the videos were presented not with their original partner but with a random partner. I expected that participants would be less accurate in detecting attraction when presented with these videos, as participants could not rely on cues indicating attraction. Contrary to my expectations, I did not find this effect. Furthermore, I found that overall, participants could not accurately detect attraction in others. As expected, children were worse than adults at detecting attraction, especially when the daters presented were not interested in their partners. In general, participants were better at detecting whether there is attraction when the people presented in the videos were attracted to their partners compared to when they were not. In Experiment 2, I examined whether the decreased accuracy observed in children was due to increased cognitive load since, in Experiment 1, two video streams were presented simultaneously. Therefore, in Experiment 2, I presented one video at a time. As in Experiment 1, I found that overall, could not accurately detect attraction in others compared to chance level. This time, there was no effect of age, as children and adults performed at chance level. Crucially, I again found that participants were able to indicate with above chance level accuracy the presence/absence of attraction when the daters presented were interested in their partners using video segments from different timeframes in a blind date. In Experiment 3, I examined whether adults could detect attraction in others with longer video segments. The results showed that this was not the case; the length of the video segments did not influence the participants' accuracy. Similar to Experiments 1 and 2, participants were more reliable in detecting attraction when the people presented in the videos were attracted to their partner. To examine whether this difference was due to the emotional expressions of the daters, I coded the emotional expressions of the daters in the 9-second videos for flirting cues (e.g., coy smiles) and examined whether they differed between daters that were interested in their partner or not. Our results suggested that subtle expressions indicating attraction differed depending on whether daters were interested in their partner. This finding combined with the ability of the participants to detect attraction when the daters were interested in their partner, might indicate that subtle expressions of attraction are detectable and can be used in decision-making. However, an alternative explanation could be that participants were biased due to the dating context and tended to indicate that the daters were interested in their partner more often than not. Overall, the findings of these experiments show that, in contrast with previous studies (Place et al., 2009), detecting attraction might not be as straightforward as, for example, detecting basic emotions.

In **Chapter 7** (Figure 1; green and blue arrow), I focused on sex differences in the sexual overperception bias. To this end, we commented on the work of Lee et al. (2020). In their speed-dating study, the authors found that projection of own interest, self-rated attractiveness, and sociosexual orientation mediated the relationship between sex and sexual overperception. They interpreted these findings as evidence that there are no sex differences in sexual overperception. Therefore, they argued that the explanation proposed by the Error Management Theory (EMT; Haselton, 2003; Haselton & Buss, 2000), that sexual overperception is adaptive for men as it increases the chances of reproduction, is incorrect. In our commentary, we proposed that their interpretation relies on a proximate level to disprove an explanation on the ultimate level, based on the "proximate-ultimate distinction" by Tinbergen (1963). In short, we explain that if, for example, we discovered that male birds sing because of an increase in testosterone levels, it would not contradict the simultaneous explanation that male birds sing as a means of courtship. Similarly, the fact that men tend to project their own interest more onto their partners, does not contradict the fact that this projection could serve as a mechanism to enhance their chances of attracting additional partners. Furthermore, the effects described by Lee et al. (2020) describe a perfect mediation between sex and overperception by means of the projection of own interest. Lee et al. (2020) interpret this as evidence that sex, therefore, is not informative or relevant in the model. On the contrary, in our interpretation, the projection of own interest is the mechanism by which the effect is manifested. Since the projection of own interest is more likely to occur in men, sex is still an important factor in the theoretical model. Finally, we proposed that EMT would benefit by incorporating the proximate mechanisms described in Lee et al. (2020).

In **Chapter 8** (Figure 1; purple arrow), we took a comparative approach to better understand the underlying mechanisms in attraction, or more generally, pair bonding. Specifically, we reviewed the effect of inter-individual coordination (IIC), an umbrella term encompassing synchrony and mimicry, for pair-bonding, maintenance, and offspring rearing based on a comparative framework. We suggested how IIC can be used to quantify the pair-bond strength, thus extending the pair-bonding hypothesis. The pair-bonding hypothesis suggests that pair-bond strength enhances a couple's reproductive success. In our framework, this can be quantified by examining differences in IIC and reproductive success between couples. Furthermore, IIC might be used as a threshold in the initial courting phases, so only couples with high coordination are formed. Crucially, we illustrated how a comparative framework might be useful in examining the effect of IIC on pair bond formation, maintenance, and offspring rearing.

In **Chapter 9** (Figure 1; purple arrow), I focused on testing our idea that inter-individual coordination can be used to quantify the strength of the bond between two individuals. To this end, I examined whether mimicry facilitates pair-bond formation. Specifically, using videos obtained from a speed-dating study, I obtained metrics regarding expressions indicating attraction for each dater in couples where both daters indicated they would like to go on another date with their partner and in couples where both daters indicated that they would not like to go on another date with their partner. As expected, based on the pair-bond hypothesis described above, I found that people mimicked coy smiles more when they were attracted to their partner than when they were not. These findings align with previous research illustrating that mimicry facilitates the formation of romantic bonds (Lakin et al., 2003; Hess & Fischer, 2014). Furthermore, these findings support the pair-bonding hypothesis (Roth, Samara, Tan, et al., 2021; Rasmussen, 1981), which suggests that mimicry and synchrony can be used to quantify the pair-bond strength.

Theoretical implications

The findings of my studies converge on three points: (1) attraction modulates attention; (2) attraction influences how we evaluate others depending on our sex; and (3) attraction facilitates the formation of romantic bonds, which rely on IIC.

It is well-known that evolutionary-relevant stimuli should capture attention (Cosmides & Tooby, 1992), and, as my studies show that attractive faces capture attention, they suggest that attractive faces constitute such an evolutionary-relevant stimulus. Attractive faces are thought to capture attention because they signal potential mates, and this is an important evolutionary adaptation for reproducing and passing on one's genes. Crucially, previous research has demonstrated that people attend more to attractive faces and that they are more likely to remember and recognize them (Langlois, Roggman, & Musselman, 1994). In my work, I show that attraction modulates attention at a very early stage of visual processing. One factor that may contribute to the attractiveness of a face is facial symmetry. Indeed, symmetry is often seen as a sign of good health and genetic quality, and research has shown that people find symmetrical faces more attractive (Thornhill & Gangestad, 1999). However, the findings of this dissertation suggest that symmetry may not be as important as previously thought. The attraction between two individuals might be much more idiosyncratic, meaning it cannot be captured by what is generally (on average) rated as attractive. Furthermore, real, unmanipulated faces are more ecologically valid, and they provide more information about what people might encounter in everyday life. Therefore, we extended the original methodology by extending it to real-life interactions. Specifically, we used as stimuli the (non-manipulated) faces of opposite-sex participants in a speed-dating paradigm, meaning that participants were rating people that they would later meet and deciding whether they would like to go on another date. This allowed us also to incorporate individual attractiveness ratings as well as dating choices when decoding attentional dwell, and we found that these modulate attention, whereas manipulated symmetric faces did not. To the best of my knowledge, this study is the first to examine whether the biases found in a laboratory attentional task would match what we find in a real-life ecologically valid speed-dating paradigm, which can have several practical implications. These implications are described in the Methodological considerations and future directions section below. For now, the question remains which features, then, are deemed attractive by people, and future studies should incorporate subjective attractive ratings to further model individual rater differences.

Attraction not only modulates our early attention but, crucially, also influences social cognition and how we perceive others' emotional states. Specifically, attraction influences our approach motivation, increasing the likelihood that we will try to increase our proximity towards others. Chapters 4, 6, and 8 focus on the sexual overperception bias and illustrate that (a) independent of the underlying emotional state, men are more likely to perceive ambivalent cues in women as sexual arousal when they find the woman attractive; (b) men are more likely to overinterpret attraction from women when they themselves are interested in them in a real-life speed-dating paradigm. However, men are able to read women's interest when they are not interested. This suggests that the sexual overperception bias is very specific, it seems to manifest when men are interested in a potential partner and not in other circumstances. Finally, (c) the likely mechanism underlying the sexual overperception bias is the projection of one's own interest in a partner. This projection could be included as a mechanism in the Error Management Theory (Haselton, 2003), which suggests that the ultimate function of the sexual overperception bias is to ensure that men do not miss mating opportunities.

Previous literature has suggested that detecting attraction in others might be beneficial, as it allows us to create a network of potentially available partners (Simao & Todd, 2002). Indeed, people are able to detect above chance whether people are interested in their partner (Place et al., 2009). In three studies, I showed that this effect might be more nuanced than initially thought. Even though people should have their own experiences with romantic interactions, meaning they have come across cues associated with attraction, such as facial expressions, they cannot extrapolate these experiences to others. As such, when confronted with expressions exchanged between other people that might or might not be interested in their partner, they fail to assess attraction correctly above chance level. This finding might suggest that attraction might not be readily discernible from a prototypical facial expression or bodily posture. Another explanation could be that similar to other studies (Hall et al., 2015), people are not familiar with flirting during first dates, as these instances are rare (Abbey, 1982), therefore they might not be able to accurately detect it. Crucially, one potential explanation is that people might be able to better detect attraction by assessing the inter-individual coordination of a couple, as in, how much and how fluidly they mimic each other. A couple with high inter-individual coordination may suggest a strong bond or "chemistry" (Tickle-Degnen & Rosenthal, 1990). However, accurately assessing this property would require the presentation of both members of a couple together, rather than in separate videos, as was done in Experiment 1 of Chapter 8. In Chapter 8, I further discuss the importance of a couple's inter-individual coordination (IIC) as an indicator of attraction and the formation of a romantic bond.

