Universidade de Aveiro Departamento de Educação e Psicologia
2020

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PROCESSAMENTO DA CONFIABILIDADE EM CARAS: O PAPEL DAS DIFERENÇAS INDIVIDUAIS NOS ESTILOS DE VINCULAÇÃO

PROCESSING TRUSTWORTHINESS IN FACES: THE ROLE OF INDIVIDUAL DIFFERENCES IN ATTACHMENT STYLE

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Tese apresentada à Universidade de Aveiro para cumprimento dos requisitos necessários à obtenção do grau de Doutor em Psicologia, realizada sob a orientação científica da Doutora Isabel Maria Barbas dos Santos, Professora Auxiliar do Departamento de Educação e Psicologia da Universidade de Aveiro e do Doutor Gene Brewer, Professor Associado do Departamento de Psicologia da Arizona State University.

Apoio financeiro da FCT e do FSE no âmbito do III Quadro Comunitário de Apoio (referência SFRH/ BD/ 89459/ 2012)

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Acknowledgements

Firstly, I would like to thank FCT (Fundação para a Ciência e Tecnologia) for believing in my research, granting me a Doctoral Fellowship.

There are so many people I would like to thank their help and support over these last years.

First and foremost, I would like to express my deepest gratitude to my supervisor, friend and mentor Gene Brewer who has been there for me every step of the way. I feel so incredibly fortunate to have been able to learn from you and work under your supervision. Somehow you could always tell when I needed a bit of hand holding and when I needed a push. Above teaching me about research, I look at Gene as a shining example of how a faculty member can help foster an environment that is conductive for academia and Ph.D student success. This thesis most definitely would have not been possible without your encouragement, support and timely feedback (…and chair spinning!). Thank you for believing in me, always pushing me to do my best.

I would also like to deeply thank my advisor Prof. Isabel Santos. Thank you for the opportunity, for believing in me since the very beginning, for all the understanding throughout the years, for the support and expertise.

Thank you for everyone in the MAC lab, there was never a dull moment. I would have never done it without Chris's relentless criticism and technical expertise. Thank you for all the afternoons spent on the EEG lab (and all your patience), for teaching me about research ethics and how to do well-conducted research. To Hunter, for truly being an example of an academic and lab friend (thanks for all the shared silences)…to Kim, for always being so welcome and ready to help…to Katerina, for making me feel more at home. To Dongchen, Derek and Blake, for always being such great lab friends. Last, but not least, thank you to the Psychology Department at ASU for welcoming with such a great smile since the very first day...I had never been so far away, yet felt so at home. Thank you!

Aos meus pais, por me terem ensinado a voar, sem que nunca me tenham retirado o ninho. Esta tese certamente também e vossa. Aos meus irmãos, pelo apoio incondicional e pelo examplo de irmãos mais velhos que sempre foram e são. À minha melhor amiga, Ri, pelo constante apoio e mensagens infindáveis de "Vais conseguir". Aos meus pequenos e pequenas, meus mais que tudo...foram tantas as gargalhadas como as lágrimas que me retiraram. Obrigada por tornarem as idas a casa tão especias e por todos os *Facetimes* que partilhamos juntos. Sem dúvida a parte mais difícil de se estar longe!

Ao meu companheiro de vida, meu melhor amigo e melhor metade...Obrigada pela paciência, por segurares o barco, por seres o meu porto seguro...Pela compreensão, pelas noites e fins-de-semana ausentes, por estes anos interminaveis. Obrigada por acreditares em mim. Sem ti, esta tese nao estaria a ser impressa, e sem dúvida esta tese é nossa. Only we know.

Palavras-chave confiabilidade em caras, estilo de vinculação, vinculação insegura, viés interpretacional, viés atencional.

Resumo

Investigações sugerem que a presença de uma cara humana provoca uma avaliação automática do seu nível de confiabilidade. Para compreender completamente as interações baseadas na confiança, a investigação deve considerar, para além das características do parceiro que o/a tornam confiável, os efeitos do observador que contribuem para a variação individual nesses julgamentos. Tendo como base a ideia de que diferentes tipos de vinculação podem influenciar os mecanismos atencionais e o processamento de informação, a presente tese teve como principal objetivo investigar o impacto do estilo de vinculação no processamento da confiabilidade em caras. Com o recurso a diferentes métodos de investigação, o presente trabalho investigou o tópico inovador de uma potencial correlação entre o tipo de vinculação e a presença de um viés interpretativo (Estudo 1) e/ou atencional (Estudos 2 e 3) em relação a caras que variam na sua confiabilidade. O Estudo 1, com uma amostra de 179 participantes, teve como base a simples, mas pertinente, questão de saber se indivíduos com estilos de vinculação diferentes diferem na sua avaliação consciente da confiabilidade com base na aparência facial. Dado que estudos recentes demonstraram que indivíduos com graus elevados de ansiedade-traço interpretam estímulos ambíguos como ameaçadores, o primeiro estudo também explorou se o grau de ansiedade (traço e estado) impacta avaliações de confiabilidade. Os resultados sugeriram que tanto indivíduos com uma vinculação ansiosa como indivíduos com graus elevados de ansiedade traço são mais sensíveis a mudanças em faces de baixa, comparativamente a alta, confiabilidade, julgando caras que parecem pouco confiáveis e neutras como menos confiáveis, do que indivíduos menos ansiosos. O Estudo 2, recorrendo a uma das tarefas mais usadas na investigação sobre enviesamentos atencionais, teve como objetivo investigar o grau de associação entre o estilo de vinculação e a atenção seletiva para caras que variam em confiabilidade. Especificamente, o segundo estudo introduziu uma adaptação no design da tarefa de dot-probe, com o intuito de investigar de forma mais precisa quais os processos responsáveis por um potencial viés atencional em indivíduos com uma vinculação insegura. Utilizando uma amostra de 167 participantes, os resultados sugeriram que ambos os indivíduos que pontuaram alto no estilo de vinculação insegura e na ansiedade-traço demonstram dificuldade em desviar a sua atenção de caras com baixa confiabilidade percebida. Por fim, no terceiro estudo, aplicamos uma tarefa amplamente usada em estudos eletroencefalográficos (a tarefa de oddball), com o intuito de avaliar os correlatos neuronais do processamento de confiabilidade em caras e identificar as características temporais de um possível enviesamento em relação a faces pouco confiáveis. Recorrendo a uma amostra de 56 participantes, os resultados revelaram uma maior amplitude na P3 em resposta a caras de baixa confiabilidade comparativamente a caras neutras, sugerindo que estas faces parecem ter um elevado grau de saliência para todos os indivíduos. Tanto quanto sabemos, a presente investigação é a primeira a avaliar se e como é que os estilos de vinculação se associam ao processamento de pistas faciais que aparentam baixa ou alta confiabilidade.

Keywords facial trustworthiness, attachment styles, insecure attachment, interpretational bias, attention bias.

Abstract

Research suggests that the presence of a human face elicits automatic appraisals of its trustworthiness. To completely understand trust-based interactions, research must consider not only the characteristics of the person that make him or her trustworthy but also the observer effects that contribute to individual variation in such judgments. Based on the assumption that different attachment styles can influence attention mechanisms and information processing, the main goal of the current dissertation was to investigate the impact of attachment representations on the processing of facial cues that resemble (un)trustworthiness. Using a multi-method approach, this thesis investigated the novel issue of whether and how attachment styles are related to interpretational (Study 1) and/or attentional biases of facial (un)trustworthiness (Study 2 and 3). In Study 1, using a sample of 179 participants, we asked the simple but fundamental question of whether individuals with different attachment styles differ in their conscious appraisal of facial trustworthiness. Given that recent studies have shown that individuals high in trait anxiety are also biased to interpret ambiguous stimuli in a threatening way, we also explored whether individuals level of (trait and state) anxiety would also impact judgments of trustworthiness. We found that both anxiosuly-attached and highly trait-anxious individuals were more sensitive to changes in untrustworthy than trustworthy faces, judging unfamiliar untrustworthy and neutral-looking faces as more untrustworthy than less anxious individuals. In study 2, using one of the most widely used tasks in attention bias research, we aimed to investigate the extent to which an individual's attachment style is associated with selective attention to un(trustworthy) faces. Specifically, our second study introduced an adapted dot-probe design to more clearly investigate what specific selective attention processes (orienting or disengaging) is responsible for a potential attentional bias in insecure individuals. With a sample of 167 participants, our findings suggested that both individuals who scored high on anxious-attachment and trait-anxiety have a difficulty disengaging their attention from untrustworthy faces. Finally, in our third study, we employed another widely used electroencephalography paradigm (the oddball task) to examine the neural correlates of facial untrustworthiness processing and shed light on the temporal characteristics of a possible processing bias toward untrustworthy faces. With a sample of 56 participants, our results revealed greater P3 (350-600 ms) amplitude in response to untrustworthy than neutral faces, suggesting that untrustworthy faces are more salient to all individuals. To our knowledge, the present investigation is the first one to assess whether and how attachment styles are associated with the processing of facial cues that resemble (un)trustworthiness.

TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

Although frequently warned to not “judge a book by its cover”, we instantly form impressions about others from minimal information (Todorov, Said, & Verosky, 2012). Faces are arguably the most important source of social information that people encounter on a daily basis, with extant research recognizing facial appearance as one of the most powerful basis for rapid and intuitive impression formation (Adolphs, 2002; Kuzmanovic et al., 2012).

In the present dissertation we are interested in studying one of the most relevant social dimensions of person perception: trustworthiness. In our daily lives, almost every action we take is determined by the levels of trust that exist between us and the people with whom we interact. Accurate and rapid inferences of an individual’s level of trustworthiness is crucial for the development of successful relationships and human survival (Chang, Doll, Wount, Frank, & Sanfey, 2010), because it can provide key information about whether to avoid/approach a stranger (Ames, Fiske, & Todorov, 2009). Extant research suggests that people tend to perceive trustworthiness on the basis of facial appearance and that the presence of a face elicits automatic appraisals of its trustworthiness (Todorov, Baron, & Oosterhof, 2008). The importance of inferring trustworthiness is further supported by evidence suggesting that such judgments are

made rapidly, without intention and hold a special processing status in information processing, attention, and memory. In fact, in studies involving different measures of trait importance, participants rated trustworthiness as the most essential and one of the very first attributes they assess when forming impressions about others (e.g., Todorov & Duchaine, 2008; Todorov, Said, Engell, & Oosterhof, 2008). The significance of trustworthiness judgments for our daily interactions with one another serves as a motivation towards understanding the cognitive and neural mechanisms guiding it.

Although much attention has been paid to the question of trustworthiness judgments based on facial cues, and on the influence of such appraisals on predicting a wide range of social, economic and political decisions (Ames et al., 2011; Stanley, Sokol-Hessner, Banaji, & Phelps, 2011; Wout & Sanfey, 2008), little research has been devoted to investigating the role of individual differences in estimating trustworthiness. To completely understand trust-based interactions, research must consider not only the characteristics of the person that make him or her trustworthy but also the observer effects that contribute to individual variation in such judgments. In whom we trust is not only a reflection of who is trustworthy, it is also a reflection of who we are (Todorov, 2008). Along these lines, the dominant model of interpersonal and intergroup trust includes a key component known as propensity to trust which encompasses a variety of known and unknown psychological characteristics that lead an individual to be more versus less trusting in general (Mayer, Davis, & Schoorman, 1995).

One theoretical framework that continues to receive considerable attention from psychologists in understanding the role of individual differences in social information processing is attachment theory (Bowlby, 1973, 1980, 1982; Cassidy & Shaver, 2008). Beyond perceptual information, to predict other's behavioral intentions and interpret social cues, humans rely on cognitive-emotional schemas that are molded during childhood and form the foundation upon which, later, more social appraisals are built (Mikulincer & Shaver, 2012; Shaver & Mikulincer, 2011). Therefore, attachment theory seems to be a useful framework for understanding what may lead one person to be trusted by some and distrusted by others (Fraley, Garner & Shaver, 2000). Although the notion of trustworthiness and the judgments of others intentions are implicit to attachment theory (Mikulincer & Shaver, 2012), as far as we are aware, no studies have directly investigated whether individual differences in attachment style predispose individuals to differently perceive trustworthiness in faces. The study of faces that vary in trustworthiness

dimensionality seem to be suitable for studies of the relation between attachment and perceived trustworthiness judgement, since such faces can be read as a cue for interpersonal threat and social proximity.

Based on the assumption that different attachment styles influence the way people perceive, attend to and process information of social significance (Cassidy & Shaver, 2008; Fraley & Shaver, 2000; Mikulincer & Shaver, 2019), the main goal of the current dissertation was to investigate the impact of attachment representations on the processing of facial cues that resemble (un)trustworthiness. Considering the vast possibilities of how and where cognitive biases related to attachment styles can emerge in facial processing, the three studies reported in this dissertation are an attempt to understand the effect of individual differences in attachment style on (a) the perception (Study 1) and (b) attentional processing of facial trustworthiness (Study 2 and Study 3). Thus, using a multi-method approach, the experimental part of this thesis will investigate the novel issue of whether and how attachment styles are related to interpretational and/or attentional biases of facial (un)trustworthiness. In an effort to establish a better understanding of this judgment process, and based on recent literature findings (Willis, Dodd, & Palermo, 2013), we also suggest that another important factor in trustworthiness processing is a person's level of (trait and state) anxiety.

It is our hope that the studies reported in this dissertation will elucidate some of the cognitive and individual differences dynamics that underlie trustworthiness processing, as well as advance theory and research on the interface of attachment styles, trust, and first impressions in general.

CHAPTER 2

PERCEPTION OF FACIAL TRUSTWORTHINESS

In our daily lives we frequently make inferences about other individuals that influence our willingness to socially engage with them. These inferences rely on cues from an individual's facial appearance to guide our judgments. Due to the high importance of the trustworthiness factor in social interactions and face evaluation, researchers have focused on the determinants of facial trustworthiness, as is described in the present chapter.

2.1 Face-Based Trustworthiness Judgments

Humans are predisposed toward making trait inferences about others even before they get to know them (Rule & Ambady, 2010). The social trait judgments that rely on snap observations of others without any other form of knowledge are referred to as “first impressions” or “trait inferences”. Extant research suggests that these first impressions about others’ personality can be formed after only brief glimpses of static pictures of others (Bar, Neta, & Linz, 2006; Rule & Ambady, 2008; Todorov, Pakrashi, & Oosterhof, 2009). Research featuring multi-modal information seems to suggest that the dominating role of the face in impression formation is largely attributed to the human brain’s distinctive specialization in face processing (Krumhuber & Manstead, 2009; Nacy & Galit, 2006). While some research has investigated the inferences that people make based on information such as impressions from the voice (e.g., Scherer, 2017) or short videos of unfamiliar others (e.g., Ambady & Rosenthal, 1992), the work contained in this dissertation focuses on trustworthiness inferences that perceivers make from static pictures of faces. Although on the lower end of the information conveyed, face pictures are ubiquitous within our society and commonly used as an evaluative source. Even within the realm of technology, this form of visual information still dominates our society, with the over 1.23 billion active users of Facebook uploading 250 million pictures a day (Sedghi, 2014). Elections, advertisements, online dating and job curriculums are also good examples, as they as well rely heavily on static photographs of people’s faces.

Faces are the single most important visual social stimulus that people encounter on a daily basis (Adolphs, 2002). In addition to advertising demographic attributes such as race and gender, they also provide crucial information about the emotional state, focus of attention, and potential future behavior of others (Hassin & Trope, 2000). Research has suggested that people make trait evaluations of novel faces rapidly and automatically (Bar, Neta & Linz, 2006; Todorov, Pakrashi, & Oosterhof, 2009; Willis & Todorov, 2006). For instance, the study of the temporal dynamics of facial trustworthiness evaluations using ERP methodology has suggested that such judgments are spontaneous and automatic, and as little as 100 ms of exposure to a neutral face is sufficient for people to form long lasting impressions of trustworthiness (e.g., Winston, Strange, O’Doherty, & Dolan, 2002). Additional exposure time seems to only increase the confidence in judgments, but does not change the judgments itself (Willis & Todorov, 2006). In fact,

Todorov and colleagues (2009) found that judgments of trustworthiness made to faces viewed for only 33 ms revealed considerable overlap with judgments made under free viewing conditions (Todorov, Pakrashi, & Oosterhof, 2009). Research studying face-based trait judgments is given particular urgency in light of work showing their numerous real-world consequences (Olivola & Todorov, 2010a, 2010b). A great body of evidence seems to suggest that impressions derived from facial appearance are so powerful that they could predict social behavior and decision-making on a large scale, such as election outcomes (e.g., Todorov, Mandisodza, Goren, & Hall, 2005). For instance, perceived trustworthiness of a person's face impacts the extent to which people are willing to cooperate with others in socioeconomic interactions (Rezlescu, Duchaine, Olivola, & Chater, 2012). Perceptions of trustworthiness from face pictures also influences real online financial decisions (Duarte, Siegel, & Young, 2012) and litigant's facial babyfaceness (which is directly related with trustworthiness) seems to also predict financial decisions in court (Zebrowitz & McDonald, 1991; see also Porter, ten Brinke, & Gustaw, 2010). The effect of perceived facial trustworthiness on cooperative behaviour is even evident in children as young as five years old (Ewing, Caulfield, Read, & Rhodes, 2015). All these studies hint at the power of the information conveyed in a mere snapshot of a face.

The belief that personality traits (such as trustworthiness, attractiveness, etc.) can be read from a person's face has persisted over the centuries (Alley, 1988). Although such judgments are highly correlated with each other, inferences of trustworthiness seem to best approximate the valence evaluation that underlies multiple social judgments from faces (Ames, Fiske, & Todorov, 2009; Oosterhof & Todorov, 2008; Todorov, Said, Engell, & Oosterhof, 2008). The Oosterhof and Todorov two-factor model (Oosterhof & Todorov, 2008) is perhaps the most prominent model of face evaluation. In a series of studies, Oosterhof and Todorov asked participants to give their spontaneous impressions of a random sample of computer-generated faces, then reducing these initial impressions to a set of 14 traits (this accounted for 68% of 1,134 unconstrained descriptions of face attributes). Judgments were submitted to a principal component analysis (PCA). The authors found that general face evaluation reflects judgments along two orthogonal dimensions: trustworthiness (valence) and dominance. The first and the second components accounted for 63.3% and 18.6% of the variance of the judgments, respectively. Judgments such as emotional stability, responsibility, happiness and

intelligence had positive loadings on the first component. Of special interest is the trustworthiness dimension, which had the highest loading (.94) on the first component, involving perceived intentions of the target (‘Do they want to hurt or help me?, Oosterhof & Todorov, 2008). Taking these results into consideration, the authors suggested that measures of trustworthiness can be used as an approximation for judgments of valence (i.e., positive/negative) and that trustworthiness judgments may be sufficient to model how the valence of faces is evaluated in the brain(Todorov & Engell, 2008). For the purpose of the present investigation, it is worthwhile to note that Oosterhof and Todorov’s model (2008) is characterized by well-controlled stimuli, with descriptions and ratings made initially to standardized face photographs, and later replication studies demonstrated that these results hold with highly controlled computer-generated faces (“FaceGen” software). Recently, Sutherland and colleagues (Sutherland et al., 2013) also replicated the trustworthiness/valence and the dominance factor of the Oosterhof and Todorov (2008) model by extending it to facial images from the internet. Further support for Todorov’s two-factor model of face evaluation also comes from social cognition models, which suggest that people evaluate social traits of others individuals on two universal dimensions: warmth and competence. Studies conducted by Anderson and colleagues (2012) are also in line with this idea, in which unconsciously encoded happy faces led individuals to judge succeeding neutral faces as more trustworthy when compared to the priming of neutral-looking faces (Study 3), as well as less trustworthy when primed with dangerous-looking faces (Study 4).

2.2 The Underlying Factors of Perceived Trustworthiness

Studies that investigated the underlying factors of the trustworthiness dimension showed that it is highly correlated with emotional facial expressions (i.e., a happy-angry dimension). Based on a series of studies, Todorov and colleagues concluded that evaluation of emotionally neutral faces is an extension of functionally adaptive mechanisms for interpreting other’s emotional expressions (Engell, Todorov, & Haxby, 2010; Olivola & Todorov, 2010; Oosterhof & Todorov, 2008; Todorov, 2008). Specifically, in the absence of emotional cues broadcasting other’s behavioral intentions, judgments of trustworthiness are an attempt to predict approach/avoidance behaviors. In the social

psychology and cognitive literature, trust appraisals have been conceptualized as an individuals' attempt to infer others' intentions, and, thus, decide whether to approach or avoid that individual (Anderson, Bechara, Damásio, Tranel, & Damásio, 2013). Using a data-driven computer model to manipulate facial trustworthiness, Todorov and colleagues concluded that trustworthiness judgments are derived from subtle facial features signaling approach/avoidance intentions. As the facial features become more exaggerated in the negative direction (-8SD from the "neutral" face) the faces were mostly classified as angry, whereas, as the trustworthy facial features become more exaggerated in the positive direction (+8 SD), the faces were mostly classified as happy (Todorov 2008; Todorov & Duchaine, 2008). The trustworthiness dimension is based on emotion overgeneralization, i.e., faces that structurally resemble angry faces are to be avoided and thus perceived as untrustworthy, whereas faces that structurally resemble happy faces are to be approached and thus perceived as trustworthy (Slepian, Young, & Harmon-Jones, 2017; Zebrowitz, Boshyan, Ward, Gutchess, & Hadjikhani, 2017). Secord (1958) has suggested that personality inferences from emotions occur through temporal extension whereby people, upon detecting a temporary emotional facial expressions on others, misattribute the transient cue to a fixed trait. That is, inferences from subtle cues related to emotional states (e.g., anger) may be inappropriately generalized to inferences of personality dispositions (e.g., untrustworthiness). Zebrowitz and colleagues (Zebrowitz et al., 2017) extended this assumption into emotional overgeneralization, suggesting that this dispositional misattribution seems to also happen when target faces are actually expressionless, but merely structurally resemble emotional expressions. Based on trait judgments of emotionally neutral faces, recent studies found that specific facial characteristics are associated with trustworthiness inferences (e.g., nose and cheekbone salience), suggesting that faces with certain features (e.g., pronounced cheekbones) appeared to be more (un)trustworthy (Todorov, Baron, et al., 2008).

Evidence supporting the hypothesis that trustworthiness judgments are associated with overgeneralized perceptions of expressions of anger and happiness also comes from different literatures (Engell et al., 2010; Tingley, 2014). By manipulating both facial features and the emotionality of a face, Osterhof and Todorov showed that dynamic changes from neutral to angry or happy expressions are perceived as more intense when accompanied by congruent changes in structural features (i.e., from a trustworthy to untrustworthy face, or vice-versa, respectively) (Oosterhof & Todorov 2009). In the same

vein, Engell and colleagues suggested that brain's adaptation to expressions of anger results in higher evaluations of trustworthiness, whereas adaptation to expressions of happiness results in lower evaluations of trustworthiness (Engell et al., 2010). Neuroimaging findings also support the idea that a common neural system is engaged during inferences of facial trustworthiness and expressions signaling approach. These studies found a nonlinear pattern of amygdala responses to both highly trustworthy and highly untrustworthy faces (Said, Baron, & Todorov, 2009; Todorov, Baron, & Oosterhof, 2008), closely mirroring previous research reporting an increased amygdala activation to happy and angry faces than to neutral faces (Pessoa, McKenna,Gutierrez, & Ungerleider, 2002).

The emotion overgeneralization hypothesis predicted by this body of research seems to account for rapid, yet, not necessarily accurate, judgments of trustworthiness (Engell et al., 2010; Oosterhof & Todorov, 2009; Said, Sebe, & Todorov, 2009; Todorov et al., 2015)[1]. From this point of view, to the extent that such impressions are formed by extrapolation and (mis)interpretation of physiognomic features cuing emotional messages about other's intentions, and that there is variability in the information that individuals extract from faces, it is not surprising that they are not accurate. Impressions from facial appearance involve a subjective evaluative component (Kuzmanovic et al., 2012), making it not expected to see a relationship between rater's judgments and target's behaviors or self-reports of personality (Porter, England, Juodis, Ten Brinke, & Wilson, 2008; Sutherland et al., 2013; Todorov, Said, et al., 2008). Specific to judgments of trustworthiness, studies suggest that the detection of trustworthiness involves an unreflective (e.g., Todorov, Mandisodza, Goren & Hall, 2005), unintentional (e.g., Todorov & Uleman, 2004) and intuitive character (Porter et al., 2008; Willis & Todorov, 2006). The intuitive way in which we evaluate others is not fully understood, yet has a powerful impact on our daily lives (both as raters/trustors and as targets/trustees). Identifying the factors affecting such automatic judgments can provide much insight that can be used in the countless social interactions that may be influenced by our first impressions. Considering the crucial role that trustworthiness judgments play in social interactions, the intuitive character involved in such inferences assumes relevant importance. In the same way,

1 Note that, the topic of accuracy is beyond the scope of the present dissertation, which focuses on perceived trustworthiness, i.e., trustworthiness as subjectively attributed by others.

although evaluations from faces are fairly consistent across perceivers, the consistency is far from perfect and a large proportion of variance in these judgments remains unaccounted for (Todorov, Olivola, Dotsch, & Mende-Siedlecki, 2015). Recent empirical work suggests that some of this variance may be attributed to individual differences (Engell et al., 2007; Todorov, Said & Verosky., 2011; Trent., 2013). For instance, trustworthiness impression seems to be affected by the rater's mood (Forgas & East, 2008), personality (Adolphs, 2002), rater's degree of trait anxiety (Willis, Dodd, & Palermo, 2013) or by the priming approach or avoidance motivation states (Forster, Friedam, Ozelsel, & Denzler, 2006). To completely understand trust-based interactions, research must also take into account the observer effects that contribute to individual variation in such judgments. However, we know very little about the sources of idiosyncratic variance in trustworthiness evaluation (Todorov et al., 2011, Todorov et al., 2015). Traditionally, the focus of trustworthiness perception research has been on the cues in that face that signals trustworthiness evaluations across perceivers. Previous studies shed light on the cognitive and neural mechanisms underlying the ability to discriminate facial properties conveying social signals, but the underlying processes supporting individual differences remain poorly understood.

Based on the social cognition literature, we next theorize that what leads one person to be trusted by some and distrusted by others may lie in the strength of subjective perceptual processing of positive versus negative motivational cues. Research on social cognition suggests that individual differences in cognitive-emotional schemas account for individual differences in social appraisals. Specifically, adult attachment theory has been shown to provide a useful conceptual framework for understanding individual differences in the perception and processing of socially-relevant cues (e.g., Shaver & Mikulincer, 2011), modulating how someone will perceive others and interpret novel encounters with strangers (Fraley, Niedenthal, Marks, Brumbaugh, & Vicary, 2006; Mikulincer, Shaver, & Pereg, 2003). We next theorize about this assumption.

CHAPTER 3

ATTACHMENT AND SOCIAL INFORMATION PROCESSING

One theoretical framework that has been used frequently to explain the effects of individual differences on the processing of social information has been attachment theory. In this chapter, we first provide a summarized theoretical account of how attachment is believed to shape the cognitive and affective mechanisms responsible for the processing of social information. We then provide a brief overview of the empirical literature on relations between attachment and social-information processing.

3.1 Attachment Theory

Since its first description five decades ago (Bowlby, 1969, 1982), attachment theory has become one of the most influential frameworks for understanding the role of individual differences in social interactions and emotional responses to others (e.g., Bartholomew & Horowitz, 1991). One of the core assumptions of attachment theory is that all humans are born with an innate attachment behavioral system that predisposes them to seek safety and support in threatening situations (e.g., stimuli signaling both social safety or interpersonal threat). Although such functions are particularly crucial for survival in early life, as a child cannot live on its own without the care of his/her primary attachment figures, attachment theorists believe that the attachment system remains active over the entire life span, as no one at any age is completely free from reliance on others (Bartholomew & Horowitz, 1991; Mikulincer et al., 2003). Importantly, the quality of these early interactions with an attachment figure will translate into differential cognitive-affective schemas for representing the self and others, and for generating predictions (i.e., expectations) regarding how others will behave. These processes are believed to lead to the establishment of so-called internal working models of attachment (Mikulincer & Shaver, 2012). This schema will then constitute the foundation of a person's individual attachment style, which remains fairly stable into adulthood and are thought to provide a template for determining how individuals perceive and behave during various types of interpersonal encounters throughout life (Bretherton & Munholland, 2008; Pietromnaco & Feldman-Barret, 2000). Thus, although adult attachment theory initially mainly focused on the impact of attachment styles on the behavioral patterns during close and romantic relationships, it is considered to also operate during social appraisals and novel encounters with strangers (Bartholomew & Horowitz, 1991; Niedenthal, Brauer, Robin, & Innes-Ker, 2001; Mikulincer & Shaver, 2007b). It is important to also recognize that according to attachment theory, the attachment system evolved to motivate adaptive proximity-seeking behaviors and support in times of distress or threat. Thus, an individual's attachment system is not always activated, and its characteristic behaviors are not always to be expected. Bowlby's seminal work, and also more recent work, suggests that the encounter with (actual or symbolic) threats are very likely to activate the attachment system. Because they communicate information that is relationship and

survival-relevant, and thus can engage attachment concerns, we hypothesize that facial cues of trustworthiness are likely activators of the attachment system.

In examining individual differences in the activation level and functioning of the adult attachment system, researchers have focused on a person's attachment style, the chronic pattern of relational expectations, beliefs and behaviors thought to result from a particular history of experiences with attachment figures (e.g., parent or caregiver during childhood, a romantic partner or best friend in adulthood; Shaver, Mikulincer, & Chun, 2008). Adults with different dispositional attachment orientations differ on a behavioral level in a number of ways. In cases of an available and responsive attachment figure (e.g., parents) providing a "secure base" and protection in times of distress, a positive view of others linked with trustworthiness and supportiveness will develop, associated with a positive view of themselves and positive self-attributes of worthy and competent. Broadly, this developmental trajectory engenders the formation of a secure attachment style. Conversely, if caregivers are consistently perceived as being unavailable or irresponsive to one's needs, a feeling of security is not attained, which leads to the establishment of an insecure attachment style and the use of alternative strategies to deal with feelings of distress. Individual differences in attachment style can be classically distinguished along two roughly orthogonal dimensions: attachment-related *anxiety* and attachment-related *avoidance*, which can be assessed in interviews, through behavioral observations, and with cognitive tasks or with self-report questionnaires (e.g., Shaver, Mikulincer, & Chun, 2008). High scores on both or one dimension are characterized by the use of insecure attachment strategies, which can be conceptualized as secondary defensive reactions to a history of nonoptimal experiences with attachment figures.

In case of attachment anxiety, a perceived failure to deal with distress independently encourages individuals to intensify their support-seeking attempts. In this case, individuals who are high in attachment anxiety are motivated by a desire to cause a relationship partner to pay more attention and provide more consistent support. Thus, these individuals still manifest an excessive desire for closeness, but fear rejection and are mistrustful of others and their continuing availability to them. Due to an ambivalent desire for attention and support, such individuals become highly vigilant and sensitized to negative emotional cues and potential threats (Bowlby, 1980). Consequently, they respond intensively to negative emotional input, by directing too much attention to it and thereby exaggerating concerns and needs. This style of attachment is also suggested to

apply a distinctive emotion regulation strategy, with preferential use of re-appraisal but in the “negative” direction: instead of decreasing the impact of negative input, these individuals tend to amplify threat appraisal due to their hypersensitivity to the latter (Mikulincer & Shaver, 2001; 2012; 2019).

The other critical dimension of insecurity is attachment avoidance, where proximity seeking is perceived as futile or even dangerous because of the distress felt by previous failed attempts to achieve support from others. Consequently, avoidant individuals develop a dismissive approach to and a negative model of others, operating through the denial of positive traits in others because they see others as unreliable. They strive to maintain autonomy and emotional distance from others, often orienting attention away from negative attachment-related information (Simpson, Rholes & Phillips, 1996). They avoid invitations for closeness and intimacy and deny attachment needs. Because any thoughts about threats might reactivate the attachment system, negative cues are chronically being avoided, allowing the individual to keep the attachment system in a low activation state (Mikulincer & Shaver, 2003; 2007). These deactivating strategies involve inhibitory and suppressive mechanisms that lead to the dismissal of threat and socially-relevant cues (Fraley & Shaver, 2000). In sum, attachment insecurities (both anxious and avoidant attachment) encourage negative, dysfunctional perceptions of others and of social information/interactions. On the other hand, individuals who are low on both attachment and avoidance (securely attached individuals) are characterized by positive and trustful social interactions and find it easy to trust and rely on others (see Mikulincer & Shaver, 2007a for an overview). Secure individuals show neither of these biases and exhibit balanced and moderate responses to affective information (Mikulincer & Shaver, 2019).

In addition to the behavioral differences described above, each attachment dimension is thought to bias the processing of socially affective information in different ways.

3.2 Attachment-related Differences in the Processing of Social Information

To date, the process of recognition, perceptual judgment and interpretation, as well as more covert behaviors such as the allocation of attention in reaction to social affective information, have been extensively investigated with regard to attachment theory (i.e., reactions to facial expressions; attachment-related words; emotional scenes).

Several studies have found that insecurely attached individuals differ in the way they perceive others and interpret others' motivations and intentions (Vrtička & Vuilleumier, 2012). To briefly summarize, a few studies examined the processing of facial expressions of emotion using a morph video paradigm, in which faces gradually changed from neutral to angry, happy or sad, and vice versa (Fraley et al., 2006; Maier et al., 2005; Niedenthal, Brauer, Robin, & Innes-Ker, 2002). Participants were instructed to stop the display when they perceived that the emotional expression disappeared or emerged. Using a categorical measure of attachment styles, Niedenthal and colleagues (2002) found that individuals with an insecure attachment style perceived the offset of emotional expressions of anger and happiness, but not sadness, later than secure individuals. The authors interpreted these findings as suggesting that both individuals who are high in attachment anxiety (anxious-preoccupied) and avoidance (dismissive-avoidant) may be more sensitive to cues that are relevant to the functioning of the attachment system (i.e., happy and angry emotions), and thus detect evidence of a facial expression with less perceptual evidence than secure individuals (i.e., compared to secure individuals, they see an emotional expression linger for a longer period of time). More recently, Fraley and colleagues (Fraley et al., 2006) used the same morph video paradigm and found that anxiously-attached individual's difficulties in decoding and judging facial emotions might be a result of heightened attention to emotional cues and a tendency to make premature judgments. Important for the present dissertation, all faces used in these experiments were from unfamiliar individuals, suggesting that adult attachment style can significantly impact how we judge and perceive others, even strangers (Fraley et al., 2006; Maier et al., 2005; Niedenthal et al., 2002).

Other research examining judgments of facial expressions, also found that anxious attachment was linked to tendencies to rate emotionally neutral faces more negatively (Meyer, Pilkonis, & Beevers, 2004). The observed interpretational bias was characterized by a tendency of anxiously-attached individuals to interpret ambiguous facial cues with

considerable suspicion, rating unknown others as less friendly, unpleasant and untrustworthy. A study using Ekman & Friesen's (1975) facial action coding system, (Magai, Distel, & Liker, 1995) also found that a more-insecure attachment style was associated with decoding biases that involved low accuracy on the identification of facial expressions of emotion. Another investigation of emotion perception looked at more controlled processes by directly asking participants to make explicit ratings of pleasantness while subjects watched emotional video-clips inducing happiness, fear and sadness (Rognoni, Galati, Costa & Crini, 2008). The results showed an enhanced responsiveness to negative social cues associated with anxious attachment, while the response from avoidant individuals was characterized by a dismissal of positive interactions. Considerable data also supports the notion that insecure individuals perceive other persons in a negatively biased schematic manner (e.g., Dykas & Cassidy, 2011; Vrtička, Sander, & Vuilleumier, 2012). Research on attachment and attributions, suggest that attachment insecurity has been linked to greater mistrust and negative expectations regarding others (Larose & Bernier, 2001). Insecure individuals have also shown less positive expectations of interpersonal interactions and trust (e.g., Rowe & Carnelley, 2003), and more hostile attributions of others' behaviors (Pereg & Mikulincer, 2004). Experimental studies have also shown that priming attachment security (i.e., priming a sense of security by having individuals to feel surrounded by supportive others) was related to more positive expectations of others and more positive group-related perceptions (e.g., Carnelley & Rowe, 2007; Gillath, Selcuk, & Shaver, 2008; Mikulincer & Shaver 2007b).

In addition to emotion processing, many studies have examined associations between attachment and individuals' attention to personally relevant social information. Using various task conditions, for different kinds of stimulus, a great body of research has revealed that insecure individuals attend to negative and threatening information in a schematically biased manner. Attachment theory suggests that, while attachment anxiety is associated with a tendency to exhibit enhanced attention, or at least exhibit heightened reactivity, towards negative and threatening cues, avoidant individuals tend to ignore and avoid threat (Maier et al., 2005; Mikulincer & Shaver, 2007). It is, thus, assumed that in anxiously-attached individuals the attachment system operates in a hyperactive mode and, consequently, the system is maintained in a chronically active state. In turn, avoidantly-attached individuals tend to use deactivating strategies when faced with

threatening information, maintaining their attachment system in a down-regulated state. Critically, the literature does not always support these basic assumptions.

Maier and colleagues (2005), for example, found quicker attention to images that contained negative facial expressions and/or interpersonal interactions by individuals who were both high on anxious (preoccupied) and avoidant (dismissive) attachment. More recently, Atkinson and colleagues (2009) also found that insecure mothers showed greater attention to negative social stimuli (words) than to neutral stimuli. The authors suggested that insecure individuals have more difficulty disengaging their attention from negative cues, and that their findings can be interpreted as reflecting not suppression but rather a more schematic processing. Using a modified version of the exogenous cueing paradigm and measuring attachment with the Experiences in Close Relationships scale, Dewitte & De Houwer (2008) more directly investigated the relation between attachment orientation and selective attention to happy, angry and neutral emotional face expressions. The authors found that a combination of high scores on both attachment anxiety and avoidance was related to greater diverting of attention away from negative facial stimuli. In general, the studies discussed here reveal that insecurely and securely attached individuals seem to process threatening information differently. However, no evidence was found for differential attentional processing in function of specific type of attachment insecurity (i.e., anxious versus avoidant). This issue will be further discussed in Chapter 6 of the present dissertation.

All together, these data underscore the selective impact of attachment orientations on perceptual and attentional responses to personally relevant affective cues. While the importance of suspiciousness of others, or untrust, in the attachment theory has been reported for decades, the experimental assessment of facial trustworthiness processing is a novel avenue for experimental research in attachment styles. Also, although extent research suggests the same underlying mechanisms for general (trait and state) anxiety and attachment patterns, only a few studies examined both attachment representations and anxiety symptoms in the processing of social affective information. Both perceptual and attentional system of (state and trait) anxious individuals has been shown to be abnormally sensitive to threat-related stimuli in the environment, leading to an even more pronounced processing bias in favor of negative information than is observed in non-anxious individuals (Bradley, Mogg, Falla, & Hamilton, 1998; Burra & Vrtička, 2018; E. H

W Koster, Verschuere, Crombez, & Van Damme, 2005; Salemink, van den Hout, & Kindt, 2007). The present investigation will also briefly investigate this assumption.

CHAPTER 4

GOAL OF THE DISSERTATION

A central assumption of attachment theory is that there is a set of cognitive processes that play a role in appraising and monitoring the environment for negative, threatening cues. More importantly, according to this model, this appraisal system is more sensitive for some people than others, reflecting, in part, differences in interpersonal attachment histories. Recently, the role of attachment-related biases in several aspects of information processing has been emphasized (e.g., Mikulincer & Shaver, 2019; Vrtička & Vuilleumier, 2012). However, it remains unknown whether anxious or avoidant attachment is linked to more general differences in trustworthiness processing, and whether such differences are specific to perception and/or attentional processes. As we have already suggested in the previous sections, first impressions of trustworthiness are essential in our everyday lives as they set the ground for the interaction patterns we establish with others.

Given that harm can come from unwarranted trust in social situations, the capacity to make accurate trustworthiness judgments is crucial (Chang et al., 2010). Daily experience and research indicate that the presence of a human face elicits rapid appraisals of its trustworthiness (Ames et al., 2011; Todorov et al., 2008). Based on the assumption that different attachment styles can influence attention mechanisms and

information processing, the overall goal of the present dissertation was, on one hand, to assess whether people with different attachment styles exhibit biases in trustworthiness judgments from faces. On the other hand, using behavioral assessments, cognitive tasks, and event-related potentials (ERP) methodology, we also aimed to examine whether and how different attachment styles influence attentional mechanisms to (un)trustworthy faces.