In Chapter 8, we review the literature on inter-individual coordination and whether it can be used to assess whether a potential partner is suitable for a romantic relationship. Previous models have suggested that coordination between people facilitates bond formation (e.g., Perper, 1985; Rasmussen, 1981). In our work, we suggested that the coordination of both motor and physiological responses is the mechanism supporting the bond formation, and maintenance, and likely enhances offspring rearing (Zeevi et al., 2022; Prochazkova et al., 2022); thus, it can be used as an index of bond strength in a comparative framework. Crucially, I then examined the predictions generated by our model by investigating whether mimicry of subtle cues predicted dating outcomes in a real-life speed-dating setup (Chapter 9). I found that mimicry of coy smiles, a smile associated with attraction, predicts a higher likelihood of people wanting to go on another date with their partner. We extend the model by Rasmussen (1981) by providing a mechanism for the pair-bond strength, namely the IIC. Furthermore, we demonstrate that mimicry, a sub-component of IIC, can indeed be used to predict the formation of a romantic bond.

Methodological considerations and future directions

Investigating how attention, social cognition, and IIC are modulated by attraction has illustrated that currently used experimental tasks, designs, and stimuli can provide first insights into the processes underlying attraction and dating choices. Future studies can build on this knowledge and improve the methodological approach in several ways.

Speed dating studies have been considered a reliable and cost-effective to acquire data on how people form romantic bonds (Finkel & Eastwick, 2008). Even though speed-dating studies are widely used (N. P. Li et al., 2013; Tidwell et al., 2013; Todd et al., 2007), they are usually combined with surveys relating to the dating experience or personality questionnaires. However, as I have shown in the present thesis, the combination of experimental cognitive tasks with speed-dating studies and precise codings of couples' behaviors provides a unique opportunity to investigate whether and the manner in which cognitive biases and nonverbal cues predict real-life dating decisions.

Several studies have demonstrated the sexual overperception bias, and multiple mechanisms have been proposed to underlie its emergence. For example, a few factors that have been proposed were sociosexual orientation, projection of one's own interest to the partner, and self-rated attractiveness. Interestingly, in our work, we found that men who were interested in their partner were likely to over-perceive attraction in them. In contrast, men who were disinterested in their partner exhibited a higher degree of accuracy in detecting whether their partner was interested in them. Women were not able to accurately detect whether their partner was interested in them or not, independent of how they felt about their partner. We suggested that this effect might be due to differences in physiological arousal between men and women, namely that men might experience physiological arousal faster than women (Kukkonen et al., 2007), which consequently biases their decision-making when they are attracted to their partner. However, no studies to date have examined the physiological underpinnings of the sexual overperception bias. I aim to investigate this in my future work, as this discrepancy might provide a physiological explanation for the sexual overperception bias.

Regarding future directions, in our work, we suggested that IIC might facilitate bond formation and maintenance. Crucially, we showed that a mimicry index could be used to quantify the pair-bond strength (Samara et al., in prep). Even though it is well-understood that coordination with a partner is beneficial for promoting a romantic bond, the underlying mechanism remains unclear. Different models and hypotheses have been proposed to explain the relationship between mimicry and social bonds. For example, recently, it was suggested that mimicry might facilitate the prediction of others' behavior (e.g., Kret & Akyüz, 2022). Others have suggested that mimicry promotes the formation of social bonds because people evaluate a synchronous interaction more positively than an asynchronous one, during which they might feel uneasy (Pfaus, Zakreski, & Safron, 2022). Disentangling the different processes that underlie this intricate relationship would benefit the literature. Thus, future work should focus on detailing cognitive models illustrating the mechanisms underlying coordination and bond formation.

In our review, we outlined evidence showing that in serially monogamous birds, the IIC between parents likely influences the couple's reproductive success. For example, zebra finch couples that picked their mate exhibited more behavioral coordination and were more successful and produced more fledglings than pairs that were formed by the researchers (Ihle et al., 2015). A few studies illustrate that hormonal synchrony between parents might facilitate parental investment (Saxbe et al., 2017); however, the relationship between IIC, reproduction, and child-rearing remains under-investigated in humans. Future research should aim to conduct longitudinal studies investigating how the IIC between parents might influence reproductive success and child-rearing.

Future research can employ experimental tasks to advance our understanding of the relationship between attention, social cognition, and inter-individual coordination in romantic bond formation. One potential task is the imitation-inhibition task, which has been used to study automatic imitation (Brass, Bekkering, Wohlschläger, & Prinz, 2000; Brass, Derrfuss, Matthes-von Cramon, & von Cramon, 2003). In this task, participants are required to perform a movement while watching a video of a person performing a movement that is either congruent (same) or incongruent (different) with the movement they were instructed to perform. Previous research has shown that participants tend to respond slower and make more errors in the incongruent condition, indicating that imitation of the observed behavior is automatic. Future studies could examine how participants' idiosyncratic attractiveness ratings of the presented stimuli influence their performance on the incongruent condition of the imitation-inhibition task. Eye-tracking measures could also be incorporated to investigate how these attractiveness ratings influence participants' attentional dwell, and whether attractive faces are prioritized over changes in movements. Finally, participants could be asked to rate the trustworthiness, intelligence, and dominance of the people in the stimuli, which would allow for an examination of how attraction, inter-individual coordination, and social cognition interact.

The use of big data is prevalent in psychology and can also be used in romantic decision-making. In Chapter 3, we showed that fixations in an eye-tracking task could be used to predict dating choices in a speed-dating study. Specifically, the more people preferentially attended to a person's image, the more likely they were to indicate later that they would like to meet them again. In other words, the findings of the present dissertation suggest that attraction to another can be detected by implicit processes, such as increased attentional dwell. Therefore, in popular dating apps, such as Tinder, decisions about a potential romantic partner could be taken using not necessarily explicit choices but rather implicit processes, such as the duration of viewing a person's profile. Whether this addition to dating apps reliably predicts initial attraction and date success would have to be further examined. However, such an approach would be a valuable first step in getting more insight into the intricate interplay between attention, implicit processes, and dating choices.

Conclusion

In conclusion, the findings of my dissertation illustrate that when people are attracted to someone, they are more likely to focus on them as their attention narrows down to the potential partner. People are also more likely to perceive a person they find attractive in a more biased way, which increases the chance that they approach them. Finally, when they approach them, they are more likely to mimic them, thus increasing their chances of getting another date. Altogether, my findings contribute to our understanding of how attraction influences social interactions and relationships.

Appendices

Appendix A

Supplemental Material for Chapter 3

Supplementary methods Participants registered for the experiment using an online form (Qualtrics). They were asked to provide informed consent and indicate that they met the inclusion criteria. After providing informed consent, participants were divided in 4 groups of 20 (10 women) and indicated their preferred timeslot. Upon arrival to the lab, participants were asked to sign an informed consent. Next, participants received a unique ID, submitted the olfactory stimuli and filled in 3 questionnaires (a) demographic information; b) 7-level Kinsey scale; (Kinsey et al., 1948); c) Sexual Desire Inventory, (SDI, Elaut et al., 2010). Next, a researcher took portrait pictures of the participants (ID photos, Puts et al., 2013) whereas, another researcher collected the audio stimuli (Dutch equivalent of RAINBOW passage; Van Lierde, Wuyts, De Bodt, & Van Cauwenberge, 2001) using a Shure V5 microphone.

Following stimulus collection, participants performed a battery of cognitive tasks. Specifically, participants were asked to perform a dot-probe (van Rooijen et al., 2017), effort (Hahn, Xiao, Sprengelmeyer, & Perrett, 2013), and preferential looking task (Leder et al., 2016) to measure visual attentional biases, and three rating tasks (i.e., visual, auditory, and olfactory). The task section of the study lasted approximately one hour. After all participants had completed the tasks, they were led into the speed-dating room to conduct 10 speed-dating sessions. Each speed date lasted for 5 minutes. Both individuals were videotaped during the date. After each date, they indicated a) how attractive they found their partner (7-point scale); b) how suitable they found their partner as a long-term romantic partner (7-point scale); c) how attractive they believed their partner perceived them to be (7-point scale); d) how suitable their partner perceived them to be as a long-term romantic partner (7-point scale); e) whether they would like to go on another date with their partner (yes/no); and f) whether they believed their partner would like to go on another date with them (yes/no). The speed-dating section of the study lasted approximately one hour. After the study was completed, participants were asked to give consent for use of their stimuli and contact information, debriefed, and given a complementary ticket to Apenheul Primate Park (Apeldoorn, the Netherlands).

Table S1. Total number of trials per level of the predictors per Gender.

	Female (N = 24)	Male (N = 33)
Pre-date attractiveness probe		
1	205	243
2	513	582
3	471	581
4	415	609
5	280	455
6	126	265
7	9	77
Pre-date attractiveness distractor		
1	202	248
2	514	592
3	464	576
4	4120	607
5	281	461
6	129	259
7	9	69

Table S2. Average RTs and SD (between brackets) per level of Pre-date attractiveness rating of the probe picture and Gender.

	Female	Male
1	389 (81.12)	356.58 (74.03)
2	361.49 (65.70)	344.52 (64.13)
3	363.53 (70.26)	338.63 (56.72)
4	378.03 (82.65)	334.11 (54.17)
5	378.34 (74.00)	349.36 (77.09)
6	361.76 (74.39)	349.23 (67.19)
7	402.67 (53.85)	363.77 (76.67)

Table S3. Average RTs and SD (between brackets) per level of Pre-date attractiveness rating of the distractor picture and Gender.

	Female	Male
1	381.74 (75.91)	354.61 (72.68)
2	366.26 (77.78)	339.59 (58.72)
3	362.66 (70.47)	336.26 (61.75)
4	377.14 (75.75)	333.73 (53.79)
5	378.8 (71.48)	346.07 (70.15)
6	358.84 (67.49)	366.64 (76.74)
7	427.56 (48.28)	393.35 (72.23)

Table S4. Model table for the Bayesian mixed model that predicts RT from Pre-date attractiveness rating and Gender.

	RT	
Predictors	*Estimates*	*CI (95%)*
Intercept	0.52	-1.18 – 2.22
Gender[Female]	0.34	-1.37 – 2.05
AttractivenessDistractor	1.44	0.18 – 2.69
AttractivenessProbe	-1.09	-2.51 – 0.29
Gender[Female]: AttractivenessDistractor	-0.41	-1.68 – 0.86
Gender[Female]: AttractivenessProbe	1.40	-0.02 – 2.82
Random Effects		
σ^2	2588.90	
$\tau 00_{Subject}$	0.97	
$\tau 11_{Subject:AttractivenessDistractor}$	7.60	
$\tau 11_{Subject:AttractivenessProbe}$	13.47	
$N_{Subject}$	57	
Observations	4831	

Notes: Gender was sum-coded, while Pre-date attractiveness ratings were centered around 4 (the middle option).

Table S5. Model table for the Bayesian mixed model that predicts RT from Post-date attractiveness ratings and Gender.

	RT	
Predictors	*Estimates*	*CI (95%)*
Intercept	0.36	-1.42 – 2.14
Gender[Female]	-0.24	-2.06 – 1.64
AttractivenessDistractor	1.89	0.66 – 3.11
AttractivenessProbe	-0.89	-2.44 – 0.63
Gender[Female]: AttractivenessDistractor	0.34	-0.89 – 1.59
Gender[Female]: AttractivenessProbe	1.16	-0.41 – 2.71
Random Effects		
σ^2	2580.38	
$\tau 00_{Subject}$	1.29	
$\tau 11_{Subject:AttractivenessDistractor}$	1.92	
$\tau 11_{Subject:AttractivenessProbe}$	13.50	
$N_{Subject}$	56	
Observations	3251	

Notes: Gender was sum-coded, while Post-date attractiveness ratings were centered around 4 (the middle option).).

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Table S6. Total number of trials per level of the predictors per Gender.

	Female (N = 24)	Male (N = 32)
Date outcome probe		
0 (= no interest)	987	1056
1 (= interest)	377	831
Date outcome distractor		
0	985	1063
1	379	824

Table S7. Average RTs and SD (between brackets) per level of Date outcome of the probe picture and Gender.

	0	**1**
female	365.36 (68.81)	384.14 (82.51)
male	342.76 (66.9)	342.16 (62.73)

Table S8. Average RTs and SD (between brackets) per level of Date outcome of the distractor picture and Gender.

	0	**1**
female	364.71 (65.78)	385.75 (88.28)
male	340.02 (67.32)	345.69 (61.96)

Table S9. Model table for the Bayesian mixed model that predicts RT from Date outcome and Gender.

	RT	
Predictors	*Estimates*	*CI (95%)*
Intercept	0.82	-1.14 – 2.824
Gender[Female]	0.97	-1.08 – 2.99
DateAgainProbe[yes]	-0.81	-3.16 – 1.45
DateAgainDistractor[yes]	2.20	0.22 – 4.24
Gender[Female]:DateAgainProbe[yes]	2.31	0.00 – 4.66
Gender[Female]:DateAgainDistractor[yes]	0.62	-1.42 – 2.67
Random Effects		
σ^2	2588.97	
$\tau00_{Subject}$	1.60	
$\tau11_{Subject:DateAgainProbe[yes]}$	26.92	
$\tau11_{Subject:DateAgainDistractor[yes]}$	4.71	
$N_{Subject}$	56	
Observations	3251	

Notes: All predictors were sum-coded.

Table S10. Total number of trials per level of the predictors per Gender.

	Female (N = 17)	Male (N = 18)
Pre-date attractiveness left		
1	74	74
2	216	158
3	164	195
4	180	197
5	84	104
6	44	51
7	0	28
Pre-date attractiveness right		
1	79	39
2	139	94
3	196	181
4	180	217
5	104	166
6	64	93
7	0	17

Table S11. Average Bias score (proportion of time looking at left picture) and SD (between brackets) per level of Pre-date attractiveness rating of the left picture and Gender.

	1	**2**	**3**	**4**	**5**	**6**	**7**
Female	0.3 (0.27)	0.39 (0.26)	0.48 (0.27)	0.52 (0.29)	0.57 (0.28)	0.68 (0.21)	
Male	0.36 (0.24)	0.37 (0.2)	0.4 (0.26)	0.42 (0.27)	0.59 (0.31)	0.73 (0.18)	0.89 (0.16)

Table S12. Average Bias score (proportion of time looking at left picture) and SD (between brackets) per level of Pre-date attractiveness rating of the right picture and Gender.

	1	**2**	**3**	**4**	**5**	**6**	**7**
Female	0.3 (0.27)	0.39 (0.26)	0.48 (0.27)	0.52 (0.29)	0.57 (0.28)	0.68 (0.21)	
Male	0.36 (0.24)	0.37 (0.2)	0.4 (0.26)	0.42 (0.27)	0.59 (0.31)	0.73 (0.18)	0.89 (0.16)

Table S13. Model table for the Bayesian zero-one inflated beta regression predicting Looking time proportion to the left picture from Pre-date attractiveness rating and Gender.

	Left bias	
Predictors	*Estimates*	*CI (95%)*
Intercept	0.97	0.91 – 1.04
phi_Intercept	5.44	4.52 – 6.56
zoi_Intercept	0.02	0.01 – 0.06
coi_Intercept	0.86	0.43 – 1.69
AttractivenessLeft	1.39	1.34 – 1.44
Gender[Female]	1.00	0.94 – 1.06
AttractivenessRight	0.69	0.67 – 0.71
AttractivenessLeft:Gender[Female]	0.98	0.95 – 1.02
Gender[Female]:AttractivenessRight	1.01	0.98 – 1.05
phi_AttractivenessLeft	0.96	0.90 – 1.02
phi_Gender[Female]	0.97	0.80 – 1.17
phi_AttractivenessRight	0.97	0.91 – 1.03
phi_AttractivenessLeft:Gender[Female]	1.02	0.95 – 1.09
phi_Gender[Female]:AttractivenessRight	1.02	0.96 – 1.09
zoi_AttractivenessLeft	1.19	1.00 – 1.43
zoi_Gender[Female]	1.10	0.55 – 2.21
zoi_AttractivenessRight	1.58	1.32 – 1.92
zoi_AttractivenessLeft:Gender[Female]	0.98	0.83 – 1.17
zoi_Gender[Female]:AttractivenessRight	0.93	0.77 – 1.12
coi_AttractivenessLeft	1.93	1.43 – 2.67
coi_Gender[Female]	0.85	0.48 – 1.52
coi_ AttractivenessRight	0.42	0.28 – 0.61
coi_AttractivenessLeft:Gender[Female]	0.86	0.63 – 1.17
coi_Gender[Female]:AttractivenessRight	1.40	0.96 – 2.12
Random Effects		
σ^2	0.01	
$\tau 00_{Subject}$	0.06	
$N_{Subject}$	35	
Observations	1569	

Notes: Gender was sum-coded, while Pre-date attractiveness ratings were centered around 4 (the middle option). Estimates for the predictors were exponentiated, so that they represent Odds Ratios for the beta, coi and zoi parameters.