To accomplish the outlined objectives, a set of 3 studies were carried out. In Study 1 (Chapter 5), we asked the simple but fundamental question of whether individuals with different attachment styles differ in their conscious appraisal of facial trustworthiness. In Study 2 (Chapter 6), using one of the most widely used tasks in attention bias research (i.e., a dot-probe task), we aimed to investigate the extent to which an individual's attachment style is associated with selective attention to un(trustworthy) faces. Specifically, our second study introduces an adapted dot-probe design to more clearly investigate what specific selective attention processes (orienting or disengaging) is responsible for a potential attentional bias in insecure individuals. Finally, in our third study (Chapter 7), we employed another widely used electroencephalography paradigm (the oddball task) to examine the neural correlates of facial untrustworthiness and shed light on the temporal characteristics of a possible processing bias toward untrustworthy faces.

To our knowledge, no studies have assessed how attachment styles are associated with the processing of facial cues that resemble (un)trustworthiness. Considering that there are no studies that investigated the relation between facial trustworthiness processing and attachment patterns, and based on the assumption that processing of face trustworthiness is subserved by the mechanisms underlying processing of emotional (i.e., angry and happy) expressions (Todorov et al., 2008), our hypotheses are based on the existing studies that suggest different patterns of emotional processing (i.e., differential responses to affective stimuli) related to insecure and secure attachment (e.g., Chavis & Kisley, 2011). Attachment theory and cognitive-behavioral methodology may be a way forward when attempting to reveal how early experiences change the way stimuli are processed in adulthood, with important implications for psychotherapy and practice (Mark, Geurdes, & Bekker, 2012). In fact, combining information from neurocognition and psychology can serve as a powerful aid when constructing models of behavior and decision-making based on trust (Todorov, 2008).

It is important to note that all our proposed studies relied on computer-generated faces that have been normatively evaluated along dimensions known to bias perceptions of trustworthiness (Dzhelyova, Perrett, & Jentzsch, 2012; Oosterhof & Todorov, 2008; Todorov et al., 2008, 2013). The faces used in all our three studies were all emotionally neutral, so any individual differences in how individuals process them refers to how individuals differing in attachment style and anxiety levels process features that resemble (un)trustworthiness. As a stimulus material, we selected pictures of faces because faces represent more potent and ecological valid threat cues than, for example, words (Bradley et al., 1997).

CHAPTER 5

STUDY 1: THE INFLUENCE OF ATTACHMENT STYLE ON PERCEIVED TRUSTWORTHINESS

Previous studies suggest that adults' attachment styles are linked to schematic perceptual biases, attributions and expectations about others (Dykas & Cassidy, 2011). The study presented in this chapter aimed to investigate whether and to what extent individual differences in attachment style affect the appraisal of facial trustworthiness.

5.1 Introduction

Attachment styles have been shown to be related to biases in social perception and appraisal, with several studies suggesting that insecurely attached adults differ in the way they perceive others and interpret other's motivations and intentions (e.g., Meyer et al., 2004; Mikulincer & Shaver, 2001; Niedenthal et al., 2002). As already discussed in the previous sections, extent research seems to suggest that people who generally score high on attachment anxiety and avoidance hold negative views of human nature (e.g., Collins & Read, 1990), have more negative expectations about others, doubt about other people's trustworthiness (Cozzarelli, Hoekstra & Bylsma, 2000), and use less positive terms when describing others (for a review see Mikulincer & Shaver, 2012; Shaver & Mikulincer, 2001). There is also considerable evidence linking attachment insecurities to biases in the perception of others nonverbal messages and facial expressions of emotion (e.g., Magai, Distel, & Liker, 1995; Magai, Hunziker, Mesias, & Culver, 2000; Mikulincer & Shaver, 2019).

The present study aimed to contribute to the growing literature on individual differences in judgements of trustworthiness based on physiognomic facial features. Specifically, we tested the hypothesis that individuals differing in their attachment styles would process these features differentially leading to systematic differences in perceived trustworthiness. Based on previous research on emotional processing, we expected that individuals scoring high on attachment anxiety and avoidance perceive others as more untrustworthy than individuals who score low on these dimensions. Although the attachment style is primary involved in regulating negative affect, we included both positive (trustworthy), negative (untrustworthy) and neutral-looking faces to explore whether insecure individuals have a generalized mistrust of others (i.e., do they judge all stimuli as less trustworthy?) or whether trustworthiness judgments are valence-specific. Studies using negative (e.g., angry) and positive (happy) facial expressions have reported mixed results (Niedenthal et al., 2002), with most studies finding attachment style differences only for negative stimuli. Given that recent studies have shown that individuals high in trait anxiety are also biased to interpret ambiguous stimuli in a threatening way (e.g., Park, Vasey, Kim, Hu & Thayer, 2016; Willis et al., 2013) we also explored whether individuals level of anxiety (trait and state anxiety) would also impact judgments of trustworthiness.

5.2 Methods

This study was approved by the Human Research Institutional Review Board at Arizona State University.

5.2.1 Participants

A total of 179 young adults (95 females, M_{age} = 22 years old) were recruited from the research participant pool at Arizona State University to participate in the study in exchange for partial class credit.[2] [3] All participants were native English speakers. After informed consent, participants were tested in small groups of approximately 4 to 6 students in sessions that lasted approximately 30 minutes in total. All participants began by performing a Trustworthiness Judgment task. Participants then completed the Experiences in Close Relationships Scale-revised (ECR-R; Fraley, Waller, & Brennan, 2000) and the State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, Lushene, Vagg and Jacobs, 1983).[4] All tasks were programmed and presented using E-Prime 2.0 software (Psychology Software Tools Inc., Pittsburgh, PA, USA) on a 15-in. computer screen.

2 There were originally 190 participants in the sample, but 11 participants were excluded from all data analyses for having corrupted data files and for failing to complete the entire experimental procedure.

3 Across all three experiments reported in this dissertation, there were no main effects of gender and gender did not significantly interact with any of the independent variables in predicting any of the dependent variables. Thus, all results reported in this dissertation are from data collapsed across the factor of gender.

4 Because the items of both the ECR-R and STAI include emotional content and thus might influence performance on the Trustworthiness Judgment task, these questionnaires were administered after the Trustworthiness Judgment task.

5.3 Materials

5.3.1 Face Stimuli

For the judgment of trustworthiness, a total of 175 emotionally-neutral faces were drawn from Todorov's Social Perception Laboratory database (25 Identities trustworthiness dataset). This database contains 25 emotionally-neutral facial identities that were randomly generated using the Facegen Modeller program (http://facegen.com) Version 3.1. For each facial identity, the authors created 7 versions that varied in perceived trustworthiness (-3; -2; -1; 0; 1, 2, 3 SD, for a total of 175 faces) using the trustworthiness computer model developed by Todorov and colleagues (see Oosterhof & Todorov, 2008; Todorov, Dotsch, Porter, Oosterhof, & Falvello, 2013 for a detailed description of the exact procedures).

Figure 5.1. illustrates a sample facial identity morphed from -3 SD (untrustworthy) to 0 SD (neutral) to +3 SD (trustworthy) levels of trustworthiness. Therefore, the faces used in all our studies have been normatively evaluated along dimensions known to bias perceptions of trustworthiness (Dzhelyova et al., 2012; Oosterhof & Todorov, 2008; Todorov et al., 2008). Importantly, all trustworthiness ratings represent physiognomic judgments (Todorov et al., 2012). All facial stimuli were male, to avoid gender bias, and they were all bald so that hair could not influence the subject's choices. Moreover, all faces are Caucasian, to eliminate potential cultural confounds.

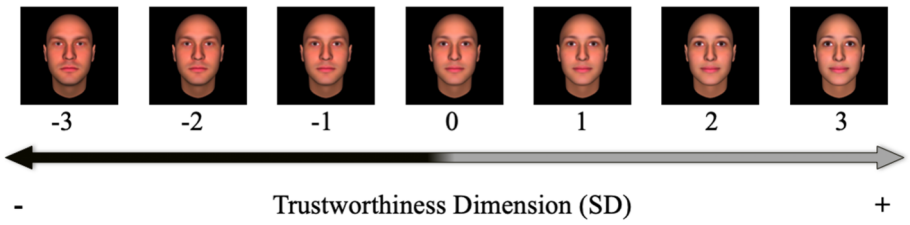

Figure 5.1-Examples of faces used in the Trustworthiness Judgment task. The face in the center (0 SD) represents a randomly generated neutral face for a given identity; then its features were exaggerated to decrease (left three columns) and increase (right three columns) its perceived trustworthiness. Importantly, all faces were emotionally neutral.

5.3.2 Trustworthiness Judgment Task

Participants were told that the experiment was about judging people based on first impressions. We adapted a trustworthiness task that has been used in previous research (see Figure 5.2.; Richell et al., 2005). In this task, participants were shown a set of 175 faces one at a time and were asked to judge how trustworthy they consider the person in the photograph to be. For each face, participants pressed numerical keys to make their response. Judgments were made on a 7-point Likert scale, ranging from 1 *"Not Trustworthy at All"* to 7 "*Extremely Trustworthy*". Consistent with previous research, this task was self-paced but participants were instructed to respond quickly based on their first impression of the face and "gut instinct" and that there was no right or wrong answers. The task started with a few practice trials to familiarize the participant with the task.

Faces were presented one at a time at the center of the screen with the response scale below each photograph, which remained on the screen until a trustworthiness judgment was made. Each trial was preceded by a 1000-ms fixation cross. A total of 175 faces were rated without time constraint and sessions typically lasted an average of 20 minutes. The order of faces was randomized for each participant.

Finally, and perhaps most importantly, as described above, the faces that participants judged in this study were always the same perceptual inputs across participants. Therefore, any variability in the participants' judgements of trustworthiness must be driven by their individual perception with variability across participants reflecting individual differences in perceived trustworthiness. It is these individual differences in judgements that we exploited to see whether ratings of trust covaried with self-reported attachment style and general anxiety. To measure the perception of trustworthiness in this task, we averaged the ratings across the 25 face identities at the same level of trustworthiness, to yield a single set of 7 mean ratings; with one mean rating for each level of the -3 SD to +3 SD trustworthiness dimension represented by the columns in Figure 5.1.

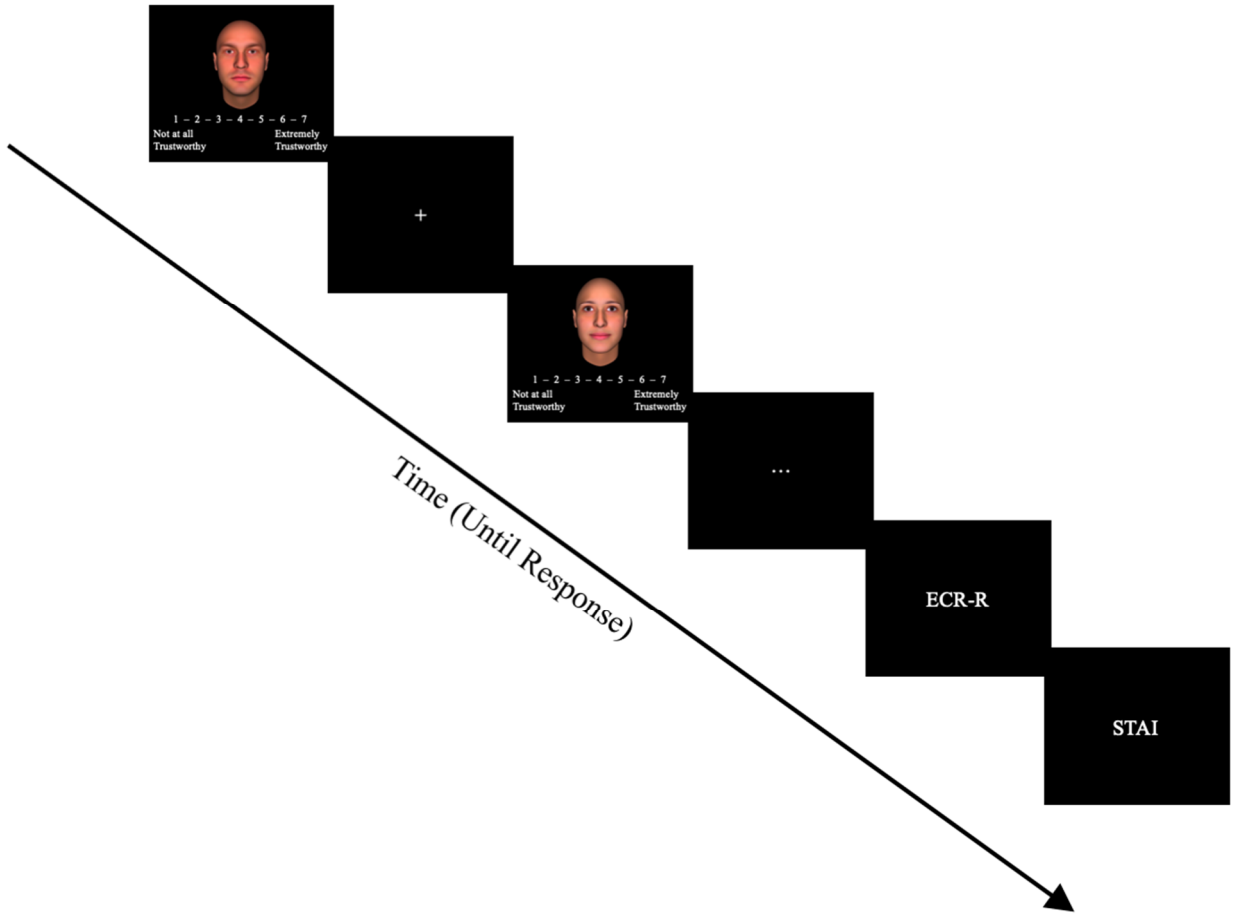

Figure 5.2. An example of two trustworthiness judgment trials.
After the trustworthiness judgment task, participants completed the Experiences in Close Relationships-Revised (ECR-R) and the State-Trait Anxiety Inventory (STAI).

5.3.3 Experiences in Close Relationships-Revised (ECR-R)

After completing the trustworthiness judgment task, we measured attachment style using the revised Experiences in Close Relationships Scale (ECR-R; Fraley, Waller, & Brennan, 2000a). This 36-item self-report questionnaire assesses individual differences in the two major dimensions underlying attachment patterns, with 18 items tapping attachment anxiety (e.g., ‘‘I worry about being abandoned’’) and 18 items tapping attachment avoidance (e.g., “I find it difficult to allow myself to depend on others”). This two-dimensional perspective for representing attachment style is considered the gold-standard in self-report measures of adult-attachment (Brennan, Clark, & Shaver, 1998; Mikulincer & Shaver, 2007), being able to predict theoretically expected outcomes in hundreds of published studies (see Mikulincer & Shaver, 2007a and 2007b, for a review). As in previous research examining adult attachment style, the instructions of the ECR-R

emphasized close relationships in general rather than just romantic relationships (Graham & Unterschute, 2015; Fraley et al., 2000). Therefore, for both anxiety and avoidance scales participants rated the extent to which each item was descriptive of their experiences in close relationships on a 7-point Likert scale (ranging from 1 *''Strongly Disagree''* to 7 *''Strongly Agree''*).

Higher scores on each scale indicate more insecure attachment. Previous studies that have also used the ECR-R to examine individual differences in attachment style report adequate discriminant and convergent validity (e.g., Brennan, Clark, & Shaver, 1998; Fraley, Waller, & Brennan, 2000a; Sibley, Fischer, & Liu, 2005) and high levels of internal consistency for both the anxiety and avoidance scale (Gillath, Giesbrecht, & Shaver, 2009; Ravitz, Maunder, Hunter, Sthankiya, & Lancee, 2010).

5.3.4 State-Trait Anxiety Inventory (STAI)

We also assessed both participants' perception of their general (trait) and current (state) levels of anxiety using the Spielberger State-Trait Anxiety Inventory (STAI; Beckler, 2010; Spielberger et al., 1983). This 40-item questionnaire is the most widely used measure in applied psychology research and has been shown to be a reliable measure (alpha = .94) (Barnes et al., 2002). It assesses state anxiety with 20 statements that participants evaluate with respect to how they feel ''right now, at this very moment''; whereas trait anxiety is assessed with 20 statements that participants evaluate with reference to how they ''generally'' feel. Responses are made on a 4-point Likert scale, ranging from 1 *"Not at All"* to 4 *"Very Much So"*. Total scores for state and trait anxiety range from 20 to 80, with higher scores reflecting greater levels of anxiety. There is considerable evidence demonstrating the construct and concurrent validity of both scales (Spielberger et al., 1983).

5.4 Results

For all statistical analyses, a conventional alpha level of .05 was used and effect sizes were calculated by using partial eta-squared (η_p^2). In agreement with guidelines set by Cohen (1988), η_p^2 of .01, .10, and .25, corresponds to small, medium, and large effects, respectively.

5.4.1 Descriptive Statistics of Individual Differences Measures

Participant's attachment style was determined and analyzed using Brennan et al (1998) scoring instructions. Therefore, an anxious-attachment and avoidant-attachment score was calculated for each participant by averaging scores for all items within each ECR-R scale. Mean scores were 3.31 (SD = 1.12) for anxious-attachment scale and 3.07 (SD = 1.03) for avoidant-attachment scale. These values corresponded to previous findings in healthy student samples (Byrow, Broeren, de Lissa, & Peters, 2016; Edelstein & Gillath, 2008). Following Fraley and Waller (1998) recommendations, we believe that adult attachment is best measured and conceptualized in terms of continuous dimensions, not as a typological variable.

In the same way, scores for all items within the trait-anxiety and state-anxiety scale were averaged together to create a trait and state anxiety scores. The sample average for both trait (M = 41.63, SD = 10.3) and state (M = 37.89, SD = 8.76) anxiety were also within the normative range (e.g., Koster, Crombez, Verschuere, & De Houwer, 2004).

5.4.2 Trustworthiness Judgments by Attachment Style and Anxiety Level

In order to investigate whether attachment style (anxious and avoidant) and level of anxiety (trait and state) affect first impressions of trustworthiness, we conducted four separate one-factor repeated measures ANOVAs for each questionnaire scale, with trustworthiness dimension for the 7 versions of faces used in this study (i.e., from a -3 SD untrustworthy face to a +3 SD trustworthy face) as a within-subjects factor. Specific differences were only assessed when ANOVA results were significant at the $p < 0.05$ level, and *post hoc* analysis were conducted with Bonferroni adjustment for multiple comparisons.

5.4.2.1 Trustworthiness Judgments and Anxious-Attachment Effect

To specifically determine whether facial trustworthiness judgments differ as a function of anxious attachment style, a Generalized Linear Model (GLM) with trustworthiness dimension as a within-subjects factor (7 Levels: -3 SD vs. -2 SD vs. -1 SD vs 0 SD vs +1 SD vs +2 SD vs +3 SD) and anxious-attachment scores as a covariate was

carried out. Supporting the validity of our stimuli, a significant main effect of trustworthiness dimension confirmed that participant's ratings of trustworthiness closely tracked the 7 levels of trustworthiness predicted by Todorov trustworthiness model, $F(6, 1062) = 28.037$, $p < .001$, $\eta_p^2 = .14$. Specifically, our stimuli differed on perceived trustworthiness with untrustworthy faces ($M_{-3SD} = 2.43$, $SD = .84$; $M_{-2SD} = 2.9$, $SD = .85$; $M_{-1SD} = 3.37$, $SD = .72$) being judged more negatively than both neutral ($M_{0SD} = 3.83$, $SD = .67$) and trustworthy faces ($M_{+1SD} = 4.28$, $SD = .75$; $M_{+2SD} = 4.62$, $SD = .8$; $M_{+3SD} = 4.9$, $SD = .83$). Most importantly, there was a significant interaction between trustworthiness dimension and anxious attachment style, $F(6, 1062) = 6.998$, $p < .001$, $\eta_p^2 = .04$, suggesting that the way in which trustworthiness ratings were affected by the perceptual facial features is moderated by attachment-related anxiety.

To better understand the moderating role of anxious attachment style, trustworthiness judgments for each face version were separately examined for participants scoring higher and lower than 50% of the average distribution in the anxious-attachment scale. As can be seen in Figure 5.3, follow-up analysis revealed that anxiously-attached individuals evaluated a face with untrustworthy features as more untrustworthy than individuals who endorsed low levels of attachment anxiety. These differences in mean trustworthiness judgments were true across all levels of facial untrustworthiness (i.e., for -3 SD faces, $t(177) = 2.979$, $p < .01$; for -2 SD faces, $t(177) = 2.813$, $p < .01$ and for -1 SD faces, $t(177) = 2.171$, $p < .05$). In the same way, individuals scoring high on the anxious-attachment dimension were also biased to perceive neutral-looking faces as significantly more untrustworthy ($M_{0SD} = 3.73$, $SD = .62$) than low anxious participants ($M_{0SD} = 3.93$, $SD = .7$) , $t(177) = 2.034$, $p < .05$, whereas they perceived trustworthy-looking faces as equally trustworthy (for +1 SD faces : $p = .172$; +2 SD faces: $p = .871$; +3 SD faces: $p = .521$). Considering that the physical distance between any two categories of faces is the same (i.e., 1 SD), these results seem to demonstrate that anxiously-attached individuals are more sensitive to the relatively subtle perceptual cues that signal untrustworthiness.