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Table S14. Slope estimates at different levels of Pre-date attractiveness rating (both left and right picture).

pre-date attr. rating left picture	**Median estimate** [MAD]	**89% CrI**	**pd**
-3	0.068 [.0028]	0.063, 0.072	1.00
-2	0.077 [.0039]	0.071, 0.083	1.00
-1	0.084 [.0048]	0.077, 0.092	1.00
0	0.087 [.0050]	0.079, 0.095	1.00
1	0.083 [.0044]	0.076, 0.090	1.00
2	0.074 [.0032]	0.069, 0.079	1.00
3	0.063 [.0020]	0.059, 0.066	1.00
pre-date attr. rating right picture	**Median estimate** [MAD]	**89% CrI**	**pd**
-3	-0.078 [.0025]	-0.081, -0.073	1.00
-2	-0.088 [.0038]	-0.094, -0.082	1.00
-1	-0.096 [.0046]	-0.103, -0.088	1.00
0	-0.098 [.0048]	-0.106, -0.091	1.00
1	-0.091 [.0041]	-0.098, -0.085	1.00
2	-0.077 [.0028]	-0.082, -0.073	1.00
3	-0.061 [.0019]	-0.064, -0.058	1.00

Table S15. Difference in slope between women and men at different levels of Pre-date attractiveness rating (both left and right picture).

pre-date attr. rating left picture	**Median estimate** [MAD]	**89% CrI**	**pd**
-3	-.0052 [.0055]	-0.014, 0.004	0.83
-2	-.0075 [.0076]	-0.021, 0.004	0.84
-1	-.0094 [.0094]	-0.025, 0.006	0.84
0	-.0097 [.0100]	-0.026, 0.007	0.83
1	-.0075 [.0088]	-0.021, 0.007	0.81
2	-.0043 [.0064]	-0.015, 0.006	0.75
3	-.0013 [.0040]	-0.008, 0.005	0.64
pre-date attr. rating right picture	**Median estimate** [MAD]	**89% CrI**	**pd**
-3	.000 [.005]	-0.009, 0.010	0.50
-2	.001 [.008]	-0.014, 0.015	0.54
-1	.005 [.009]	-0.014, 0.022	0.70
0	.012 [.010]	-0.006, 0.032	0.91
1	.013 [.008]	-0.002, 0.030	0.95
2	.008 [.006]	-0.003, 0.020	0.94
3	.003 [.004]	-0.004, 0.011	0.82

Table S16. Model table for the Bayesian zero-one inflated beta regression predicting Looking time proportion to the left picture from Post-date attractiveness rating and Gender.

	Left bias	
Predictors	*Estimates*	*CI (95%)*
Intercept	0.93	0.85 – 1.01
phi_Intercept	4.49	3.62 – 5.53
zoi_Intercept	0.01	0.00 – 0.04
coi_Intercept	0.70	0.18 – 2.21
AttractivenessLeft	1.21	1.15 – 1.26
Gender[Female]	1.01	0.93 – 1.09
AttractivenessRight	0.79	0.75 – 0.82
AttractivenessLeft:Gender[Female]	0.98	0.94 – 1.02
Gender[Female]:AttractivenessRight	1.07	1.02 – 1.11
phi_AttractivenessLeft	0.90	0.84 – 0.97
phi_Gender[Female]	0.94	0.76 – 1.16
phi_AttractivenessRight	1.02	0.95 – 1.10
phi_AttractivenessLeft:Gender[Female]	1.03	0.95 – 1.10
phi_Gender[Female]:AttractivenessRight	1.00	0.93 – 1.07
zoi_AttractivenessLeft	1.26	0.99 – 1.63
zoi_Gender[Female]	1.09	0.51 – 2.31
zoi_AttractivenessRight	1.60	1.26 – 2.08
zoi_AttractivenessLeft:Gender[Female]	1.07	0.84 – 1.36
zoi_Gender[Female]:AttractivenessRight	0.79	0.61 – 1.00
coi_AttractivenessLeft	1.84	1.19 – 2.95
coi_Gender[Female]	0.98	0.46 – 2.23
coi_ AttractivenessRight	0.57	0.36 – 0.87
coi_AttractivenessLeft:Gender[Female]	0.88	0.56 – 1.45
coi_Gender[Female]:AttractivenessRight	1.14	0.73 – 1.80
Random Effects		
σ^2	0.01	
$\tau 00_{Subject}$	0.06	
$N_{Subject}$	35	
Observations	1009	

Notes: Gender was sum-coded, while Post-date attractiveness ratings were centered around 4 (the middle option). Estimates for the predictors were exponentiated, so that they represent Odds Ratios for the beta, coi and zoi parameters.

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Table S17. Total number of trials per level of the predictors per Gender

	Female (N = 24)	**Male (N = 32)**
Date outcome probe		
0 (= no interest)	277	326
1 (= interest)	140	266
Date outcome distractor		
0	272	326
1	145	266

Table S18. Average Bias score (proportion of time looking at left picture) and SD (between brackets) per level of Date outcome of the left picture and Gender.

	0	**1**
female	0.45 (0.27)	0.51 (0.3)
male	0.39 (0.25)	0.56 (0.28)

Table S19. Average Bias score (proportion of time looking at left picture) and SD (between brackets) per level of Date outcome of the left picture and Gender.

	0	**1**
female	0.52 (0.29)	0.37 (0.24)
male	0.53 (0.26)	0.38 (0.27)

Table S20. Model table for the Bayesian zero-one inflated beta regression predicting Looking time proportion to the left picture from Date outcome and Gender.

	Left bias	
Predictors	*Estimates*	*CI (95%)*
Intercept	0.87	0.80 – 0.96
phi_Intercept	4.18	3.38 – 5.21
zoi_Intercept	0.02	0.00 – 0.05
coi_Intercept	0.58	0.19 – 1.50
DateAgainLeft[Yes]	0.79	0.73 – 0.84
Gender[Female]	1.03	0.93 – 1.13
DateAgainRight[Yes]	1.32	1.24 – 1.41
DateAgainLeft[Yes]:Gender[Female]	1.03	0.96 – 1.11
Gender[Female]:DateAgainRight[Yes]	0.98	0.91 – 1.04
phi_DateAgainLeft[Yes]	1.16	1.05 – 1.29
phi_Gender[Female]	1.03	0.84 – 1.27
phi_DateAgainRight[Yes]	0.92	0.83 – 1.03
phi_DateAgainLeft[Yes]:Gender[Female]	0.98	0.88 – 1.08
phi_Gender[Female]:DateAgainRight[Yes]	0.88	0.79 – 0.97
zoi_DateAgainLeft[Yes]	0.73	0.52 – 1.03
zoi_Gender[Female]	1.03	0.49 – 2.15
zoi_DateAgainRight[Yes]	0.49	0.34 – 0.69
zoi_DateAgainLeft[Yes]:Gender[Female]	0.81	0.57 – 1.13
zoi_Gender[Female]:DateAgainRight[Yes]	1.27	0.89 – 1.79
coi_DateAgainLeft[Yes]	0.43	0.23 – 0.83
coi_Gender[Female]	0.85	0.42 – 1.89
coi_DateAgainRight[Yes]	3.18	1.67 – 6.18
coi_DateAgainLeft[Yes]:Gender[Female]	1.62	0.86 – 3.08
coi_Gender[Female]:DateAgainRight[Yes]	1.38	0.73 – 2.75
Random Effects		
σ^2	0.01	
$\tau 00_{Subject}$	0.06	
$N_{Subject}$	35	
Observations	1009	

Notes: All predictors were sum-coded. Estimates for the predictors were exponentiated, so that they represent Odds Ratios for the beta, coi and zoi parameters.

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Table S21. Model table for the Bayesian mixed model that predicts RT from Pre-date attractiveness ratings and Gender. This analysis was performed on the complete cases-dataset.

	RT	
Predictors	*Estimates*	*CI (95%)*
Predictors	Estimates	CI (95%)
Intercept	1.19	-0.93 – 3.34
Gender[Female]	0.74	-1.49 – 2.92
AttractivenessDistractor	2.06	0.61 – 3.48
AttractivenessProbe	-1.11	-2.83 – 0.65
Gender[Female]:AttractivenessDistractor	-0.10	-1.52 – 1.28
Gender[Female]:AttractivenessProbe	2.06	0.28 – 3.79
Random Effects		
σ^2	2580.38	
$\tau 00_{Subject}$	2.29	
$\tau 11_{Subject:AttractivenessDistractor}$	5.24	
$\tau 11_{Subject:AttractivenessProbe}$	19.83	
$N_{Subject}$	55	
Observations	3198	

Table S22. Model table for the Bayesian mixed model that predicts RT from Post-date attractiveness ratings and Gender. This analysis was performed on the complete cases-dataset.

	RT	
Predictors	*Estimates*	*CI (95%)*
Predictors	Estimates	CI (95%)
Intercept	0.38	-1.38 – 2.19
Gender[Female]	-0.27	-2.19 – 1.63
AttractivenessDistractor	1.78	0.55 – 3.01
AttractivenessProbe	-0.91	-2.48 – 0.64
Gender[Female]: AttractivenessDistractor	0.46	-0.77 – 1.68
Gender[Female]: AttractivenessProbe	1.19	-0.38 – 2.75
Random Effects		
σ^2	2581.06	
$\tau 00_{Subject}$	1.30	
$\tau 11_{Subject:AttractivenessDistractor}$	1.73	
$\tau 11_{Subject:AttractivenessProbe}$	13.89	
$N_{Subject}$	55	
Observations	3198	

Notes: Gender was sum-coded, while Post-date attractiveness ratings were centered around 4 (the middle option).

Table s23. Model table for the Bayesian mixed model that predicts RT from Date outcome and Gender. This analysis was performed on the complete cases-dataset.