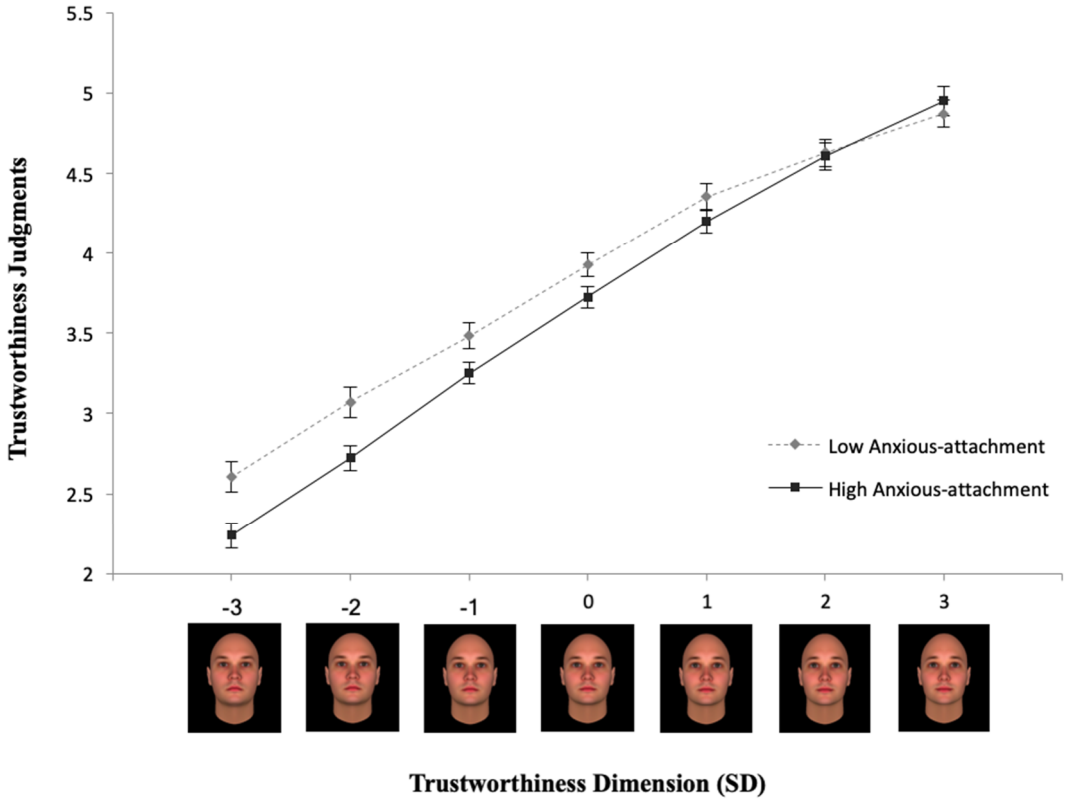

Figure 5.3. Mean Trustworthiness Judgments as a function of Trustworthiness Dimension and Anxious Attachment Style. Error bars represent standard errors.

The same analytic procedure was followed for avoidant attachment style. The Generalized Linear Model with trustworthiness dimension as a within-subjects factor (7 Levels: -3 SD vs. -2 SD vs. -1 SD vs 0 SD vs +1 SD vs +2 SD vs +3 SD) and avoidant-attachment scores as a covariate did not show any significant effects, $F(6, 1062) = .431$, $p = .859$, suggesting comparable perceptions of trustworthiness between varying levels of facial trustworthiness. Therefore, anxious-attachment, but not avoidant-attachment, seems to moderate facial trustworthiness judgments.[5]

5 We also tested the interaction between anxiety and avoidance in this, and the studies that follow. In no case was the interaction term a significant predictor of the dependent measures. Therefore, throughout all our studies, all effects were best predicted by the unique main effects of attachment anxiety and or/ attachment avoidance, and not by the interaction between the two.

5.4.2.2 Trustworthiness Judgments and Trait-Anxiety Effect

The same Generalized Linear Model with trustworthiness dimension as a within-subjects factor (7 Levels: -3 SD vs. -2 SD vs. -1 SD vs 0 SD vs +1 SD vs +2 SD vs +3 SD) and trait-anxiety as a covariate was carried out. The significant interaction effect between trustworthiness dimension and trait-anxiety suggests that high-trait anxious participants seem to be more sensitive to the perceptual changes in faces that cue trustworthiness, $F(6, 1062) = 6.882$, $p < .001$, $\eta_p^2 = .04$. To shed light on the moderating role of trait-anxiety, trustworthiness judgments for each face version were separately examined for participants scoring higher and lower than 50% of the average distribution in the trait-anxiety scale (Figure 5.4). The follow-up analysis revealed that individuals with high levels of trait anxiety were also biased to perceive a face with untrustworthy features as significantly more untrustworthy than individuals with lower levels of trait-anxiety. Replicating the same response pattern as individuals who are anxiously-attached, individuals who are high in trait anxiety evaluated all untrustworthy-looking faces as less trustworthy (i.e., for -3 SD faces: $t(171) = 3.104$, $p < .01$, for -2 SD faces: $t(171) = 3.180$, $p < .01$ and for -1 SD faces: $t(171) = 3.348$, $p < .01$). In the same way, highly anxious individuals evaluated neutral-looking faces as more untrustworthy ($M_{0SD} = 3.71$, $SD = .67$) than less anxious individuals ($M_{0SD} = 3.96$, $SD = .66$), $t(171) = 2.481$, $p < .05$. However, similar to anxiously-attached individuals, there were no significant differences between high and low-trait anxiety participants for judgements of trustworthy-looking faces (for +1 SD faces: $p = .128$; +2 SD faces: $p = .291$; +3 SD faces: $p = .643$).

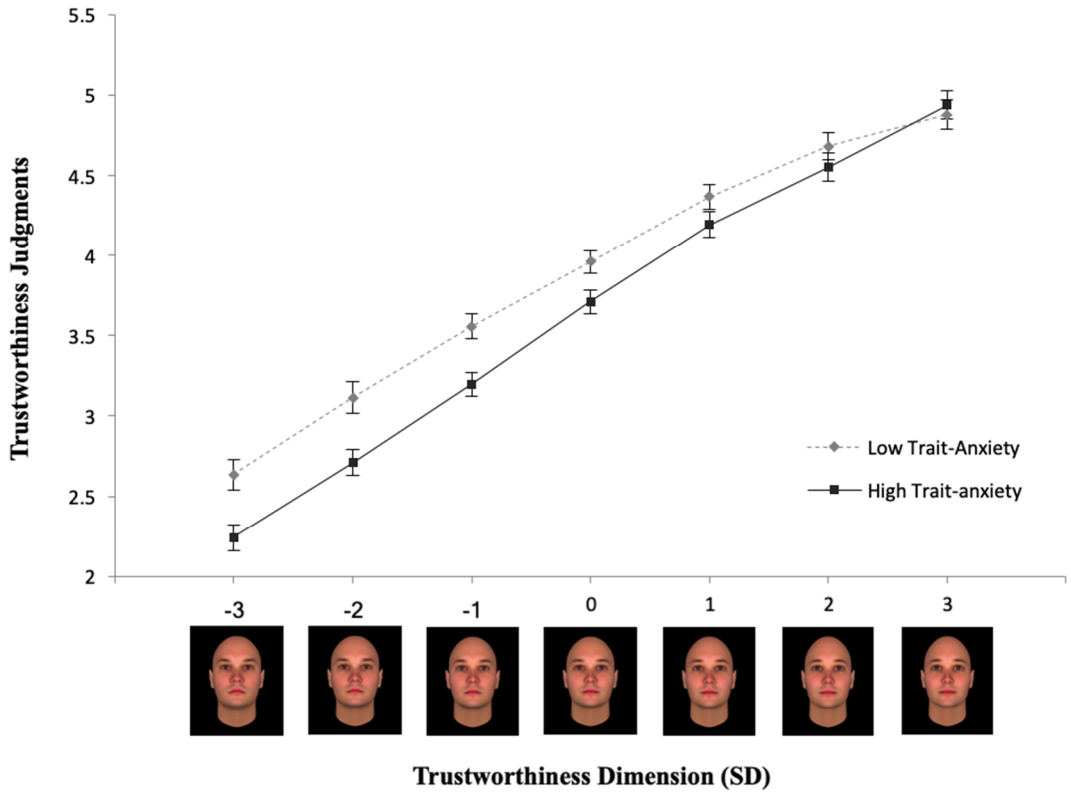

Figure 5.4. Mean Trustworthiness Judgments as a function of Trustworthiness Dimension and Trait Anxiety. Error bars represent standard errors.

The same analytic procedure was followed for state-anxiety. The Generalized Linear Model with trustworthiness dimension as a within-subjects factor (7 Levels: -3 SD vs. -2 SD vs. -1 SD vs 0 SD vs +1 SD vs +2 SD vs +3 SD) and state-anxiety scores as a covariate did not reveal any significant effects, $F(6, 1062) = 2.882$, $p = .074$. Therefore, trait-anxiety, but not state-anxiety, seems to moderate facial trustworthiness judgments.

5.5 Discussion

According to attachment theory, attachment insecurities influence mental representation of others, with research suggesting that people with different attachment styles differ in their perception of familiar and unfamiliar others (e.g., Mikulincer & Shaver, 2012; 2019). The aim of the current study was to explore whether individual differences in attachment style and anxiety level affect trustworthiness judgments of unfamiliar and emotionally-neutral faces.

The results suggested that trustworthiness judgments are equally affected by anxious-attachment and trait-anxiety, although this effect depends on the type of the face being perceived. Specifically, we found that anxiously-attached individuals tend to judge untrustworthy-looking and neutral faces as significantly more untrustworthy than less anxious individuals. It is noteworthy that there were no attachment style differences for judgments of trustworthy-looking faces, suggesting that anxiously attached individuals do not exhibit a generalized response bias to judge all the stimuli as less trustworthy. In other words, and consistent with previous research on perceptual changes in facial expressions of anger (Niedenthal et al., 2002), highly anxious individuals were more sensitive to changes in untrustworthy than trustworthy facial cues. Research examining face appraisals also suggest an interpretational bias in anxiously-attached individuals, such that neutral facial expressions were rated as more negative, unfriendly or unpleasant (Meyer et al., 2004). Our findings seem to be in line with assumptions from attachment theory, which suggests that anxious attachment is associated with more ambivalent views of others (Vricka & Vuilleumier, 2012). Although people scoring high on attachment-anxiety have a history of frustrating interpersonal interactions, they nevertheless tend to believe that if they intensify their efforts, they may compel others to provide appropriate support. As a result, they do not form a simple, linear negative view of others (Shaver & Mikulincer, 2011). This is an important finding because it suggests that, in appraising others, the attachment system differently weights signals that are indicative of rejection (untrustworthy faces) versus acceptance (trustworthy-looking faces).

The majority of previous studies addressing attachment style differences focused mainly on perceptual encoding (Fraley et al., 2006; Niedenthal et al., 2002) and emotional recognition of facial expressions (Mikulincer & Shaver, 2007). To the best of our knowledge, our study is among the first to examine the potential contributions of individual differences in attachment style in judging the trustworthiness of novel, unfamiliar others. The observed effects of anxious-attachment style on perceived trustworthiness is consistent with the definition of this superordinate attribute as an aggregation of lower-levels traits such as trust, generosity, straightforwardness and compliance. Likewise, in the attachment style model, high anxious-attachment is often characterized by skepticism about other people's motives, resulting in suspicious, unfriendliness (Mikulincer & Shaver, 2019), and, as confirmed by the present study, the tendency to perceive unknown people as untrustworthy. The fact that anxiously-attached individuals continue to see evidence

of negative untrustworthy traits as this trait dwindled away (i.e., goes from a -3 SD, untrustworthy face, to 0 SD, neutral face) is in line with previous studies on the perception of facial expressions of emotion. Niedenthal and colleagues (2002) found that insecurely-attached individuals saw the offset of angry expressions as occurring later than did secure individuals. It is possible that this higher threshold for trusting someone may serve a protective function by preventing “false positives” in trusting others (Miano, Fertuck, Arntz, & Stanley, 2013). However, the negative consequence of this high threshold may be to precipitate foreclosure of potentially enriching relationships through avoidance of people who may actually be trustworthy. It is important to note that, as discussed in chapter 2, these facial trait impressions are formed by extrapolation of physiognomic features and, therefore, are subjective in nature and not necessarily accurate (Engell et al., 2010; Said, Sebe, & Todorov, 2009). Consistent with these studies, our findings suggest that attachment style is a factor that should be considered in studies of first impressions.

In contrast to anxious-attachment, we found that individual differences in attachment-related avoidance does not seem to moderate perceptions of facial trustworthiness. Our results seem to suggest that individuals who reject or fear intimacy and close interactions, and the associated behavioral requirements, may consciously or unconsciously avoid processing cues that invite such interactions (such as trustworthy-looking faces; Slepian et al., 2017). Previous studies have also found that, unlike avoidant people, anxiously-attached people tend to perceive negative stimuli as congruent with their goal of attachment-system hyperactivation. As a result, highly anxiously-attached, but not avoidantly-attached individuals, tend to intensify and more extremely rate negative emotional cues (e.g., cues related with fear, distress; Mikulincer & Shaver, 2012). In contrast, more avoidant individuals are better able than less avoidant ones to suppress and reduce the intensity of their automatic responses to negative information (Mikulincer & Shaver, 2012; 2019). Fraley and colleagues (2000) found that these avoidant defensive strategies act in a preemptive mode by holding affective information out of awareness right from the moment they encounter it. As a consequence, while anxiously-attached individuals tend to intensify negative emotional states and exaggerate negative-related information, attachment-avoidant individuals tend to distance themselves from emotional scenarios and threatening-related cues. At first glance, our results seem peculiar because other research seems to suggest that avoidant attachment is related with a variety of affective and interpersonal cognitive processes. It is important to note, however, that the

trustworthiness judgment task used in our study may not be well suited to tapping the psychological processes underlying avoidant attachment. The difference between avoidant's more conscious denial of a need for close interactions, and the preoccupations that characterize some of their unconscious, perhaps automatic perceptual behaviors, render predictions about this individual's behavior somewhat complicated. Further studies on the role of attachment styles in perceptual and attentional processing would therefore be of great interest.

We did not observe attachment style differences for judgments of trustworthy-looking faces. The attachment style differences found only for judgments of untrustworthy-looking faces could be interpreted as an effect of subtle variations in the facial features that contribute to perceptions of trustworthiness. Based on behavioral studies and computational modeling, Todorov and colleagues argued that as the untrustworthy facial features become more exaggerated in the negative direction, the faces are classified as angry, whereas, as the trustworthy facial features become more exaggerated in the positive direction, the faces are classified as happy. In line with this theoretical account, studies examining attachment style differences in the processing of emotional stimuli found that insecure individuals only show a processing bias toward negative, but not positive, information (e.g., angry, but not happy faces; e.g., Mikulincer & Shaver., 2012). Based on these studies, our findings seem to suggest that untrustworthy faces, like angry faces, are able to differentially activate the aversive system in individuals with high and low anxious attachment style.

Concerning the effect of anxiety differences on first impressions, the present study suggests that individuals with higher levels of trait anxiety also tend to perceive unfamiliar untrustworthy faces as more untrustworthy than those with lower levels of trait anxiety. In line with existing evidence, this finding indicates that emotionally-neutral or ambiguous stimuli are differently evaluated by high and low trait anxious individuals. In contrast, state anxiety did not affect judgments of trustworthiness. In a study more closely related to the present research, participants were shown a series of neutral faces and were asked whether they would trust that stranger in the picture with their camera (Willis, Dodd, & Palermo, 2013). Using the STAI scale to measure anxiety, the authors found that individuals with high levels of trait, but not state, anxiety judge affectively neutral faces as less trustworthy than those with lower levels of trait anxiety. Corroborating previous work, our findings suggest that trustworthiness judgments are more closely related to a stable

anxious disposition than how the participants felt at the moment when they completed our study (Willis et al., 2013). As previous studies also suggest, the observed relationship between trait anxiety and trustworthiness judgments illustrates the potential importance of also controlling for trait anxiety levels when assessing trustworthiness judgments. The fact that high-trait anxious individuals in our study processed faces very similarly to those scoring high on anxious-attachment, is interesting, and suggests that processes underlying anxious attachment and anxiety may overlap (Mark et al., 2012; Read, Clark, Rock & Coventry, 2018). Cassidy and colleagues (2009) have suggested that attachment theory offers a theoretical framework for how generalized anxiety disorder can develop in adulthood.

Our findings that both attachment style and trait anxiety are associated with more negative, untrusting initial impressions of others illustrates the importance of assessing attachment representations in future studies assessing trustworthiness judgments, particularly those studies involving clinical populations who report abnormal levels of anxiety (Masland, 2016; Miano et al., 2013). Future research on attachment should examine the locus of information processing differences that lead to this effect. Specifically, we must ascertain whether this interpretation bias occurs at the level of early face processing or later in judgement and decision making about the face. Specifically, our hypothesis is that an early attentional bias towards un(trustworthy) looking faces should be the source for this effect.

CHAPTER 6

STUDY 2: EFFECTS OF ATTACHMENT REPRESENTATION ON ATTENTION TO UNTRUSTWORTHY FACES: A DOT-PROBE STUDY

Selective attention is believed to be essential in the activation and regulation of the attachment system, with research suggesting that individuals differ in their ability to regulate attention to affective information as a function of existing working models of attachment. No empirical studies to date have, however, examined attentional processing of facial cues of trustworthiness, despite the theoretical importance of this regulatory process and personality trait. Thus, the study presented in this chapter was designed to explore attachment-style differences in attentional biases of facial trustworthiness. We start by presenting the main assumptions on the role of attention in attachment theory.

6.1 Introduction

Extent research has now documented that negative (threatening) stimuli are highly triggering cues in the activation of the attachment system, and that the internal working models of attachment selectively filter incoming, significant information by directing attention towards or away from these stimuli. Insecure attachment patterns are assumed to be characterized and maintained in part by attentional biases, and attachment theory seems to make clear theoretical predictions on the relation between attachment style and attention (Bowlby, 1973, 1982). Specifically, attachment anxiety is characterized by an oversensitivity in detecting threat and by intense distress reactions (Dykas & Cassidy, 2011). For example, some studies show that anxiously-attached participants are faster to make lexical decision responses to attachment-related words (Dewitte, De Houwer, Koster, & Buysse, 2007). Anxious individuals selectively attend to threatening information and are assumed to adopt an hyperactivated attentional style that is oriented towards negative information. In these individuals, attention to threatening information is strongly prioritized over neutral or positive information (Vrtička & Vuilleumier, 2012). Studies focusing on these secondary attachment strategies in adulthood and their effects on attention, have found that people with anxious attachment style tend to focus their attention on, and found it difficult to disengage from attachment-related and negative social stimuli (Mikulincer, Gillath, & Shaver, 2002; Mikulincer & Orbach, 1995). Caution is necessary, however, when interpreting some of these results, as attention was only assessed indirectly as a measure of the difficulty to encode or disengage from negative thoughts and memories (e.g., difficulty letting go and not focus attention on negative childhood memories or imagined scenarios that evoked negative emotions; Gillath, Bunge, Shever, Wendelklen, & Mikulincer, 2005; Mikulincer & Orbach, 1995). This approach to measuring attention could account for some conflicting findings in the literature, especially when different cognitive tasks are employed.