	RT	
Predictors	*Estimates*	*CI (95%)*
Predictors	Estimates	CI (95%)
Intercept	0.80	-1.19 – 2.77
Gender[Female]	1.01	-1.04 – 3.05
DateAgainProbe[yes]	-0.93	-3.31 – 1.35
DateAgainDistractor[yes]	1.97	0.01 – 3.97
Gender[Female]:DateAgainProbe[yes]	2.39	0.04 – 4.70
Gender[Female]:DateAgainDistractor[yes]	0.87	-1.14 – 2.86
Random Effects		
σ^2	2590.00	
$\tau 00_{Subject}$	1.62	
$\tau 11_{Subject:DateAgainProbe[yes]}$	26.86	
$\tau 11_{Subject:DateAgainDistractor[yes]}$	4.46	
$N_{Subject}$	55	
Observations	3198	

Notes: All predictors were sum-coded.

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Table S24. Model table for the Bayesian zero-one inflated beta regression predicting Looking time proportion to the left picture from Pre-date attractiveness rating and Gender. This analysis was performed on the complete cases-dataset.

	Left bias	
Predictors	*Estimates*	*CI (95%)*
Intercept	0.95	0.88 – 1.03
phi_Intercept	5.64	4.55 – 7.03
zoi_Intercept	0.02	0.01 – 0.06
coi_Intercept	0.83	0.30 – 2.13
AttractivenessLeft	1.38	1.32 – 1.45
Gender[Female]	0.99	0.92 – 1.08
AttractivenessRight	0.70	0.67 – 0.72
AttractivenessLeft:Gender[Female]	1.00	0.95 – 1.04
Gender[Female]:AttractivenessRight	1.01	0.97 – 1.05
phi_AttractivenessLeft	0.95	0.87 – 1.04
phi_Gender[Female]	1.02	0.82 – 1.26
phi_AttractivenessRight	0.98	0.91 – 1.06
phi_AttractivenessLeft:Gender[Female]	0.98	0.90 – 1.07
phi_Gender[Female]:AttractivenessRight	1.07	1.00 – 1.16
zoi_AttractivenessLeft	1.13	0.89 – 1.44
zoi_Gender[Female]	1.04	0.51 – 2.11
zoi_AttractivenessRight	1.56	1.25 – 1.98
zoi_AttractivenessLeft:Gender[Female]	0.97	0.77 – 1.23
zoi_Gender[Female]:AttractivenessRight	0.83	0.65 – 1.04
coi_AttractivenessLeft	1.61	1.07 – 2.45
coi_Gender[Female]	0.83	0.42 – 1.77
coi_ AttractivenessRight	0.48	0.30 – 0.76
coi_AttractivenessLeft:Gender[Female]	0.84	0.56 – 1.32
coi_Gender[Female]:AttractivenessRight	1.22	0.77 – 2.00
Random Effects		
σ^2	0.01	
$\tau 00_{Subject}$	0.06	
$N_{Subject}$	35	
Observations	1009	

Notes: Gender was sum-coded, while Pre-date attractiveness ratings were centered around 4 (the middle option). Estimates for the predictors were exponentiated, so that they represent Odds Ratios for the beta, coi and zoi parameters.

Table S25. Model table for the Bayesian zero-one inflated beta regression predicting Looking time proportion to the left picture from Post-date attractiveness rating and Gender. This analysis was performed on the complete cases-dataset.

	Left bias	
Predictors	*Estimates*	*CI (95%)*
Intercept	0.93	0.85 – 1.01
phi_Intercept	4.49	3.62 – 5.53
zoi_Intercept	0.01	0.00 – 0.04
coi_Intercept	0.70	0.18 – 2.21
AttractivenessLeft	1.21	1.15 – 1.26
Gender[Female]	1.01	0.93 – 1.09
AttractivenessRight	0.79	0.75 – 0.82
AttractivenessLeft:Gender[Female]	0.98	0.94 – 1.02
Gender[Female]:AttractivenessRight	1.07	1.02 – 1.11
phi_AttractivenessLeft	0.90	0.84 – 0.97
phi_Gender[Female]	0.94	0.76 – 1.16
phi_AttractivenessRight	1.02	0.95 – 1.10
phi_AttractivenessLeft:Gender[Female]	1.03	0.95 – 1.10
phi_Gender[Female]:AttractivenessRight	1.00	0.93 – 1.07
zoi_AttractivenessLeft	1.26	0.99 – 1.63
zoi_Gender[Female]	1.09	0.51 – 2.31
zoi_AttractivenessRight	1.60	1.26 – 2.08
zoi_AttractivenessLeft:Gender[Female]	1.07	0.84 – 1.36
zoi_Gender[Female]:AttractivenessRight	0.79	0.61 – 1.00
coi_AttractivenessLeft	1.84	1.19 – 2.95
coi_Gender[Female]	0.98	0.46 – 2.23
coi_ AttractivenessRight	0.57	0.36 – 0.87
coi_AttractivenessLeft:Gender[Female]	0.88	0.56 – 1.45
coi_Gender[Female]:AttractivenessRight	1.14	0.73 – 1.80
Random Effects		
σ^2	0.01	
$\tau 00_{Subject}$	0.06	
$N_{Subject}$	35	
Observations	1009	

Notes: Gender was sum-coded, while Post-date attractiveness ratings were centered around 4 (the middle option). Estimates for the predictors were exponentiated, so that they represent Odds Ratios for the beta, coi and zoi parameters.

Table S26. Model table for the Bayesian zero-one inflated beta regression predicting Looking time proportion to the left picture from Date outcome rating and Gender. This analysis was performed on the complete cases-dataset.

	Left bias	
Predictors	*Estimates*	*CI (95%)*
Intercept	0.87	0.80 – 0.96
phi_Intercept	4.19	3.37 – 5.21
zoi_Intercept	0.02	0.00 – 0.06
coi_Intercept	0.58	0.19 – 1.52
DateAgainLeft[Yes]	1.27	1.19 – 1.36
Gender[Female]	1.03	0.94 – 1.13
DateAgainRight[Yes]	0.76	0.71 – 0.81
DateAgainLeft[Yes]:Gender[Female]	0.97	0.90 – 1.04
Gender[Female]:DateAgainRight[Yes]	1.03	0.96 – 1.09
phi_DateAgainLeft[Yes]	0.86	0.78 – 0.95
phi_Gender[Female]	1.03	0.83 – 1.28
phi_DateAgainRight[Yes]	1.08	0.98 – 1.21
phi_DateAgainLeft[Yes]:Gender[Female]	1.03	0.92 – 1.14
phi_Gender[Female]:DateAgainRight[Yes]	1.14	1.03 – 1.27
zoi_DateAgainLeft[Yes]	1.37	0.97 – 1.94
zoi_Gender[Female]	1.04	0.49 – 2.16
zoi_DateAgainRight[Yes]	2.04	1.45 – 2.96
zoi_DateAgainLeft[Yes]:Gender[Female]	1.24	0.88 – 1.76
zoi_Gender[Female]:DateAgainRight[Yes]	0.80	0.56 – 1.13
coi_DateAgainLeft[Yes]	2.34	1.22 – 4.46
coi_Gender[Female]	0.84	0.42 – 1.93
coi_DateAgainRight[Yes]	0.31	0.16 – 0.59
coi_DateAgainLeft[Yes]:Gender[Female]	0.62	0.32 – 1.16
coi_Gender[Female]:DateAgainRight[Yes]	0.72	0.37 – 1.35
Random Effects		
σ^2	0.01	
$\tau 00_{Subject}$	0.06	
$N_{Subject}$	35	
Observations	1009	

Notes: All predictors were sum-coded. Estimates for the predictors were exponentiated, so that they represent Odds Ratios for the beta, coi and zoi parameters.

Appendix B

Supplemental Material for Chapter 6

Expressions of attraction in videos

The video segments were coded to examine whether daters exhibited expressions signalling attraction during the dates. All video segments (N = 32; 16 female) were coded offline using the Observer XT 11.5 event-logging software (Noldus, Trienes, Hendriksen, Jansen, & Jansen, 2000) for both the 3-second First Impression (FI) and 9-second Verbal Interaction (VI) conditions, for a total of 64 videos. We used a coding scheme including multiple composite and single-unit behaviours associated with positive experience during romantic interactions. Specifically, we coded the following expressions: a) coyness; b) flirting; c) interest; d) positive affect; e) embarrassment, and minor variations of these expressions thereof (e.g., coy smiles with and without raised cheeks; see Table 1) based on Cordaro et al. (Cordaro et al., 2018). The video segments were coded by two independent coders following extensive training. To assess inter-rater reliability, Cohen's intra-class correlation (ICC) for absolute agreement was calculated for 4 video segments (12.5% percent of video segments; IIC $>$ 0.60, for all continuous behaviours, except embarrassment which was not included in the analyses and kappa = 1.00 for all categorical behaviors). The durations and frequencies were extracted and analysed in JASP (version 0.16; JASP Team, 2021). For all coded behaviours, we compared daters who were interested to their partner versus daters who were not interested in their partner. We used either independent Bayesian t-tests or chi square tests for continuous and count data, respectively. All tests were conducted using default prior distributions.

Regarding the 3 second videos, there were no robust differences in expression duration between daters that were interested in their partner and daters that were not interested in their partner. However, there were numerical trends between conditions (see Table 2) suggesting that the number of videos might have limited our power to detect these differences.

Regarding the 9 second videos, daters showed more coyness when they were attracted to their partner (M = 2740.00 ms; SD = 1137.52) than when they were not (M = 1700.00 ms; SD = 916.52; BF_{10} = 3.13; see Table 3). All other expressions had a $BF_{10} < 3$ (indicating anecdotal evidence) and thus were not interpreted (BF_{10}: coyness (with cheek raised) = 0.54; flirting = 1.47; genuine smile = 0.35; polite smile = 0.58). Bayesian contingency tables showed no robust differences in head nodding, blushing, and rolling the pelvis (coded 1 if present; 0 if absent) between daters who were interested in their partner than not (BF_{10}: blushing = 0.43; rolling the pelvis = 0.59).

Table 1. Description of coded behaviours including Event Type, Description, and associated Reliability Values (IIC for absolute agreement or Cohen's kappa)

Variable	Event type	Description	Reliability
Leaning forward	Event	Leaning toward the partner	1
Coyness	State	A smile with a gaze aversion	0.99
Coyness (cheeks raised)	State	A genuine smile (incl. cheeks raised) with gaze aversion & 0.94	
Flirting	State	A smile with eye-contact and head tilt	0.69
Head nod	State	Nodding	1
Genuine smile	State	Lip corners up with cheeks raised	0.76
Polite smile	State	lip corners up without cheeks raised	0.86
Blushing	Event		1
Rolling the pelvis	Event		1

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Table 2. Overview of differences in duration of emotional expressions between videos in which the daters were attracted to their partner or not in First Impression 3-second videos.)

	Attracted to Partner			**Not Attracted to Partner**		
Behavior	*M*	*SD*	95% CrIs	*M*	*SD*	95% CrIs
Coyness cheek raised	293.75	392.38	84.67, 502.83	443.75	847.72	-7.97, 895.47
Coyness	800.00	752.77	398.88, 1201.12	693.75	813.61	260.21, 1127.29
Genuine smile	1175.00	1216.28	526.89, 1823.11	618.75	1059.07	54.41, 1183.09
Polite smile	1562.50	1071.37	991.61, 2133.39	2081.25	1366.37	1353.17, 2809.34
Flirting	4			12		
Blush	6			10		
Rolling pelvis	0			1		

Note: Flirting was treated as categorical due to the low variance in duration.

Table 3. Overview of differences in duration of emotional expressions between videos in which the daters were attracted to their partner or not in 9-second videos.)

	Attracted to Partner			**Not Attracted to Partner**		
Behavior	*M*	*SD*	95% CrIs	*M*	*SD*	95% CrIs
Coyness cheek raised	1546.67	1326.70	792.03, 2301.31	1081.25	977.90	560.16, 1602.34
Coyness	2740.00	1385.02	1973.00, 3507.00	1700.00	916.52	1211.62, 2188.38
Genuine smile	2833.33	1776.30	1849.65, 3817.02	2643.75	2275.95	1430.98, 3856.52
Polite smile	2683.33	1831.30	761.50, 4605.17	3580.00	2025.29	2131.20, 5028.80
Flirting	446.67	552.74	140.57, 752.77	1093.75	1137.52	487.61, 1699.89
Blush	6			10		
Rolling pelvis	3			2		

Participant accuracy per actor

Here, we explored whether participants were more likely to detect attraction in some videos than others. We plotted the mean accuracy in detecting attraction by Actor (person depicted in the video; see Figure 1). Interestingly, it can be noted that 10 videos (2 women; 7 attracted to partner) were consistently rated with over 0.5 level accuracy (henceforth referred to as conspicuous) compared to all other videos in our stimulus set (henceforth referred to as inconspicuous). This pattern suggests that these video segments might have specific elements that rendered them easier to interpret, such as higher duration of behaviours associated with attraction.

To investigate this question, we split the data between the Conspicuous ($N = 10$) and Inconspicuous videos ($N = 22$) and analysed whether the duration of behaviours associated with attraction differed between these two groups (for an overview of all descriptives see Table 3). Bayesian independent t-tests showed that in Conspicuous videos, daters exhibited a greater duration of happiness (M = 1540.00, SD = 1200.19) compared to all remaining videos (M = 604.55, SD = 1035.32; BF_{10} = 2.20). Furthermore, in the Conspicuous videos, daters exhibited lower duration of polite smiles (M = 1040.00; SD = 915.55) compared to the Inconspicuous videos (M = 2177.27; SD = 1213.78; BF_{10} = 4.09).

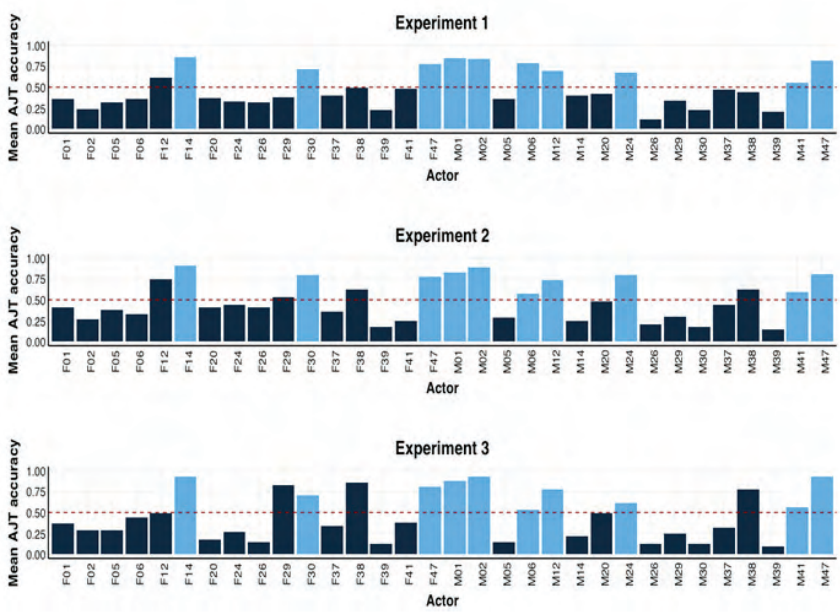

Figure 1. Mean accuracy as a function of Actor (person depicted in video) for Experiments 1-3. Only accuracy from the FI3 Condition are presented in all experiments. The red line denotes chance level (0.5) accuracy. Stimuli that were consistently rated with over 0.5 accuracy are presented in light blue.

Positive response bias

Here, we examined whether differences in attraction detection accuracy as a function of whether the dater depicted was attracted to their partner or not can be explained by a general propensity of the participants to indicate that a dater is attracted to their partner more often than that a dater is not

Table 4. Overview of differences in duration of emotional expressions between videos in which the daters were attracted to their partner or not in 9-second videos.)

	Inconspicuous			**Conspicuous**		
Behavior	*M*	*SD*	95% CrIs	*M*	*SD*	95% CrIs
Coyness cheek raised	345.46	740.481	17.14, 673.77	420.00	436.654	107.64, 732.36
Coyness	872.73	864.20	489.56, 1255.89	470.00	437.29	157.18, 782.82
Genuine smile	604.545	1035.318	145.51, 1063.58	1540.00	1200.19	681.44, 2398.56
Polite smile	2177.27	1213.783	1639.11, 2715.43	1040.00	915.545	385.06, 1694.94

attracted to their partner. We conducted three Bayesian Generalized linear mixed models with participant response (yes/no) as dependent variable and Attraction to Partner as a fixed effect. All models included a random intercept per participant (nested in Group ID for Experiment 1).

The results show that participants were indeed more likely to generally respond yes than no (Exp 1: β = 0.37, [0.27, 0.48], p_+ = 100%; Exp 2: β = 0.23, [0.13, 0.33], p_+ = 100%; Exp 3: β = 0.18, [0.10, 0.26], p_+ = 100%). General response propensity was not influenced by Attraction to Partner (Exp 1: β = -0.06, [-0.12, 0.01], p_- = 96.28%; Exp 2: β = -0.01, [-0.09, 0.08], p_- = 57.26%; Exp 3: β = 0.01, [-0.04, 0.07], p_+ = 68.91%).

Effect of gender congruence on the detection of attraction

To examine whether gender congruence (i.e., a match between the gender of the observer and the person observed) facilitates attraction detection, we included the fixed effects of Age Group (Experiments 1 and 2) or Video Condition (Experiment 3), respectively, Shuffled, and Gender Congruence, as well as their interaction. The analysis was conducted separately for each experiment (see Table 4). We found no substantial evidence that gender congruence facilitated attraction detection.

Differences in sample characteristics between Experiments 1, 2, and 3.

A Bayesian independent samples *t*-test showed no differences in age between children in Experiment 1 and Experiment 2 (BF_{01} = 3.13). A Bayesian chi-square test showed that there were no differences in gender distribution between Experiment 1 and Experiment 2 (BF_{01} = 3.39).