On the other end, attachment theory proposes that attachment avoidance is marked by attenuated (negative) emotionality which is manifested in the denial, inhibition and dismissal of threatening information in an attempt to prevent activation of the attachment system (Mikulincer & Shaver, 2003; 2007). Individuals with an avoidant attachment tend to shift their attention away from emotionally significant information (e.g., pictures of people separating, threatening words) and take longer to identify attachment-

related information (e.g., Mikulincer, Birnbaum, Woddis, & Nachmias, 2000; Mikulincer, Gillath & Shaver., 2002). Consistent with the proposal that attachment avoidance is linked to cognitive suppression of potentially distressing information, Edelstein and Gillath (2008) reported that avoidant individuals tended to limit their attention (i.e., showed reduced interference) to negative words during a Stroop task. Theoretically, avoidant individuals should present an attentional bias of inhibiting attention to threatening information, however this hypothesis has received only limited empirical support (e.g., (Dan & Raz, 2012; Mark et al., 2012). For example, in contrast with the findings mentioned above, Dewitte and colleagues (2007) used a dot-probe task to investigate selective attention for different types of social information (i.e., negative words and emotional facial expressions) and failed to find a unique effect of attachment avoidance on selective attention (even though they found that the interaction between anxiety and avoidance did affect attentional processing). In addition, anxiously-attached individuals also showed an attentional bias towards positive and negative attachment-related (versus attachment-unrelated) words (Mikulincer & Shaver, 2007). Taken together, such findings seem to suggest that negative information might be feared by highly anxious and/or highly avoidant attachment orientations, but only attachment anxiety seems to lead to an enhanced response to threatening signals (Vrticka & Vuilleumier, 2012). Other studies also reported that the ability of avoidant individuals to ignore and regulate their attention to threatening information is not always found (Gillath et al., 2009). As pointed by previous research, the pattern of bias toward or away/avoidance of threat might depend on the length of stimulus exposure time. Attentional avoidance, directing attention away from negative information, is sometimes found following initial vigilance for threat when stimulus presentation durations are prolonged. Thus, attentional engagement/disengagement tasks can potentially determine whether anxiously and/or avoidantly attached individuals show an early attentional bias towards emotional stimuli and then differ in their secondary processing strategy.

So far, most of the research on attention and attachment styles does not always finds evidence to support the assumed theoretical differences in attentional processing as a function of the specific type of attachment insecurity (Dan & Raz, 2012; Fraley et al., 2006; Mark et al., 2012; Zeijlmans Van Emmichoven, Van IJzendoorn, De Ruiter, & Brosschot, 2003). Instead, it was found that increases in both anxious and avoidant-

attachment was linked to quicker attention to images of facial expressions (Maier et al., 2005), negative words (Atkinson et al., 2009) and negative social stimuli in general (Dykas & Cassidy, 2011). Although attachment theory predicts an attentional bias (greater attention) towards threat in anxious persons and cognitive avoidance (direct attention away) of threat in avoidant persons, a few studies have demonstrated that anxiously as well as avoidantly-attached individuals attend more to negative, threatening information (e.g., Atkinson et al., 2009; Dykas & Cassidy., 2011; Shaver & Mikulincer., 2011). In general, the studies discussed here reveal that insecurely attached individuals seem to process threatening information differently from secure individuals. However, no evidence seems to be found for differential attentional processing in function of the specific type of attachment insecurity (i.e., anxious versus avoidant; Vrticka & Vuilleumier., 2010; Zeijlmans Van Emmichoven, Van IJzendoorn, De Ruiter, & Brosschot, 2003). One important reason for the presence of mixed results when studying attentional bias/allocation as a function of attachment style might be the type of tasks used (Edelstein & Gillath, 2008; Zeijlmans Van Emmichoven, Van IJzendoorn, De Ruiter, & Brosschot, 2003). For instance, previous research has mentioned some interpretative difficulties with the Stroop and lexical decision tasks, and there is considerable doubt whether the results reflect a bias in the allocation of attentional resources (De Ruiter & Brosschot, 1994; see Mogg, Millar & Bradley, 2000, for a summary). Most importantly, it has been suggested that the Stroop effect might not reflect attention, but arises from other factors such as interruption effects or other task-irrelevant processes. Moreover, it has been suggested that interference occurs at the phase of response generation rather than attention allocation (Rosenfeld & Skogsberg, 2006). As such, it is not clear what interference might indicate in the Stroop task, as it can be the result of either vigilance (attentional bias) or cognitive avoidance of negative information (De Ruiter & Brosschot., 1994). Such distinction seems to be crucial when investigating attentional biases as a function of attachment orientation. Therefore, it might be interesting to look at other paradigms that provide a less ambiguous measure of attentional processing (see Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & Van Ijzendoorn, 2007, for a review of differences between Stroop and Dot-probe task).

It has been suggested that a more straightforward method of measuring attentional bias for threat-related (socially-relevant) information is the dot-probe task (MacLeod et al., 1986). The dot probe task measures the slowing or speeding effects of presenting

socially-relevant stimuli in the vicinity of a probe. In a visual probe detection task, two stimuli, consisting of a relevant stimulus (usually a threatening stimuli, such as a negative word or a negative facial expression) and a neutral stimulus, are simultaneously presented at two different spatial locations on a computer screen. Following stimuli offset, a small dot probe occasionally appears either at the location of the relevant/threatening stimulus (congruent presentation) or at the location of the neutral stimulus (incongruent presentation). Participants are required to detect the dot as quickly as possible by pressing a button. It is presumed that detection of the probe will be faster if attention is already allocated to that location where the probe appears. Thus, attentional bias to threat is inferred when participants are faster to detect probes appearing in the location of the threatening stimuli relative to the neutral stimuli. This finding has been interpreted as vigilance for threat but there may also be additional attention mechanisms responsible for driving performance in this task.

While attentional bias has been extensively studied with the dot-probe task, it is not exactly clear what attentional processes the dot probe task reflects and what aspects of attention are exactly being measured. Posner and Peterson (1990) have decomposed the human attention system into several subcomponents, two of which seem to be relevant in the present context: orienting toward stimuli and disengaging from stimuli. Note that in its original format, the attentional bias measure in a dot-probe task is a combined score made up of orienting toward and disengaging from a stimulus. That is, the original attentional bias "index" is calculated by subtracting the mean reaction times (RT) to dots replacing threatening stimuli, from the mean RT to dots replacing neutral stimuli in a threat-neutral stimulus pair. As previous research has already pointed out (Derryberry & Reed, 2002), a positive attentional bias index score may, thus, arise from (a) small reaction times to threat, reflecting fast responses to dots replacing threat stimuli (i.e., greater orientation toward threat), and/or (b) large reaction times to neutral, reflecting slow responses do dots replacing neutral stimuli, presumably because of slow disengagement from threat stimuli. Thus, high attentional bias scores, as measured in previous studies using the traditional dot-probe paradigm, could be due to greater initial capture of attention by threat (i.e., vigilance toward threat) or to more difficulty in disengaging attention from threat (i.e., greater attentional hold) or both. That is, in its traditional approach, the dot probe task can confirm the presence of the threat bias but

cannot identify the mechanisms through which it occurs because there is not a true control condition. A modification of the task includes adding a trial type, where two neutral (non-threatening) stimuli are presented simultaneously and then followed by a probe in the location of one of the stimuli (Koster et al., 2004). Using this approach, one can assess the threat bias more directly by comparing probe response time on these neutral trials to probe response times on threatening trials.

Differentiating between vigilance (facilitated engagement) and difficulty to disengage attention in the dot probe task is of crucial importance for several reasons. First, it allows us to redefine the current conceptualization of attention to threat in the attachment literature. Vigilance to negative/threatening stimuli has been used indiscriminately to describe some of the core features of attachment style. Should differences in attachment style, however, be characterized by a difficulty to disengage attention from threat this would lead to a different set of problems, specifically at breaking and shifting attention away from negative information and engaging in more adequate patterns (Vrtička, 2017). Furthermore, it is important to note that several influential studies and theories on attention to threat partially rely on data obtained through the original dot probe methodology. Therefore, in the present study, we employed a probe detection task that empirically allows us to investigate and differentiate between different mechanisms of visual attention (i.e., orienting toward and disengaging from negative information).

The main goal of the present study was to investigate attention bias to emotionally neutral stimuli which still have the potential threat value (untrustworthy faces) as a function of adult attachment orientation. Since there is considerable body of evidence suggesting that both trait and state-anxiety has also been implicated in contributing to bias in attentional allocation to threat, we also measured both trait and state-anxiety with a subsidiary goal of comparing anxiety-related effects with attachment-related effects (see Bar-Haim,Lamy, Pergamin, Bakermans-Kranenburg, & van Ijendoorn, 2007, for a meta-analysis). Based on previous studies using different paradigms, we predicted that anxious-attachment and both trait and state-anxiety would be related to an increased attentional bias for untrustworthy faces. Regarding the association between avoidance and negative attentional biases in the dot-probe task, past research is not clear, and there are at least two competing hypotheses that can be derived from attachment theory. One hypothesis is that highly avoidant individuals are sensitive and vigilant to untrustworthy faces because they need to be able to detect threatening-related cues to defend

themselves effectively. If this hypothesis is correct, avoidantly-attached individuals should, in the same way as anxiously-attached individuals, show faster responses to untrustworthy faces, as compared to neutral faces. An alternative hypothesis is that avoidant individuals defend themselves against attachment-related information in part by blunting the perception of threatening cues. As in our first study, trustworthy faces were also included to ensure that any attentional bias we found was specific to threat material (i.e., untrustworthy faces) rather than socially-relevant faces in general, regardless of valence (i.e., trustworthy and untrustworthy faces). In the case of trustworthy faces, it is, however, complex to make clear predictions. Because the attachment system is especially oriented towards dealing with negative information, attachment theory comprises few assumptions about the effects of different representations of attachment in the processing of positive cues (Vrtička, 2017). Furthermore, most past research reveals no association between individual differences in the organization of the attachment system and attention to positive stimuli (Dewitte, Koster, De Houwer, & Buysse, 2007).

In light of the literature reviewed above, we used a dot-probe task designed to overcome the limitations of previous paradigms and address important gaps in the research on attachment styles. Thus, in order to assess changes in attentional capture and hold, we incorporated two modifications to the dot probe task: (a) we included baseline trials (with two neutral-neutral stimuli) in order to disentangle between facilitated attention (vigilance) for threat and difficulty disengaging from threat in the attentional bias and (b) we included three presentation durations of the stimuli to assess potential changes in the threat bias in short and longer exposure times.

6.2 Methods

This study was approved by the Human Research Institutional Review Board at Arizona State University.

6.2.1 Participants

A total of 167 young adults (92 females, M_{age} = 21 years old) were recruited from the research participant pool at Arizona State University to participate in the study in exchange for partial class credit.[6] All participants were native English speakers. After informed consent, participants were tested in small groups of approximately 4 to 6 students in sessions that lasted approximately 75 minutes in total. All participants received both verbal and written instructions and began by performing a dot-probe detection task. Just as in our previous study, attachment style and general anxiety (both trait and state-anxiety) were then measured by having participants complete the Experiences in Close Relationships Scale-revised (ECR-R; Fraley, Waller, & Brennan, 2000a) and the trait and state version of the Spielberger State-Trait Anxiety Inventory (STAI; Spielberg et al., 1983). All tasks were programmed using E-prime 2.0 software (Psychology Software Tools Inc., Pittsburgh, PA, USA) and presented on a 15-inch computer screen.

6.3 Materials

6.3.1 Face Stimuli

For the dot-probe task, a total of 300 emotionally-neutral faces were drawn, as in Study 1, from Todorov's Social Perception Laboratory database (Original Computer Generated Faces - 100 Trustworthiness data set). This database contains 100 different face identities that vary on 3 levels of trustworthiness: -3 SD (untrustworthy), 0 SD (neutral) and +3 SD (trustworthy; see Figure 6.1), for a total of 300 faces. Similar to our first study, the faces contained in this database were generated using FaceGen Modeller 3.2 (Singular Inversions, 2007), according to the methods described in Oosterhof & Todorov (2008; Todorov, Said, et al., 2008). Thus, all the faces used in our study have been normatively evaluated along dimensions known to bias trustworthiness perceptions. All faces were Caucasian men, to avoid gender and race bias, and they were all bald so that hair could not influence a subject's choice.

6 There were originally 174 participants in the sample, but 7 participants were excluded from all data analyses for having corrupted data files and for failing to complete the entire experimental procedure.

Four types of face-pairs were created for the dot-probe task: *Untrustworthy-Neutral* (U/N), *Trustworthy/Neutral* (T/N), *Neutral/Neutral* (N/N), and *Untrustworthy/Trustworthy* (U/T). Each face-pair comprised two images of the same person (i.e., same face identity), and each face image was presented at equal distance to the left and right of a continuously visible central white fixation cross. All stimuli were presented on a black background.

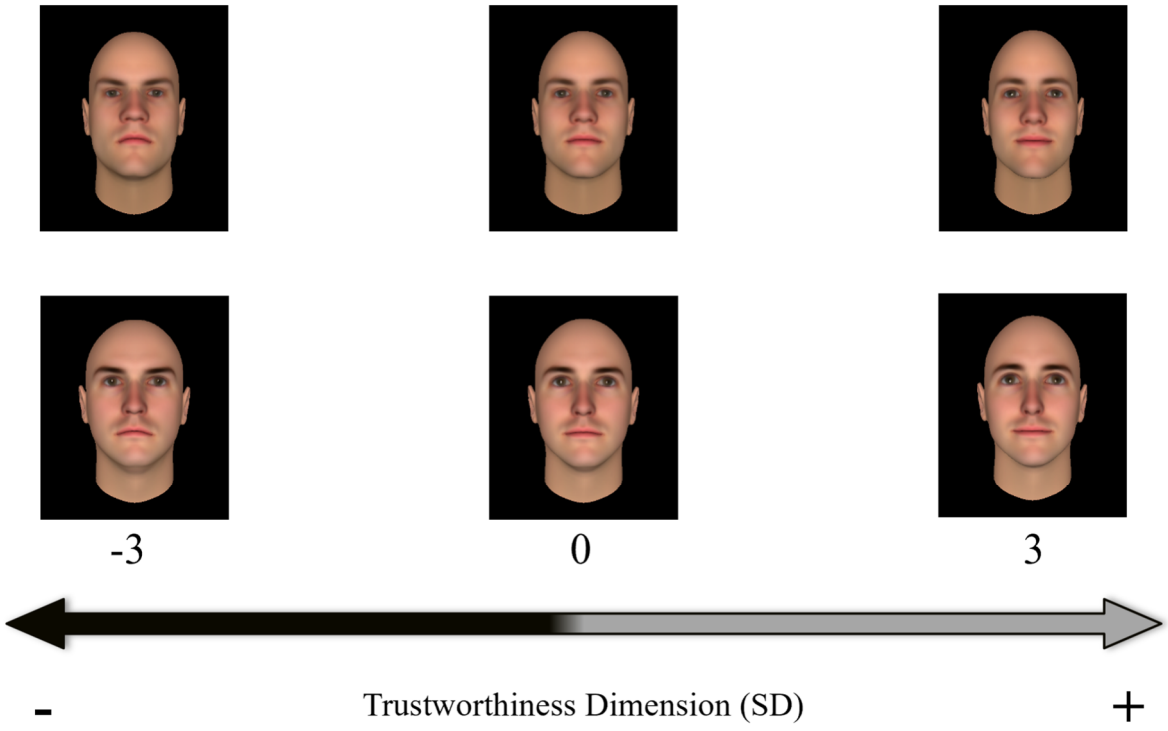

Figure 6.1. Examples of faces used in the Dot-probe task. All faces were drawn from Todorov's Social Perception Laboratory database. The faces in the center column (0 SD) represent a neutral face for a given identity; then their features were exaggerated to decrease (-3 SD) and increase (+3 SD) their perceived trustworthiness. All faces are emotionally neutral.

6.3.2 Dot-probe Task

Figure 6.2 displays the sequence of events for a trial of the dot probe task. Each trial began with a white fixation-cross displayed for 500 ms in the middle of the screen. Then, a pair of faces was presented for either 500, 750, or 1000 ms. Immediately following the offset of the two pictures a small dot-probe appeared in the location previously occupied by one of the two faces. Participants' task was to detect the dot, as quickly and

as accurately as possible, by pressing the "*Spacebar"* key on a standard keyboard. The dot-probe remained on the screen for 1000 ms or until a response was made, whichever came sooner. The computer measured the time (in milliseconds) it took the participant to respond as the dependent variable (i.e., response time was recorded from probe onset). Comparable to other dot-probe studies, participants were also told that the face images were irrelevant to the task and were instructed to maintain central fixation throughout each trial (e.g., Kappenman, Farrens, Luck, & Proudfit, 2014).

Participants completed 8 practice trials followed by 6 blocks of 120 trials (for a total of 720 trials) consisting of 30 *Untrustworthy-Neutral* pairs, 30 *Trustworthy/Neutral* pairs, 30 *Neutral/Neutral* pairs, and 30 *Untrustworthy/Trustworthy* pairs. In each block, 96 face-pairs (i.e., 80% of the trials) were followed by a dot probe. The faces as well as the dot probe were presented equally often and with equal frequency at the right or left side of the screen and the dot-probe was equally likely to replace either a relevant (i.e., trustworthy and untrustworthy) or a neutral face. All stimuli were randomized and counterbalanced across participants. Each block was separated by a self-paced rest break. Face pairs were presented in fully randomized order across trials and participants. The inter-trial interval (ITI) varied randomly between 500 and 1000 ms (in 100 ms increments), after which a new trial began.

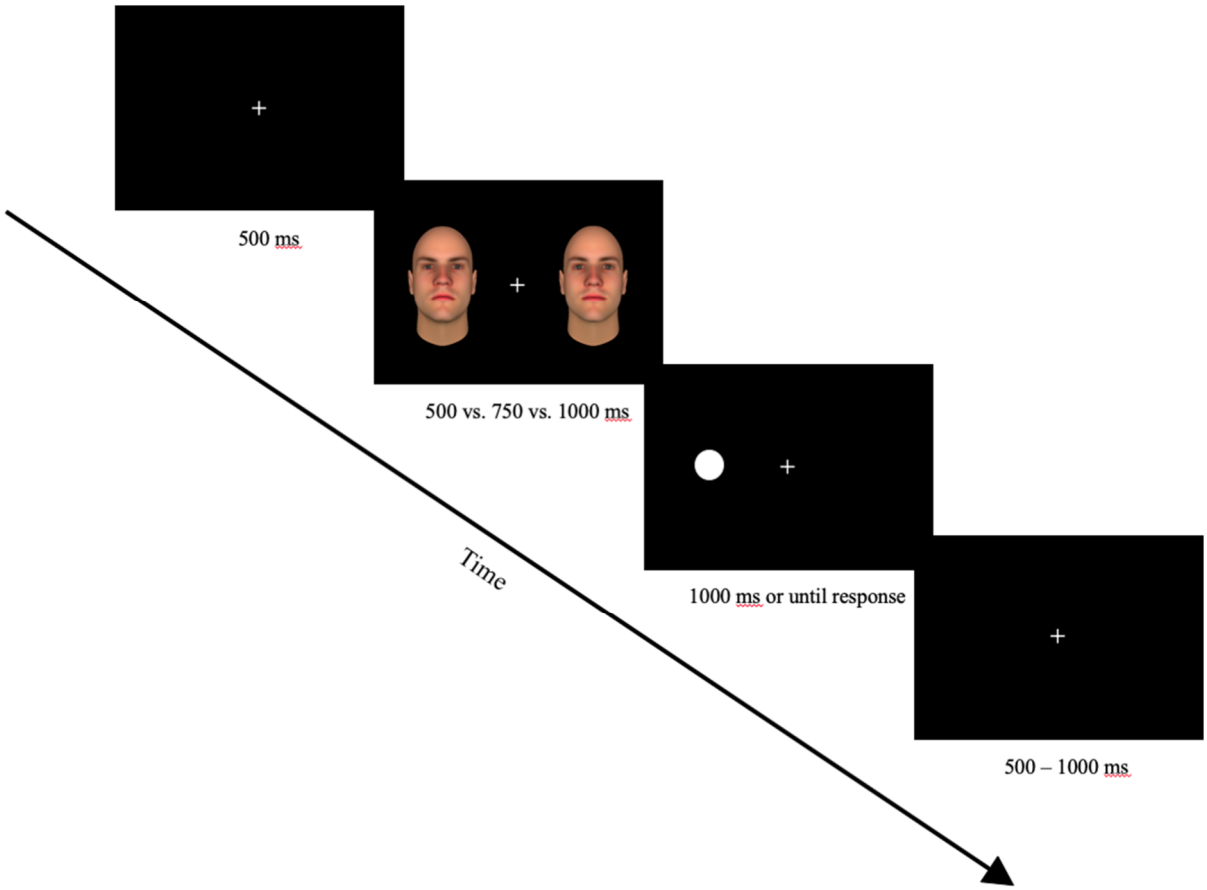

Figure 6.2. Example trial sequence in the Dot-probe task.

6.3.3 Experiences in Close Relationships-Revised (ECR-R)

After completing the dot-probe task, as in Study 1, we measured attachment style using the revised Experiences in Close Relationships Scale (ECR-R; Fraley, Waller, & Brennan, 2000). More details about the ECR-R can be found in section 5.5.1 of the present dissertation.

6.3.4 State-Trait Anxiety Inventory (STAI)

Just as in Study 1, participants then completed trait and state versions of the State-Trait Anxiety Inventory (STAI, Spielberger et al., 1983). More details about the STAI can be found in section 5.5.2 of the present dissertation.

6.4 Results

Unless otherwise stated, for pairwise comparisons we used two-tailed tests with the alpha level set to .05 throughout. Greenhouse-Greisser corrections are reported where assumptions of sphericity were violated. A measure of effect size is given by partial eta-squared (η_p^2). In agreement with guidelines set by Cohen (1988), η_p^2 of .01, .10, and .25, corresponds to small, medium, and large effects, respectively.

6.4.1 Descriptive Statistics of Individual Differences Measures

Just as Study 1, we created an anxious-attachment and avoidant-attachment score by averaging scores for all items within each ECR-R scale. Mean scores were 3.01 (*SD* = 1.13) for anxious-attachment scale and 2.99 (*SD* = 1.06) for avoidance-attachment scale. These values correspond to previous findings in healthy student samples (Byrow et al., 2016; Edelstein & Gillath, 2008) and to findings in our first study. In the same way, scores for all items within the trait-anxiety and state-anxiety scale were averaged together to create a trait and state anxiety scores. The mean trait anxiety score of this sample was 41.95 (*SD* = 12.13). Mean state anxiety score was 39.61 (*SD* = 11.17). As in our first study, these mean scores correspond to STAI scores of previous studies that used undergraduates participants (e.g., Koster et al., 2004; O'Toole & Dennis, 2012).

6.4.2 Reaction Times

6.4.2.1 Preparation of Reaction Time Data

The data analysis for the dot probe task was based on reaction times (RTs) for correct responses, i.e., valid trials were there was a dot probe, and participants correctly detected the dot by pressing the "*Spacebar"* key [7]. Consistent with prior research, reaction times (RTs) shorter than 200 ms (reflecting anticipatory responses) were also removed from the data (e.g., Salemink, van den Hout, & Kindt, 2007). Probe detection latencies that were three SDs above or below the individual mean (calculated separately for each experimental condition) were also removed, as they are likely to represent either inattention to the task (usually slow latencies) or anticipatory responses prior to processing the dot probe (e.g., Chun, Shaver, Gillath, Mathews, & Jorgensen, 2015). In

7 Participants responded correctly to the majority of the dot-probe trials (mean accuracy = 92.4%; SD = 2.87).

total, errors and outliers accounted for 3.1% of the data, which is comparable to previous studies (e.g., Ernst H.W. Koster et al., 2004). Analyses were conducted on the inter-participant mean response times (ms) using a Generalized Linear Model. In order to examine individual differences in the allocation of attention to socially-relevant faces (untrustworthy and trustworthy faces), individual differences measures (attachment-anxiety, attachment-avoidance, trait-anxiety and state-anxiety) were separately included as covariates in the general-linear model (GLM).

Our initial analysis included the within-subjects factor of face-pair duration (500 ms vs. 1000 ms vs. 1500 ms.). A preliminary analysis revealed no main effect of exposure duration, nor did the duration manipulation interact with any of the dependent variables (*ps* > .05). As such, the following results are from data collapsed across the factor of face-pair duration.

6.4.2.2 Typical Attentional Bias

In order to investigate the effects of attachment orientation and level of anxiety on the allocation of attention to untrustworthy faces, we conducted four separate Generalized Linear Models for each questionnaire scale (i.e., anxious-attachment, avoidant-attachment, trait-anxiety and state-anxiety), with congruency on untrustworthy-neutral trials as a within-subjects factor (i.e., congruent = dot appears at untrustworthy location versus incongruent = dot appears at neutral location)[8].

The GLM revealed a significant main effect of congruency, $F(1, 165) = 4.024$, $p < .05$, $\eta_p^2 = .02$, showing that participants were slower to respond to incongruent untrustworthy trials ($M = 429$, $SD = 60$) compared to congruent untrustworthy trials ($M = 427$, $SD = 60$). This is in line with the prediction that participants have an inherent attentional bias to socially-threatening (i.e., untrustworthy) faces. Central to the current research question, this effect was qualified by a significant interaction between congruency and anxious attachment style, $F(1, 165) = 7.029$, $p < .01$, $\eta_p^2 = .04$. To interpret the moderating role of anxious-attachment, we did a median split of the data based on anxious-attachment score. As can be seen in Figure 6.3a, follow-up analysis

8 The same analysis were calculated for trustworthy faces. There were no significant attentional bias or individual differences effects for trustworthy faces. Thus, descriptive statistics and analysis are reported for untrustworthy faces only.

revealed that the main effect of congruency was only significant for individuals with high levels of anxious-attachment, $t(76) = 3.182$, $p < .01$, with this group showing faster responses to congruent ($M = 426$, $SD = 66$) than incongruent untrustworthy trials ($M = 431$, $SD = 68$). In contrast, individuals that were low on anxious-attachment performed similarly on these trials and did no show the attentional bias for untrustworthy faces, $t(89) = 1.596$, $p = .114$ ($M_{congruent} = 429$, $SD = 56$ versus $M_{incongruent} = 426$, $SD = 54$).

A significant interaction effect of avoidant-attachment was found as well, $F(1, 165) = 6.903$, $p < .01$, $\eta_p^2 = .04$ (see Figure 6.3b). To clarify the nature of this interaction, we also did a median split of the data based on avoidant-attachment score. Follow up analysis revealed the same pattern of attentional bias that was found for anxious-attachment. Specifically, only individuals that were high on avoidant-attachment, $t(75) = 1.997$, $p < .05$, but not low-avoidant individuals, $t(90) = .702$, $p = .485$, responded faster to congruent untrustworthy ($M = 420$, $SD = 56$) than incongruent untrustworthy trials ($M = 424$, $SD = 58$). In contrast, low avoidant individuals did not show this attentional bias toward untrustworthy faces ($M_{congruent} = 433$, $SD = 63$ versus $M_{incongruent} = 432$, $SD = 62$).

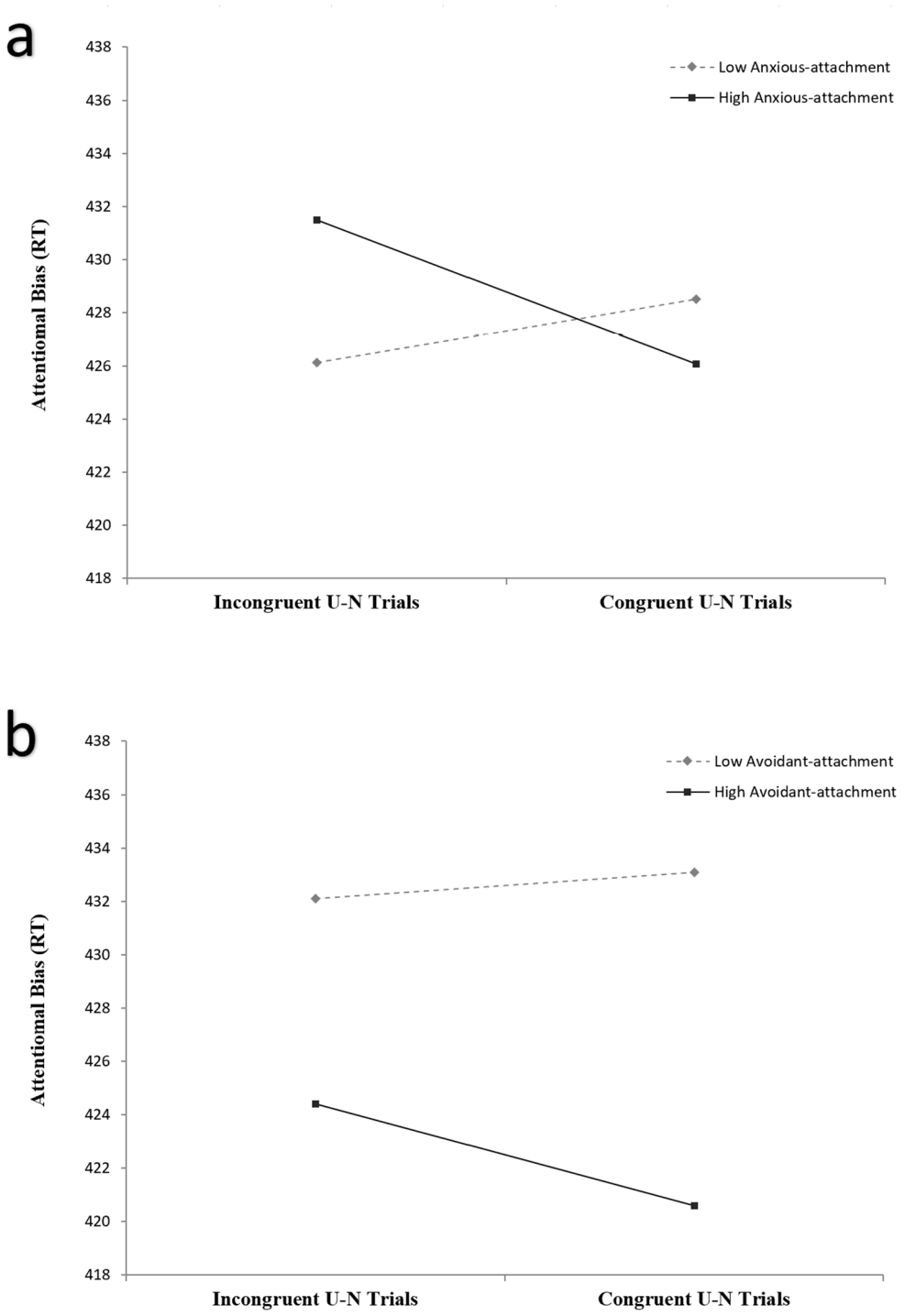

Figure 6.3. Attentional Bias to untrustworthy faces. Mean reaction times on Untrustworthy- Neutral (U-N) trials as a function of congruency (congruent = dot appears at untrustworthy location versus incongruent = dot appears at neutral location) and (a) anxious-attachment and (b) avoidant-attachment.

Consistent with previous research, and our initial hypothesis, both trait and state-anxiety also significantly interacted with congruency, $F(1, 165) = 7.008$, $p < .01$, $\eta_p^2 = .04$ and $F(1, 165) = 9.687$, $p < .01$, $\eta_p^2 = .05$, respectively (see Figure 6.4a and 6.4b). Trait-anxiety scores impacted RTs, making more anxious individuals faster in detecting dots replacing untrustworthy ($M_{congruent} = 432$, $SD = 61$) compared to neutral faces ($M_{incongruent} = 436$, $SD = 63$), $t(78) = 2.008$, $p < .05$. In contrast, low-trait anxious individuals responded similarly to incongruent ($M = 422$, $SD = 57$) and congruent ($M = 422$, $SD = 58$) untrustworthy trials, $t(87) = .533$, $p = .595$. Following the same negative attentional bias pattern, follow-up analysis for state-anxiety also revealed that the main effect of congruency was only significant for individuals with high levels, but not individuals with low levels, of state-anxiety, $t(75) = 2.308$, $p < .05$ and $t(90) = .601$, $p = .550$, respectively. Specifically, while high state-anxious individuals responded faster to congruent ($M = 431$, $SD = 62$) than incongruent untrustworthy trials ($M = 435$, $SD = 61$), individuals that were low in state-anxiety responded similarly to these trials and did not show any differences in RTs ($M_{congruent} = 424$, $SD = 59$ versus $M_{incongruent} = 423$, $SD = 59$).

In sum, as depicted in Figure 6.3a and 6.3b, both anxiously and avoidantly-attached individuals and also individuals high on trait and state anxiety (see Figure 6.4a and 6.4b) showed a stronger attentional bias toward untrustworthy-looking faces. These results indicate that both insecurely-attached and anxious individuals attend more to negative, threatening information than to neutral.

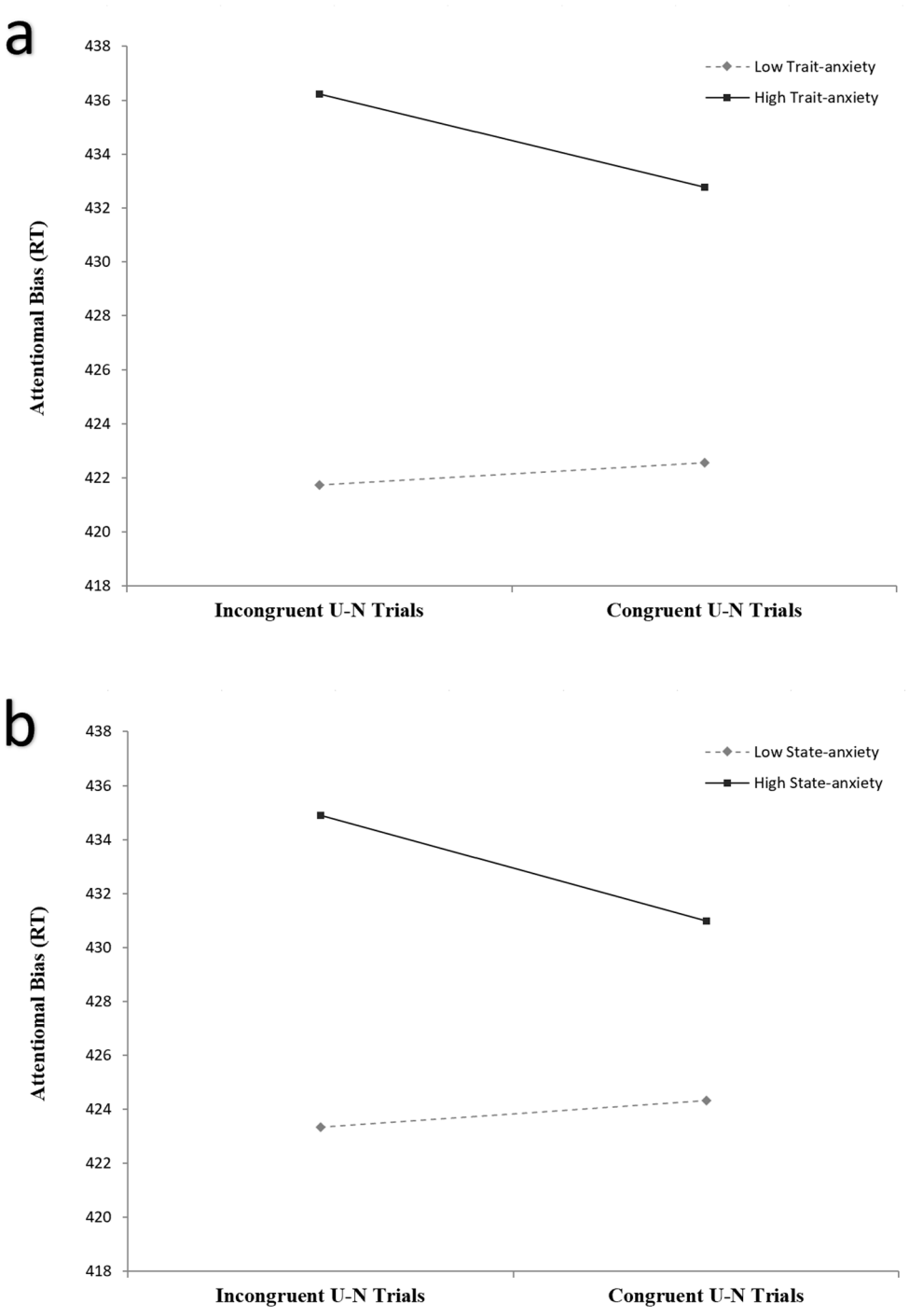

Figure 6.4. Attentional Bias to untrustworthy faces.
Mean reaction times on Untrustworthy- Neutral (U-N) trials as a function of congruency (congruent = dot appears at untrustworthy location versus incongruent = dot appears at neutral location) and (a) trait-anxiety and (b) state-anxiety.

6.4.2.3 Disengagement / Vigilance

To allow for a differentiation and specifically examine the two aspects of selective attention to untrustworthy faces, neutral–neutral trials were incorporated. RTs on incongruent and congruent threatening trials were compared to RTs on the neutral trials to determine whether the attentional bias scores reflect a difficulty to disengage attention or vigilance, respectively. Difficulty to disengage attention from threat should result in slower responses to incongruent threatening trials (in untrustworthy-neutral trial, dots replacing a neutral face) compared to neutral trials. Vigilance (facilitated engagement) for threat should be reflected in facilitated responding (faster RTs) to congruent threatening trials (dots replacing an untrustworthy face) compared to neutral trials. Identical repeated-measures analyses were therefore conducted first for the disengagement effect and then for the orienting effect, entering the four individual differences measures (i.e., anxious-attachment, avoidant-attachment, trait-anxiety and state-anxiety) as covariates.

Inspections of the disengaging data revealed a significant disengaging × anxious-attachment interaction $F(1, 165) = 6.236$, $p < .01$, $\eta_p^2 = .04$, suggesting that anxious-attachment modulated attentional disengagement from untrustworthy faces. Further post-hoc analysis broken down by anxious-attachment group revealed that, while low anxiously-attached individuals responded similarly to incongruent untrustworthy ($M = 426$, $SD = 53$) and neutral trials ($M = 428$, $SD = 53$), $t(89) = 1.633$, $p = .106$, individuals who scored high on anxious-attachment revealed a difficulty disengaging their attention from untrustworthy faces ($M_{incongruent} = 431$, $SD = 68$ vs. $M_{neutral} = 426$, $SD = 66$), $t(76) = 2.749$, $p < .01$ (see *Figure 6.5a*). Analysis with avoidant-attachment as a covariate did not reveal any significant effects, $F(1, 165) = 1.905$, $p = .169$, $\eta_p^2 = .01$.

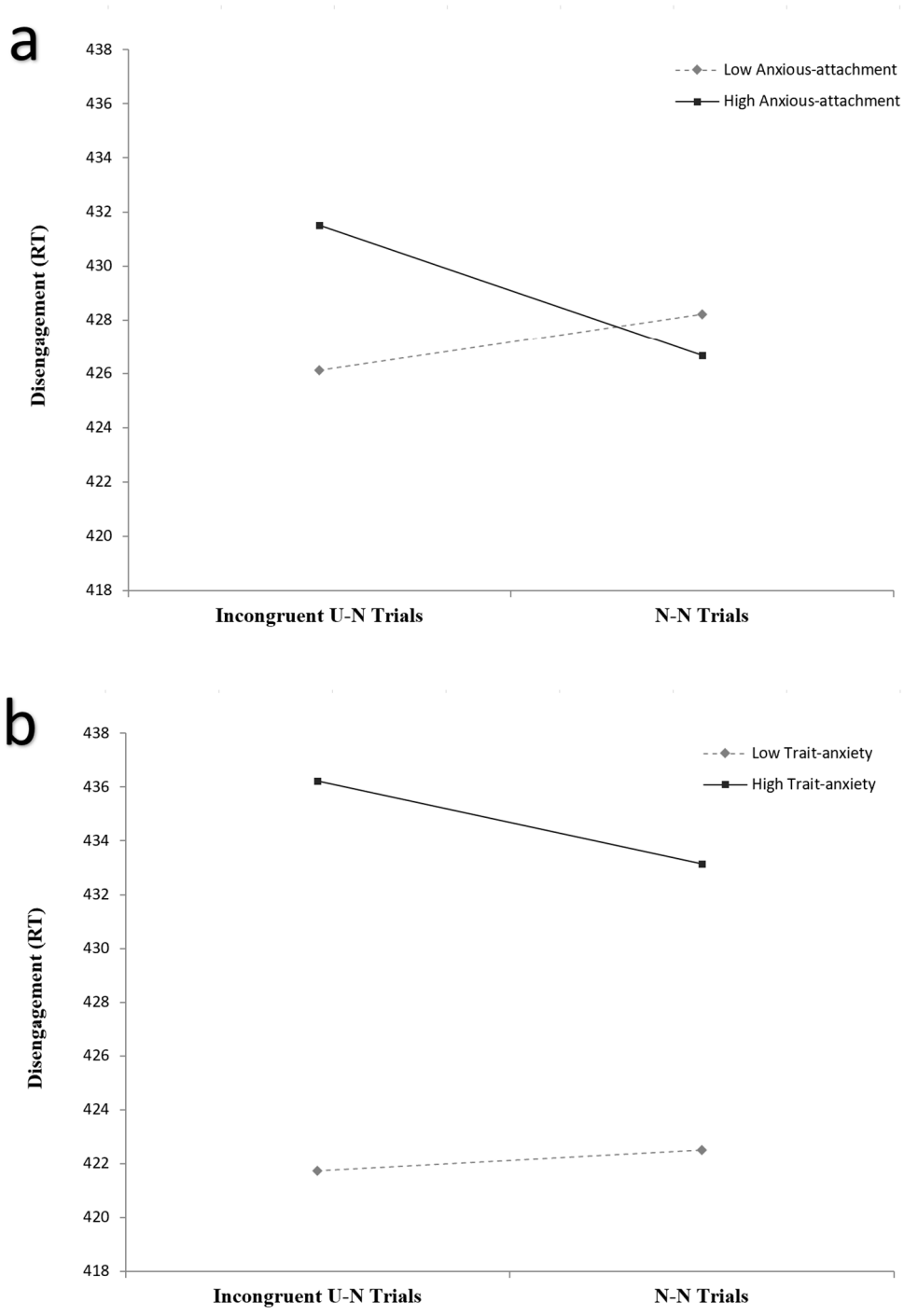

Figure 6.5. Difficulty Disengaging Attention from Untrustworthy faces.
Mean reaction times on Neutral-Neutral (N-N) and Incongruent Untrustworthy- Neutral (U-N) trials as a function of (a) anxious-attachment and (b) trait-anxiety.