A Bayesian one-way Analysis of Variance (ANOVA) showed that there were differences in age between adults ($BF_{10} > 10$). Specifically, the age mean in Experiment 2 was higher than Experiment 1 ($BF_{10} > 10$) and Experiment 3 ($BF_{10} > 10$). There were no differences in age between Experiment 1 and Experiment 3 (BF_{01} = 0.23). Bayesian chi-square tests

Table 5. Overview of all Gender Congruency models for Experiments 1-3.

Predictors	*Accuracy (Median estimate of the coefficient with 95% HDI*					
	Model 1		**Model 2**		**Model 3**	
	β (95% HDI)		β (95% HDI)		β (95% HDI)	
Intercept	-0.06	-0.13, 0.01	-0.02	-0.11, 0.07	0.01	-0.04, 0.07
Age Group	-0.14	-0.21, -0.07	-0.05	-0.14, 0.04		
Shuffled	-0.01	-0.07, 0.06				
Gender Congruence	0.02	-0.04, 0.08	-0.01	-0.10, 0.09	-0.02	-0.07, 0.04
VI3					0.03	-0.07, 0.12
VI6					0.04	-0.06, 0.13
VI9					0.05	-0.04, 0.14
Age Group × Shuffled	0.04	-0.02, 0.11				
Age Group × Gender Congruence	-0.01	-0.07, 0.06	0.01	-0.07–0.10		
Shuffled × Gender Congruence	0.02	-0.04, 0.09				
Age Group × Shuffled × Gender Congruence	0.06	0.00, 0.12				
VI3 × Gender Congruence					0.01	-0.08, 0.11
VI6 × Gender Congruence					-0.05	-0.15, 0.04
VI9 × Gender Congruence					0.07	-0.02, 0.17
Random Effects						
Var(Participant)	0.00		0.00		0.00	
Var(GroupID)	0.00					

showed no differences in gender distribution between experiments (Experiments 1-2: $BF_{10} = 0.58$; Experiments 1-3: $BF_{10} = 0.50$; Experiments 2-3: $BF_{10} = 0.23$).

Stimuli employed in the Emotion Recognition Task

Regarding the Emotion Recognition Task (ERT), we used stimuli from the Facial Expressions and Emotion Database (FEEDTUM; Wallhoff, Schuller, Hawellek, & Rigoll, 2006). The FEEDTUM database consists of 18 individuals displaying 7 spontaneously elicited emotional facial expressions (happiness, disgust, anger, fear, sadness, surprise, and neutral). Here, we only included 10 actors (5 female) and opted to not include the emotion of disgust. Therefore, the final stimulus set consisted of 60 videos (6 emotional expressions × 10 actors). To ensure potential luminance confounds, the background of all videos was standardized (r = 128, g = 128, b = 128; Akdag, 2020)). All videos were 2000 ms in length, whereby the first 500 ms consisted of a neutral expression and 1500 ms of an emotional expression.

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Samenvatting

Hoe vormen we een romantische band? Een onderzoek naar het effect van aantrekkingskracht op sociale cognitie

Emoties zijn een fundamenteel onderdeel van de menselijke ervaring en geven vorm aan de manier waarop we naar de wereld kijken en ermee omgaan. Van een boze vreemdeling tot het geluid van een hartelijke lach, onze emoties spelen een belangrijke rol bij het vasthouden van onze aandacht en het sturen van onze gedachten en acties. Onderzoek heeft zelfs aangetoond dat we suboptimale beslissingen nemen als we geen rekening houden met onze emoties. Maar heb je er ooit bij stilgestaan hoe je emotionele toestand van invloed is op hoe je anderen waarneemt en op hen reageert? Zou je, afhankelijk van of je je verdrietig of opgetogen voelt, iemand op een andere manier beoordelen en anders op diegene reageren? In mijn proefschrift heb ik me op deze vragen gericht, met een focus op de emotie seksuele aantrekkingskracht. Specifiek onderzocht ik de invloed van seksuele aantrekkingskracht op onze aandacht en sociale cognitie, het begrijpen van anderen, interpretatie van sociale signalen en effectieve interactie in sociale situaties. Verder onderzocht ik het verband tussen het automatisch spiegelen van anderen en het vormen van een romantische band.

In mijn proefschrift onderzoek ik hoe aantrekkelijkheid en symmetrie van het gezicht van invloed zijn op onze aandacht en sociale oordelen. Om dit te onderzoeken, heb ik gemeten of mensen sneller of langzamer reageren als ze afbeeldingen zien van gezichten van mensen die zo gemanipuleerd zijn dat ze er meer of minder symmetrisch uitzien. Een snellere reactie op een bepaald type afbeelding noemen we een aandachtsbias. In hoofdstuk 2 heb ik laten zien dat deelnemers een aandachtsbias vertoonden voor aantrekkelijke gezichten, maar niet voor onaantrekkelijke gezichten. Daarnaast leek gezichtssymmetrie de aandacht niet te beïnvloeden. Opvallend was dat de aantrekkelijkheid van het gezicht geen invloed had op het volgen van de kijkrichting van dit gezicht. Met andere woorden: mensen lijken de blik van aantrekkelijke mensen niet meer te volgen dan die van onaantrekkelijke mensen, in tegenstelling tot bevindingen die beschreven zijn in eerdere literatuur (Hoofdstuk 2).

Naar wie we kijken en hoe lang kan veel onthullen over onze voorkeuren en mogelijke partnerkeuzes. In hoofdstuk 3 combineerde ik speed-dating met experimentele taken die ontworpen waren om voorkeuren in onmiddellijke (automatische) en vrijwillige aandacht te meten. Tijdens deze taken bekeken de deelnemers beelden van de mensen die ze een uur later in een real-life speed date zouden ontmoeten. Met behulp van verschillende meet technieken, zoals eye tracking, konden we bijhouden waar de deelnemers naar keken en wat hun aandacht trok. De bevindingen uit dit onderzoek toonden aan dat als het aankomt op onmiddellijke (automatische) aandacht, mannen makkelijker werden beïnvloed door aantrekkelijkheid dan vrouwen en dus vaker automatisch keken naar vrouwen die ze aantrekkelijk vonden. Maar als het gaat om vrijwillige aandacht (d.w.z., met opzet de aandacht ergens op richten), keken zowel mannen als vrouwen langer naar gezichten die ze aantrekkelijk vonden voordat hun date begon. Bovendien besteedden de deelnemers meer aandacht aan de gezichten van degenen met wie ze later aangaven dat ze een date zouden willen hebben. Weerspiegelt vrijwillige aandacht écht onze keuze voor een partner? Daar lijkt het wel op, maar de resultaten voor onmiddellijke aandacht gaven geen eenduidig beeld. Desalniettemin blijkt dat hoe we iemands aantrekkelijkheid inschatten vóór de date meer voorspellend is voor zowel onmiddellijke als vrijwillige aandacht, dan voor wat er gebeurt op het afspraakje zelf (Hoofdstuk 3).

Ik onderzocht deze zogenaamde ‘functionele projectiehypothese’ verder door voort te bouwen op het baanbrekende werk van Maner e.a. (2005) uitgevoerd in de Verenigde Staten in hoofdstuk 4. Cruciaal is dat ik, in tegenstelling tot de bevindingen van Maner e.a. (2005), vond dat mannen zeer aantrekkelijke vrouwen als seksueel opgewonden beoordeelden. Het maakte daarbij niet uit of deze mannen vooraf een romantische of neutrale (controle) video te zien kregen. Bovendien vond ik, wederom in tegenstelling tot de bevindingen van Maner e.a. (2005), dat deelnemers blanke mannen als bozer beoordeelden dan hun zwarte tegenhangers, ongeacht of ze vooraf naar een beangstigende video of naar een controlevideo keken (Hoofdstuk 4). Deze discrepantie in bevindingen zou verklaard kunnen worden door de tijd die is verstreken tussen de twee onderzoeken (tussen 2005 en 2021), omdat sindsdien veel sociopolitieke bewegingen die zich richten op ras in het nieuws zijn gekomen (zoals de Black Lives Matter-beweging), evenals aan culturele verschillen tussen de Verenigde Staten en Nederland.