The analysis on the disengagement effect for general anxiety, revealed a significant interaction only for trait-anxiety, $F(1, 165) = 4.375$, $p < .05$, $\eta_p^2 = .03$, but not for state-anxiety, $F(1, 165) = 2.650$, $p = .105$, $\eta_p^2 = .02$. As can be seen in Figure 6.5b, similarly to anxiously-attached individuals, individuals high on trait-anxiety seem to have difficulty shifting their attention away from untrustworthy faces ($M_{incongruent} = 436$, $SD = 63$ vs. $M_{neutral} = 433$, $SD = 62$), $t(78) = 2.010$, $p < .05$. In contrast, low trait-anxiety individuals responded similarly to incongruent ($M = 422$, $SD = 57$) and neutral trials ($M = 422$, $SD = 57$), $t(87) = .477$, $p = .634$.

The repeated-measures analysis on vigilance to threat did not reveal any significant effects (anxious-attachment × vigilance interaction, $F(1, 165) = .069$, $p = .793$, $\eta_p^2 = .00$; avoidant-attachment × vigilance interaction, $F(1, 165) = 1.608$, $p = .207$, $\eta_p^2 = .01$; trait-anxiety × vigilance interaction, $F(1, 165) = .392$, $p = .532$, $\eta_p^2 = .002$; and state-anxiety × vigilance interaction, $F(1, 165) = 2.223$, $p = .138$, $\eta_p^2 = .01$).

In sum, results from the dot-probe paradigm indicate that anxious-attachment and trait-anxiety yield similar response patterns. The main attentional bias of both anxiously-attached and highly trait-anxious individuals is to delay attentional disengagement in case of untrustworthy faces. We found no evidence of enhanced attentional orienting to untrustworthy faces. This indicates greater attentional hold, but not greater initial capture of attention, by threat.

6.4.2.4 Correlations

To further test the relationship between selective attention to threat and individual difference measures (anxious and avoidant-attachment; trait and state-anxiety), indices for both components of selective attention were calculated. The disengaging index was calculated by subtracting the mean RT for neutral faces in the presence of other neutral faces from the mean RT for neutral faces in the presence of untrustworthy faces. A positive score on the disengaging index indicates slower responses to dots replacing neutral faces as compared to untrustworthy faces. To calculate vigilance for threat, the mean RT for untrustworthy faces in the presence of neutral faces was subtracted from the mean RT for neutral faces in the presence of other neutral faces. A positive score on

the orienting index indicates faster responses to untrustworthy faces in the presence of neutral faces compared to neutral faces in the presence of other neutral faces[9].

Confirming the disengagement results above, both anxious-attachment and trait-anxiety were significantly correlated to the disengaging index, $r(165) = .16$, $p = .038$ and $r(165) = .19$, $p = .013$, respectively, suggesting that higher levels of both attachment-anxiety and trait-anxiety were associated with greater difficulty in disengaging attention from untrustworthy faces. There was no significant Pearson product moment correlation between the disengaging index and avoidant-attachment, $r(165) = .107$, $p = .169$ or state-anxiety, $r(165) = .126$, $p = .105$. Regarding the orientation index, none of the individual differences' measures were significantly correlated with the vigilance score, $.138 < p < .793$.

The correlation results thus confirm the disengagement/vigilance results described above.

6.5 Discussion

Attention is widely implicated in the attachment system functioning (e.g., Dykas & Cassidy., 2011; Shaver & Mikulincer., 2012). To our knowledge, no study to date has, however, investigated attentional processing of (un)trustworthy faces as a function of attachment style. Similar to our first study, the second study of the present dissertation revealed some sensible differences in how individuals with different attachment styles process trustworthiness from faces. We predicted specific patterns of attention to untrustworthy, but not trustworthy, faces, but did not necessarily expect this pattern to differ by anxious and avoidant attachment style. Similar to some previous studies on general attention to threat (e.g., Atkinson et al., 2009; Dykas & Cassidy., 2011; Maier et al., 2005; Zeijlmans Van Emmichoven et al., 2003), anxiously-attached and avoidantly-attached individuals behaved similarly to each other in attending to untrustworthy faces. Specifically, we found that both highly anxious and avoidant individuals attended more to

9 A disengaging and orienting index was similarly calculated for trustworthy faces. Person correlations did not reveal any significant effects for trustworthy faces. Again, this indicates that the effects of attachment style and general anxiety were specific to attentional bias only for untrustworthy, but not trustworthy, faces.

negative information (i.e., untrustworthy faces) than to neutral information. As suggested by the attachment literature, such finding of an attentional bias to negative information may represent preoccupation with this type of social cues by individuals with both types of attachment insecurity (e.g., Mikulincer & Shaver., 2007). In the case of anxiously-attached individuals, this attentional processing would probably later be passed to higher levels of processing, with the ultimate aim of dwelling, even obsessing about that information further. In the case of avoidantly-attached individuals, this information would be met with defensive avoidance with the ultimate aim of repressing or ignoring the information. (Chun et al., 2015; Niedenthal, Brauer, Robin & Innes-Ker, 2002; Vrtička, 2017). Thus, the initial attention behavior as measured by the dot-probe task may be similar for these two groups. With this reasoning, both anxiously-attached and avoidantly-attached individuals would be predicted to exhibit a negative attentional bias to untrustworthy faces. In line with our findings, Niedenthal and colleagues (2002) also found that both dismissing-avoidant (i.e., those who are highly avoidant) and preoccupied individuals (i.e., those who are highly anxious) showed a perceptual bias toward the processing of facial emotions of anger. Although highly avoidant individuals typically report that affective-related information are not important to them, this denial is not often observed when measuring more automatic processes (Andriopoulos & Kafetsios, 2015; Liu, Ding, Lu, & Chen, 2017). As the authors suggested, the previously reported bias of avoidantly-attached individuals to orient away and cognitively avoid negative information might in fact reflect a secondary, more controlled strategy (see also Maier et al., 2005). Thus, in accordance with our study, at early stages of processing, individuals who are high on avoidant attachment seem to have a similar way of processing social-related cues as anxiously-attached individuals. It is possible, however, that the typical differences between the two attachment orientations reported by some studies came into play and emerge when attention is assessed at a later stage of processing. In our study, we manipulated stimulus presentation time and found that the magnitude of our effects was not influenced by the duration of face-pair exposure. Although the methods employed in the present study have some advantages, there are also limitations to the current work. For example, our approach does not allow us to identify how early in the perceptual process attachment-relevant individual differences emerge. The main problem in both attachment and the attentional literature is that the timing of stimulus processing is difficult to monitor. Future studies should employ more sophisticated methods, such as event-

related potentials (ERPs; Chavis & Kisley, 2011; Vrtička, 2017), to better assess the specific time course and mechanisms underlying attachment differences in information and attentional processing.

Attentional bias in general anxiety has also been studied extensively with the dot probe task (e.g., Salemink et al., 2007). However, to our knowledge, the current study is among the first to examine attention to (un)trustworthy faces as a function of trait and state-anxiety. Consistent with our initial hypothesis, our findings of an attentional bias toward untrustworthy faces are in line with previous research on threat on both trait and state-anxiety, which suggests that individuals who are experiencing an emotional state are more sensitive and show an attentional bias to cues congruent with that state (Niedenthal, Brauer, Halberstadt and Innes-Ker, 2001). There is strong evidence that clinically and high anxious individuals selectively attend to threatening information, strongly prioritizing attention to negative over neutral or positive information (e.g., Amir, Klumpp, Przeworski, 2003; Fox, Russo, Bowles & Dutton, 2001; Salemink et al., 2007). Our results seem to be particularly important, as in many theories of clinical anxiety, these attentional biases have been regarded as initiating and maintaining anxiety (Williams Watts, McLeod & Mathews, 1997).

A second aim of the present study was to more clearly investigate whether an attentional bias towards untrustworthy faces reflects facilitated engagement (i.e., greater initial capture of attention by untrustworthy-looking faces) or a difficulty to disengage attention (i.e., greater attentional hold). We have shown that attachment-related anxiety and trait-anxiety yield similar response patterns in attentional bias, namely attentional difficulty disengaging from faces that resemble untrustworthiness. In contrast, no individual differences in orienting toward these, or any type of (un) trustworthy faces were found. Previous studies using different paradigms, also suggest that attachment insecurity is associated with a difficulty in disengaging attention from negative information rather than faster orienting toward negative cues (Mikulincer, Gillath, & Shaver, 2002; Mikulincer & Orbach, 1995). The current data has important implications for the interpretation of previous findings on attachment styles using the dot probe and other attentional tasks (Cooper, Rowe, Penton-Voak, & Ludwig, 2009; Dewitte & De Houwer, 2008; Dewitte, Koster, et al., 2007; Mark et al., 2012). Most importantly, data from previous dot probe studies cannot unambiguously be interpreted as vigilance for threat.

Clearly, a comparison with neutral trials is necessary to determine the precise component of visual attention reflected by the attentional bias effect (Klumpp & Amir, 2009; O'Toole & Dennis, 2012; Salemink et al., 2007). Our findings also add to a growing body of evidence that anxiety is related to a bias in disengagement from threat and not in orienting toward threat (threat-related words; Amir, Klumpp, Przeworski, 2003; Fox, Russo, Bowles & Dutton, 2001; Salemink et al., 2007). Provided these parallels between attachment and general anxiety and the important role of early adverse interpersonal experiences in the development of clinical anxiety, the study of selective attention in adult attachment adds to the existing knowledge on the link between attachment and psychopathology.

In conclusion, our second study represents an important investigation of selective attention to faces that resemble (un)trustworthiness in the research field of adult attachment and general anxiety. Taken together our results suggest that variation in difficulty to disengage attention from untrustworthy faces underlies both attachment-related anxiety and trait anxiety. Similar to our first study, it is noteworthy that our findings are dependent on the valence of the face being perceived. We tested the hypothesis that individuals with different attachment styles would differ in the processing of trustworthy faces. However, there was no support for this hypothesis. In other words, and in line with our first study, both insecurely-attached and anxious individuals were more sensitive to changes in untrustworthy than trustworthy looking faces.

CHAPTER 7

STUDY 3: EXAMINATION OF THE P3 ERP COMPONENT AS A FUNCTION OF ATTACHMENT STYLE

Despite theoretical claims and evidence that individual differences in attachment provide a foundation for affective perception, only a few studies have investigated the specific neural mechanisms underlying these patterns. The aim of the present study was to examine late ERP correlates (P3) of trustworthiness face processing within individuals with different attachment orientations.

7.1 Introduction

As discussed in the previous chapters, cognitive processing in insecure attachment styles is characterized by a negative schema that distorts one's view of the world and self. These schemata affect information processing by increasing the salience of negative information, as experiments using attention and memory tasks have shown. For example, faces expressing anger seem to be more easily detected by insecure and anxious individuals than by secure and non-anxious individuals (Mogg & Bradley., 1998). Insecure attachment and general anxiety have also been associated with a bias for interpreting threatening information. An understanding of the detailed time course of cognitive processing of facial trustworthiness could help understand attachment-related biases. While it is known that the presence of a human face elicit rapid appraisals of its trustworthiness, relatively little is known about the exact brain processes related to this response (Kovács-Bálint, Stefanics, Trunk, & Hernádi, 2014; Marzi, Righi, Ottonello, Cincotta, & Viggiano, 2014; Meconi, Luria, & Sessa, 2013; Yang, Qi, Ding, & Song, 2011).

Investigations into information processing time courses have frequently utilized event-related potential (ERP) measurements to examine how a person processes a stimulus from its presentation until a response is required on a temporal scale of milliseconds (Hajcak, Weinberg, MacNamara & Foti, 2012). ERPs have the advantage over other neuroimaging methods in that they provide a temporally precise measurement that allow us to investigate the time course and specificity of attachment-related information processing, yet few studies have utilized ERP measurements for this purpose. Few studies to date, have used ERP methodology to assess how different attachment styles are associated with the processing of relevant emotional information. Zhang, Li and Zhou (2008) divided a sample of 30 participants into three attachment style groups (secure, anxious and avoidant) and explored brain responses to happy, fearful and neutral facial expressions. The authors found that differences in attachment representation seems to influence any or all stages of information processing, as they found differences in both early visual components (N200 and P200) and later, more elaborative processing of emotional contents (N400 component). However, caution is needed when interpreting these results as no significant attachment group main effects or group × facial expression interactions were found. In another study, Zilber, Goldstein, & Mikulincer (2007) asked participants with different attachment styles (also based on the

ECR) to categorize unpleasant, pleasant and neutral pictures according to their valence while recording their ERPs. The authors found that individuals scoring high on attachment anxiety had larger Late Positive Potential (LPP) amplitudes to negative pictures than those with low-anxious attachment style. The authors interpret this positive variation in the ERP to reflect an increase in motivational engagement and attentional hyperactivation to negative information, but suggest this was only the case during later stages of information processing. Owing to their detailed time resolution, ERPs appear as an appropriate method to investigate the temporal characteristics of processing facial trustworthiness. The current study utilized the facial stimuli from our previous study to investigate more directly than behavioral studies the time course and potentially differential processing of facial cues of untrustworthiness. While most studies on attachment and information-processing bias use behavioral and reaction-time tasks, which focus on the final motor response, ERPs can productively be used to investigate whether insecure attachment styles are related to neural differences in facial trustworthiness processing.

ERPs components have been linked with specific aspects of information processing including early sensory evoked responses, attention-based responses, working memory maintenance, and response execution and motor responses (Luck, 2005). The majority of studies have focused on the P3. Using stimuli that differ from each other elicits a late cognitive waveform component, the P3, which seem to represent stimulus evaluation (Falkenstein, Hohnsbein & Hoormann., 1994), attentional allocation (Polich & Comerchero, 2003) and context updating (DonChin & Coles., 1988; Polich, 2012). P3 is a long-lasting positive component that is maximal between 300 and 700 ms after stimulus onset (Luck et al., 2009; Polich & Herbst, 2000). The most frequently used method to elicit the P3 component has been the “two-stimulus oddball” paradigm, in which participants are confronted with a train of repeated “standard” stimuli (e.g., an angry face, which occurs 80% of the time), and a rare “deviant” stimuli (e.g., a neutral face, 20% occurrence rate). The participant is asked to detect the rare (deviant) stimuli from the frequent standard stimuli by responding covertly or overtly on these trials (Picton, 1992; Polich, 2012). Repeated oddball testing produces good test–retest correlation coefficients for both amplitude (.50 to .80) and latency (.40 to .70) measures (Luck, 2005; Polich, 2012; Segalowitz & Barnes, 1993)—values comparable to many neuropsychological tests. The emotional oddball task has been proven to be well-suited to investigate the

effects of psychological traits and characteristics on emotion processing. Many studies have been carried out using ERP methodology to investigate how individuals process emotional stimuli (Hajcak, Weinberg, MacNamara & Foti, 2012). In general, augmented P3 amplitudes are found to affectively relevant stimuli in comparison to neutral stimuli, suggesting that emotional stimuli are processed more deeply or fully is some way (Cuthbert et al., 2000; Orozco & Ehlers., 1998). Larger P3 amplitudes in response to unpleasant stimuli compared to neutral and pleasant stimuli have been considered as support for the negativity bias, a framework which accounts for the fact that responses are more rapid and salient to threatening compared with equally arousing non-threatening information (Ito & Cacioppo, 2000). Fewer significant results have been found for P3 latencies, with arousal effects being found more consistently than valence effects (Olofsson, Nordin, Sequeira & Polich., 2008).

Although it has been suggested that facial expressions related to trustworthiness modify face-sensitivity ERP components, little is known about the processing of trustworthiness cues on the face. In order to address these questions, the present study used an emotional oddball paradigm, in which participants were confronted with a series of frequent standard facial stimuli and are asked to detect deviant or rare facial stimuli (Rossignol, Philippot, Douilliez, Crommelinck, & Campanella, 2005). The present study used a modified version of the oddball paradigm that instructed subjects to make the frequent/rare distinction by pressing different keys. Rather than requiring a single response for the deviants, we designed two responses to mask the true purpose of the experiment, so as to avoid a “relevance-for-task” effect that was repeatedly reported to affect the amplitude of the P3 component (Carretié, Mercado, Tapia, & Hinojosa, 2001; Yuan et al., 2007). This task pursued two main goals: firstly, (a) it was useful for ensuring attention to stimuli and for facilitating the detection of those participants whose level of attention may have been too low; our secondary goal was (b) to avoid making it easy for subjects to consider that some of the stimuli were more important than others e.g., untrustworthy faces more important than neutral faces. It was predicted that P3 amplitude would be larger in response to untrustworthy compared to neutral faces. Examining the evocation of the P3 component in response to the stimuli used in the present study should (1) build on the current understanding of the processing of trustworthiness from faces and (2) help to elucidate the stage at which any processing bias takes place.

7.2 Methods

This study was approved by the Human Research Institutional Review Board at Arizona State University

7.2.1 Participants

A total of 61 young adults (30 females, M_{age} = 20.5 years old) were recruited from the research participant pool at Arizona State University to participate in the study in exchange for partial class credit. All participants were native English speakers. As detailed below, 5 participants were eliminated because of excessive artifact during EEG recording and low performance in the central task(performance accuracy under 80%). The final sample comprised 56 participants. All participants were neurologically normal and had normal or corrected- to-normal vision. After providing consent, each participant was tested individually in sessions that last approximately 60 minutes, preceded by about 20 minutes for preparation of EEG recording. All participants received both verbal and written instructions and began by completing the Experiences in Close Relationships Scale-revised (ECR-R) and the State-Trait Anxiety Inventory (STAI). Participants then performed a Trustworthiness rating task followed by an EEG Oddball task. All tasks were programmed using E-prime 2.0 software (Psychology Software Tools Inc., Pittsburgh, PA, USA) and presented on a 17-inch computer screen.

7.3 Materials

7.3.1 Experiences in Close Relationship-Revised (ECR-R)

As in our previous studies, attachment style was measured by having participants complete the revised Experiences in Close Relationships Scale (ECR-R; Fraley, Waller, & Brennan, 2000). Mean scores for anxious-attachment was 2.59 (SD = 1.07) and 2.66 (SD = .98) for avoidance-attachment scale.

7.3.2 State-Trait Anxiety Inventory (STAI)

Also similar to our previous studies, trait and state-anxiety was measured with the Spielberger State-Trait Anxiety Inventory (STAI; Spielberger et al., 1983). At the time of the study, the data for the STAI was corrupted by a programming error. Participants were then invited via email to complete the STAI questionnaire approximately one week after their testing session; thirty-nine participants, from the original fifty-six sample, responded. Thus, data for the STAI is reported for 39 participants only. The mean trait-anxiety score of this sample was 40.3 (SD = 10.36). Mean state-anxiety score was 37.28 (SD = 9.86). As in our previous studies, these mean scores correspond to STAI scores of previous studies that used undergraduates participants (e.g., O'Toole & Dennis, 2012).

7.3.3 Face Stimuli

From the same database used in our Study 2 (Original Computer Generated Faces - 100 Trustworthiness data set), we randomly selected 9 facial identities (see Figure 7.1). For each of these 9 identities, the most extreme untrustworthy version (- 3 SD) and the neutral version (0 SD) were used as stimuli for a total of 9 (identities) × 2 (untrustworthy and neutral) = 18 faces. In all tasks, stimuli within each section was presented in randomized order.