Ben je nieuwsgierig naar wat ons tot een ander aantrekt? In een van mijn onderzoeken gebruikte ik speed dates om de elementen te onderzoeken die ten grondslag liggen aan mispercepties in romantische aantrekkingskracht. Ten eerste ontdekte ik dat mannen vaker dan vrouwen geïnteresseerd waren om uit te gaan met een potentiële partner. Maar de belangrijkste bevinding was dat mannen beter in staat waren om in te schatten of hun partner zich tot hen aangetrokken voelde als ze zelf niet geïnteresseerd waren in hun partner. Als mannen wél geïnteresseerd waren in hun partner, hadden ze de neiging om de interesse van hun partner in henzelf meer te overschatten dan vrouwen. Wanneer deelnemers echter niet geïnteresseerd waren in hun partner, was er geen verschil tussen de seksen in de herkenning van aantrekking. Seksueel verlangen en zelf ingeschatte aantrekkelijkheid leken geen rol te spelen in de nauwkeurigheid van de seksuele overperceptiebias (Hoofdstuk 5). In hoofdstuk 7 bekeek ik samen met mijn collega Tom S. Roth het mechanisme dat ten grondslag ligt aan deze bias door in te gaan op het werk van Lee et al. (2020). Lee et al. (2020) toonden aan dat wanneer mediatoren zoals socioseksuele oriëntatie (iemands neiging om informele relaties aan te gaan) en iemands eigen interesse in een ander worden gebruikt om de relatie tussen sekse en overperceptie te verklaren, het effect van iemands sekse verdwijnt. Met andere woorden, sekse blijkt niet belangrijk voor het verklaren van de seksuele overperceptiebias. De auteurs suggereerden verder dat de bias in feite volledig verklaard kan worden door de twee eerdergenoemde mediatoren, namelijk socioseksuele oriëntatie en interesse in een ander. In ons commentaar voerden we aan dat Lee et al. (2020) hiermee verschillende verklaringsniveaus van Tinbergen door elkaar halen, wat theoretisch gezien onjuist is en kan zorgen voor onjuiste interpretaties van bevindingen.

In Hoofdstuk 6 beschrijf ik mijn resultaten met betrekking tot het afleiden van emoties uit videobeelden van twee andere mensen tijdens een date. Specifiek liet ik mensen korte videoclips (zonder geluid) zien van mensen tijdens een blind date-onderzoek en vroeg ik de deelnemers aan te geven of de personen op de date geïnteresseerd waren in hun partner. Uit mijn resultaten blijkt dat mensen deze informatie al uit hele korte videofragmenten kunnen halen. Het bleef echter wel onduidelijk of mensen aantrekkingskracht bij anderen kunnen herkennen aan de hand van zulke korte videobeelden. In drie verschillende experimenten ontdekte ik dat het moeilijk is om aantrekkingskracht te herkennen alleen op basis van non-verbale signalen. Ik vond echter wel dat de nauwkeurigheid in het herkennen van aantrekkingskracht toenam als de persoon in de video zich daadwerkelijk aangetrokken voelde tot zijn of haar partner. Met andere woorden, hoewel emoties en persoonlijkheidskenmerken af te lezen zijn uit korte videobeelden van mensen die op een date zijn, is het voor degene die toekijkt moeilijk om de aantrekkingskracht tussen twee mensen juist in te schatten, behalve als de twee potentieel geliefden zich daadwerkelijk tot elkaar aangetrokken voelen. De leeftijd van de mensen in de videofragmenten en kleine verschillen in de lengte van de video's leken geen rol te spelen in de herkenning van aantrekking.

In hoofdstuk 8 ging ik samen met mijn collega Tom S. Roth in op de relatie tussen interpersoonlijke coördinatie (IPC) en paarvorming bij mensen en andere dieren. Hierbij borduurden we voort op eerder werk dat suggereert dat IPC essentieel is voor het vormen van een partnerband. In onze review onderzochten we het verband tussen IPC, paarvorming en ouderzorg (de actieve zorg voor het nageslacht door beide ouders), maar de richting van causaliteit bleef onduidelijk. Worden sterkere banden gevormd door IPC, of vertonen compatibele personen gewoon een betere coördinatie? Om daarachter te komen, stelden we een vergelijkende aanpak voor voor toekomstig onderzoek, vergelijkbaar met studies naar paarvorming bij woelmuizen. Door nauw verwante dieren soorten te vergelijken die verschillen in hun ouderzorg en paarvorming, kunnen we de contexten en frequentie waarin IPC voorkomt beter begrijpen. Uiteindelijk zou dit soort onderzoek ons begrip van de ingewikkelde relatie tussen IPC en paarvorming bij mensen en andere dieren kunnen vergroten (Hoofdstuk 8). In dezelfde geest heb ik onderzocht of IPC, in de vorm van het automatisch spiegelen van iemands gezichtsuitdrukkingen, kan leiden tot wederzijdse aantrekkingskracht tijdens speed dates. Het is bekend dat automatische spiegelen helpt bij het creëren van sociale banden, maar de rol ervan bij aantrekkingskracht is een punt van discussie. Ik concentreerde me op subtiele non-verbale uitdrukkingen, zoals verlegen glimlachen, die in verband worden gebracht met flirten en aantrekkingskracht. De bevindingen toonden aan dat het automatisch spiegelen van deze subtiele gezichtsuitdrukkingen inderdaad wederzijdse aantrekkingskracht kan voorspellen (Hoofdstuk 9).

In mijn proefschrift onderzoek ik hoe emoties en aantrekkingskracht onze waarneming en interacties met anderen beïnvloeden. Een belangrijke bevinding is dat aantrekkelijke personen onze aandacht trekken. Dit geldt met name voor mannen, en deze aantrekkingskracht lijkt invloed te hebben op hun daaropvolgende besluitvorming. Met andere woorden, mannen hebben de neiging om meer aandacht te besteden aan aantrekkelijke individuen en laten zich mogelijk door deze aantrekking beïnvloeden bij het nemen van beslissingen. Een interessante observatie is dat aantrekking samen lijkt te hangen met spiegelgedrag. Dit houdt in dat we de neiging hebben om ons gedrag en onze houding aan te passen aan die van de persoon waartoe we ons aangetrokken voelen. Dit spiegelgedrag kan een rol spelen bij het vormen van romantische banden, waarbij de wederzijdse aantrekkingskracht leidt tot gelijksoortig gedrag en een gevoel van verbondenheid. Het doel van mijn proefschrift is om inzicht te bieden in deze complexe en fascinerende onderwerpen en als een opstap te dienen voor toekomstig onderzoek. Ik hoop dat mijn werk andere onderzoekers zal inspireren om verder te gaan met het verkennen van de rol van emoties, aantrekking en spiegelgedrag in onze waarneming en sociale interacties.

Curriculum Vitae

Curriculum Vitae

Iliana Samara, born in Athens in 1991, is an alumna of Arsakeion Lyceum, class of 2009. She earned her Bachelor of Science in Psychology in 2014. Subsequently, she relocated to the Netherlands where she completed a Master's in Applied Cognitive Psychology in 2015 and a Research Master's in Cognitive Neuroscience, graduating cum laude in 2017.

Throughout her Master's programs, Iliana acquired practical experience in a variety of projects and techniques, including EEG, fMRI, eye tracking, and psychophysiological methods, through internships and contributions in several research laboratories. For her Research Master's thesis, she collaborated with Prof. Mariska E. Kret to investigate the impact of sexual arousal and fear on physiological responses and trust. Subsequently, she joined Prof. Jan Theeuwes at Vrije Universiteit to explore the influence of statistical regularities on attention.

In 2019, Iliana started her PhD on attraction and social cognition under the supervision of Mariska E. Kret and later Milica Nikolic. During her PhD, she conducted several studies, three of which are included in the present dissertation. Together with Tom S. Roth, she obtained funding from the popular science Dutch magazine, *Quest*, to lead a large dating study (eventually recruiting more than 1000 people) investigating the effect of personality traits on romantic bond formation. Furthermore, under the supervision of Mariska E. Kret, Iliana assisted in the development and coordination of the Psychology Lab on Wheels, a mobile lab equipped with state-of-the-art psychological equipment. Moreover, throughout her PhD, Iliana taught several BSc courses at Leiden University and supervised Bachelor's and Master's theses, as well as pre-university projects.

During her PhD, Iliana brought together an interdisciplinary team and obtained funding by an interdisciplinary seed grant from the Social Resilience and Security department at Leiden University to investigate the behavioral correlates associated with the sexual overperception bias using machine learning. Furthermore, Iliana successfully obtained a grant from the Dutch Research Council (NWO) for a citizen science initiative, which entails conducting interactive sessions with adolescents to explore and empirically investigate adolescents' queries regarding attraction and social cognition.

List of Publications

List of publications

Published work

Samara, I*., Roth, T. S., Perea Garcia, J. O., & Kret, M. E. (in press). Individual mate preferences differentially modulate immediate and voluntary attention. *Scientific Reports.*

Samara, I., Roth, T. S., Nikolić, M., Prochazkova, E., & Kret, M. E. (2022). Can third-party observers detect attraction in others based on subtle nonverbal cues? *Current Psychology.* https://doi.org/10.1007/s12144-022-02927-0

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Work submitted for publication

Roth, T. S., **Samara, I.**, & Kret, M. E. (2024) No immediate attentional bias towards or choice bias for male secondary sexual characteristics in Bornean orangutans (Pongo pygmaeus).
Manusript submitted to Scientific Reports.

Work in preparation

Samara, I., Fiacchino, D., Roth, T. S., de Vries, E., Kret, M. E., & Nikolić, M. (in preparation). The subtle art of seduction: Mimicry of coy smiles enhances interpersonal attraction

Samara, I., Roth, T. S., Nikolić, M., & Kret, M. E. (in preparation). Investigating the functional projection hypothesis: A replication of Maner et al. (2005)

Roth, T. S., **Samara, I.**, Perea Garcia, J. O., & Kret, M. E. (in preparation). "I go bananas for you": Extending sexually selective cognition to non-human primates.

**Authors equally contributed to the paper*