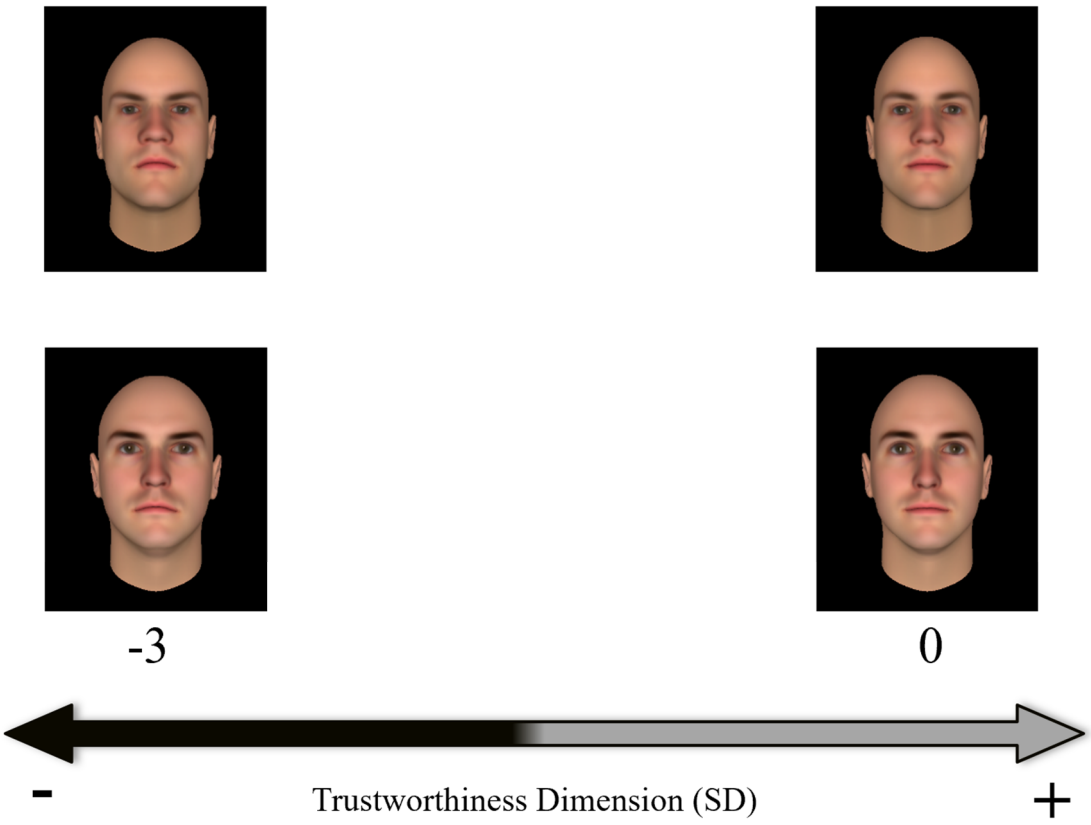

Figure 7.1. Example of Stimuli used in the Trustworthiness Judgment task and Oddball task.

7.3.4 Trustworthiness Judgment Task

Prior to ERP testing, a trustworthiness judgment behavioral task was run to check how each participant perceived the face stimuli. The trustworthiness judgment task used in the present study followed the exact same procedures and parameters as the one used in our first study. As in Study 1, participants were asked to rate the trustworthiness of a face, one at a time, on a 7-point Likert scale, ranging from 1 *"Not Trustworthy at All"* to 7 "*Extremely Trustworthy*". As mentioned above, participants were shown a total of 18 faces; for the 9 facial identities, we used the most untrustworthy (-3 SD) and neutral face (0 SD).

Participants rated each of the 18 faces three times, for a total of 54 trustworthiness ratings. Again, as in Study 1, to measure the perception of trustworthiness in this task, we averaged the ratings across the 9 face identities at the same level of trustworthiness, to yield a single set of 2 mean ratings; with one mean rating for -3 SD (untrustworthy) faces and one mean rating for 0 SD (neutral) faces.

7.3.5 EEG Oddball Task

Figure 7.2 shows a schematic of the experimental design for the oddball task.

Each stimulus in this experiment was a neutral “0 SD” or an untrustworthy face “-3 SD” (belonging to the same face identify), with one category rare (*probability* = .2) and the other frequent (*probability* = .8). Faces were presented one at the time at the center of a 17-inch computer screen. Because attention to stimuli is required, participants were told that *“You will see two different faces go by*” and were instructed to respond to a designated “face” stimulus by pressing one of two keys: *Left key* (the number 1 on the computer keyboard) or *Right key* (the number 2 on the computer keyboard). Participants pressed a button with the index finger of the right hand for one face category and with the index finger of the left hand for the other face category; the assignment of faces to buttons was counterbalanced. Participants were naive with respect to the specific questions investigated; it was an implicit emotional oddball task. At the beginning of each block, participants read instructions about which kind of block they would encounter next. The experimenter avoided associating and naming the faces (i.e., naming a face untrustworthy or neutral) when instructing the participants to avoid any biases. Instead, participants were instructed to *“Whenever you see [this face], press “Left”*; *Whenever you see [this face], press “Right””* (see Figure 7.2 for full details on the instructions). To obtain reliable and stable measures of the P3, participants performed a total of 8 blocks of 200 trials each (40 “*rare*” trials and 160 “*frequent*” trials in each block). A rest break was provided between each block. Thus, participants alternate between blocks in which untrustworthy faces were 80% probable and neutral faces were 20% probable, and blocks in which this was reversed. The monitor was viewed at a distance of 70 cm and had a black background and a continuously visible white fixation cross (500 ms). Each face was randomly presented and stayed on the screen until a response was made, followed by a blank interval of 200-500 ms (with increments of 100 ms). All subjects easily understood the instructions.

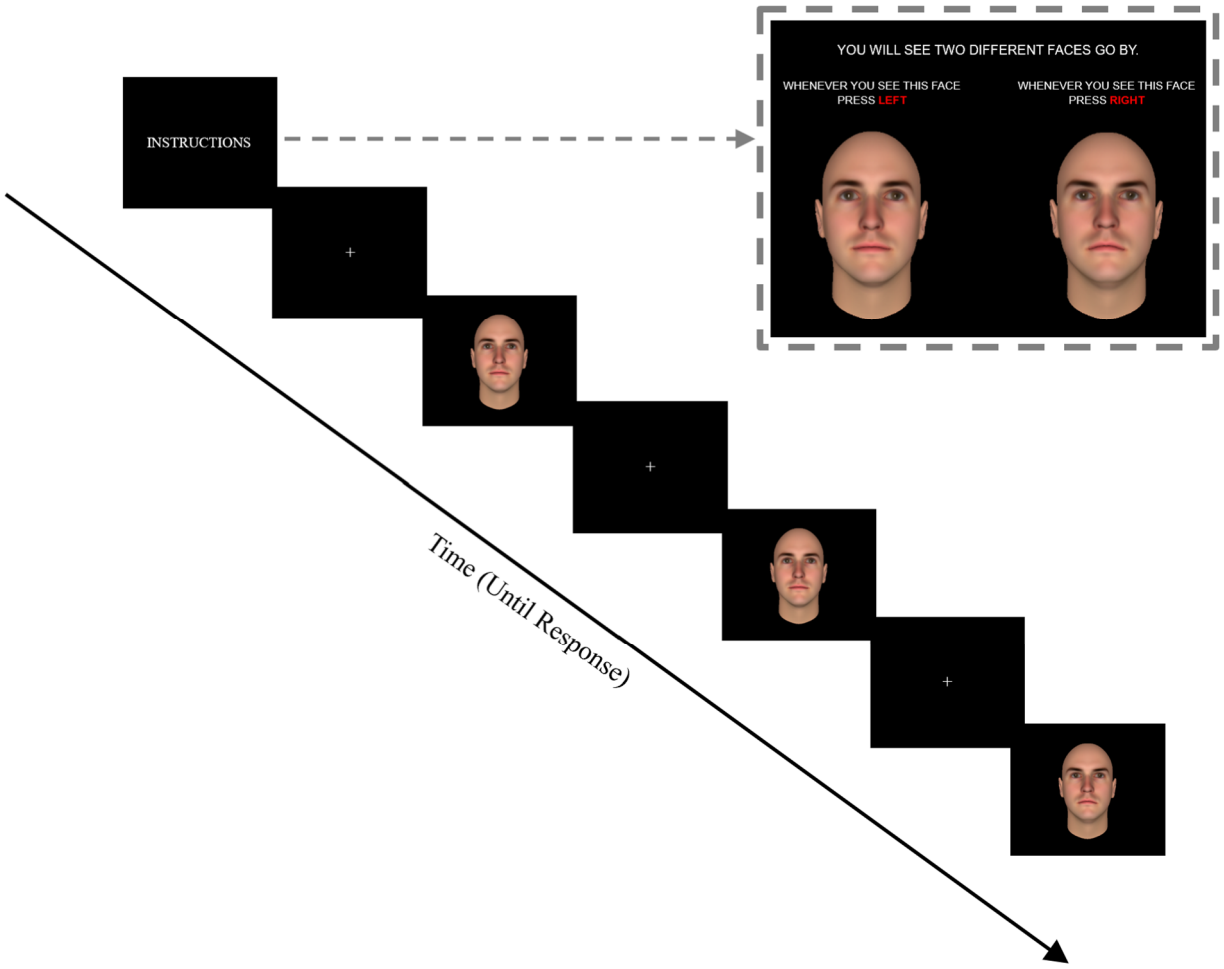

Figure 7.2. Example trial sequence of an oddball block where the untrustworthy face is the rare stimuli. Participants saw a fixation for 5 s, followed by an untrustworthy or neutral face. Participants then had unlimited time to provide a response.

7.4 EEG Equipment Recording and Data Reduction

Continuous EEG activity was recorded from 30 scalp locations according to the International 10/20 System using silver/silver-chloride (Ag/AgCl) electrodes mounted in an elastic electrode cap, and re-referenced offline to the average of the right and left mastoids electrodes(Duncan et al., 2009). Electrooculogram (EOG) activity was simultaneously recorded with two electrodes positioned above and below the left eye to detect eye blinks and two electrodes positioned lateral to the external ocular canthi to detect horizontal eye movements. EEG activity was amplified, bandpass filtered (0.1–100 Hz) and digitized at 1000 samples per second using Neuroscan Synamps amplifiers. All

signal processing and analysis procedures were performed in Matlab using EEGLAB toolbox (Delorme & Makeig, 2004) and ERPLAB toolbox (Lopez-Calderon & Luck, 2014). All channels were down-sampled offline to 250 Hz and band-pass filtered from 1 to 30Hz, using an infinite impulse response (IIR) Butterworth filter, and submitted to a GPU-optimized version of the infomax independent component analysis (ICA; Raimondo, Kamienkowski, Sigman, & Fernandez Slezak, 2012) procedure in EEGLAB.

Data preprocessing also included the removal of large muscle artifacts or extreme offsets (identified by visual inspection). The ocular components in the ICA were also identified using visual inspection (independently performed and then compared between two researchers) and then removed from the unfiltered raw data. The ICA procedure subsumed 1.1% of the data. The ICA procedure subsumed 1.1% of the data. The raw 1000 Hz data without ocular artifacts were then filtered to .1 to 30 Hz using an IIR Butterworth filter. By computing a rare-minus-frequent difference wave in an oddball paradigm, it is possible to isolate probability-sensitive ERP components such as the P3 wave (see, e.g., Luck et al., 2009; Vogel et al., 1998). To remove trials with excess electrical noise, we used a moving window that was 60 ms wide, moving in increments of 20 ms across the epoch to detect peak-to-peak voltage differences exceeding 80 μV across any EEG channel. If four or fewer electrodes exceeded this threshold, those electrodes were removed and approximated using spherical interpolation. Otherwise, the trial was removed. This resulted in the exclusion of 1.0% of correct trials across participants.

Corrected EEG data were segmented into epochs that began 200 ms prior to the onset of the stimulus and continued for 1,000 ms (i.e., 800 ms following the stimulus) and baseline corrected to the first 200 ms pre-stimulus period. ERPs were constructed by separately averaging trials from the four conditions of interest (i.e., rare untrustworthy; rare neutral; frequent untrustworthy; frequent neutral). A minimum of 20 trials per condition was ensured for each subject. Trials with incorrect behavioral responses or electrophysiological artifacts were excluded from the averages using standard procedures (Woodman & Luck, 2003). Also, by computing a rare-minus-frequent difference wave in an oddball paradigm, it is possible to isolate probability-sensitive ERP components such as the P3 wave (see, e.g., Luck et al., 2009; Vogel et al., 1998).

7.5 Results

Unless otherwise stated, for pairwise comparisons we used two-tailed tests with the alpha level set to .05 throughout. A measure of effect size is given by partial eta-squared (η_p^2). In agreement with guidelines set by Cohen (1988), η_p^2 of .01, .10, and .25, corresponds to small, medium, and large effects, respectively.

7.5.1 Behavioral Data

The behavioral trustworthiness ratings in the trustworthiness task were submitted to a Generalized Linear Model to check that the participants in the oddball task perceived the stimuli in line with what was intended. As expected, participants rated untrustworthy-looking faces (*M* = 3.04, *SD* = .81) as significantly more untrustworthy than neutral-looking faces (*M* = 4.2, *SD* = .79), $F(1, 55) = 171.529$, $p < .001$, $\eta_p^2 = .76$.[10]

7.5.2 ERP Data

Trials with incorrect responses in the oddball task were excluded from response time (RT) analysis[11]. Consistent with prior research, corrected responses faster than 200 ms or slower than 1,000 ms were considered outliers and also removed from the RT analysis (e.g., Salemink et al., 2007). Responses that were three SDs above or below the individual mean (calculated separately for each experimental condition) were also removed, as they are likely to represent either inattention to the task or anticipatory responses prior to processing the face (e.g., Chun, Shaver, Gillath, Mathews, & Jorgensen, 2015).

Analyses for the oddball task were conducted on the inter-participant mean ERPs using a Generalized Linear Model. Follow-up paired sample t-tests were used to examine

10 Although not the main focus of this study, we assessed whether judgments of trustworthiness would differ as a function of attachment style and/or general anxiety. The results of these analysis were all non-significant.

11 Participants responded correctly to the majority of the oddball task (*mean accuracy* = 96.7%; *SD* = 1.87). High performance in the oddball task suggests that participants allocated a great amount of attention to the task, and that any observed brain responses to the difference between rare and frequent face stimuli cannot be accounted for by potential attentional effects. There were no differences in reaction times.

interaction effects. In order to examine individual differences in the allocation of attention to untrustworthy-looking faces, individual differences measures (attachment-anxiety, attachment-avoidance, trait-anxiety and state-anxiety) were separately included as covariates in the general-linear model (GLM).

7.5.3 P3 Results

Compared with peak amplitude, mean amplitude is an unbiased, widely-used approach to ERP analysis which has been used in many studies assessing late ERPs in response to emotional faces (Luck, 2005; Polich, 2012). Mean ERP amplitudes data for all electrode sites were thus submitted to a 2 (trial type: oddball vs. frequent) × 2 (face type: untrustworthy vs. neutral) repeated measures analysis of variance (ANOVA)[12]. Our focus was on a priori hypothesis related to a late positive (P3) voltage deflection in the ERP occurring after target onset. As can be seen in Figure 7.3, the effect was maximal over midline parietal (Pz) electrode within the time window of 350-600 ms post-stimulus onset, replicating prior research. As expected, the results restricted to Pz revealed a main effect of trial, $F(1,55) = 268.927$, $p < .000$, $\eta_p^2 = .83$, suggesting larger P3 amplitudes to rare ($M = 10.07$, $SD = 4.12$) than frequent faces ($M = 3.09$, $SD = 2.98$). Importantly, this effect was qualified by a significant trial × face interaction, $F(1,55) = 5.567$, $p < .05$, $\eta_p^2 = .092$ (Figure 7.3).

12 Analysis of differences in latency to mean amplitude in response to untrustworthy and neutral faces within different attachment styles revealed no significant Trial or Face type main effects or interactions. Latency values are therefore not reported.

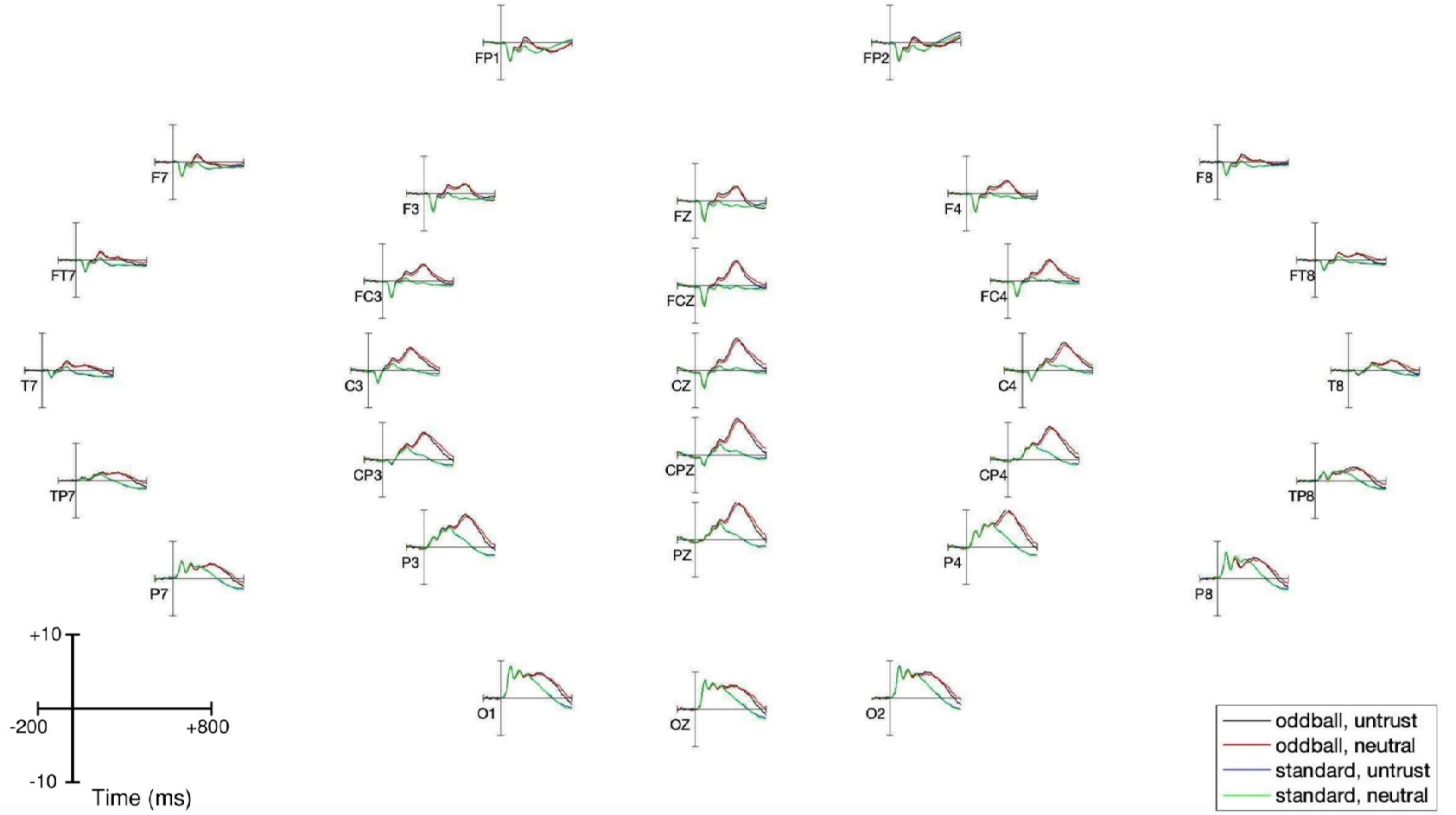

Figure 7.3. Grand averaged event-related potential waveforms elicited by oddball faces (untrustworthy and neutral) and standard faces (untrustworthy and neutral) for the 30 channels.

In order to better understand this oddball effect, and following previous study procedure, a rare - frequent difference waves were calculated, first collapsed across the untrustworthy and neutral faces (i.e., a rare untrustworthy minus frequent untrustworthy difference wave and a rare neutral minus frequent neutral difference wave). As can be seen in Figure 7.4, there was a significantly different oddball effect maximal at electrode Pz from 350 - 600 ms, $t(55) = 2.359$, $p < .05$. This difference is consistent with larger P3 to untrustworthy ($M = 7.4$, $SD = 3.69$) than to neutral faces ($M = 6.55$, $SD = 3.19$).

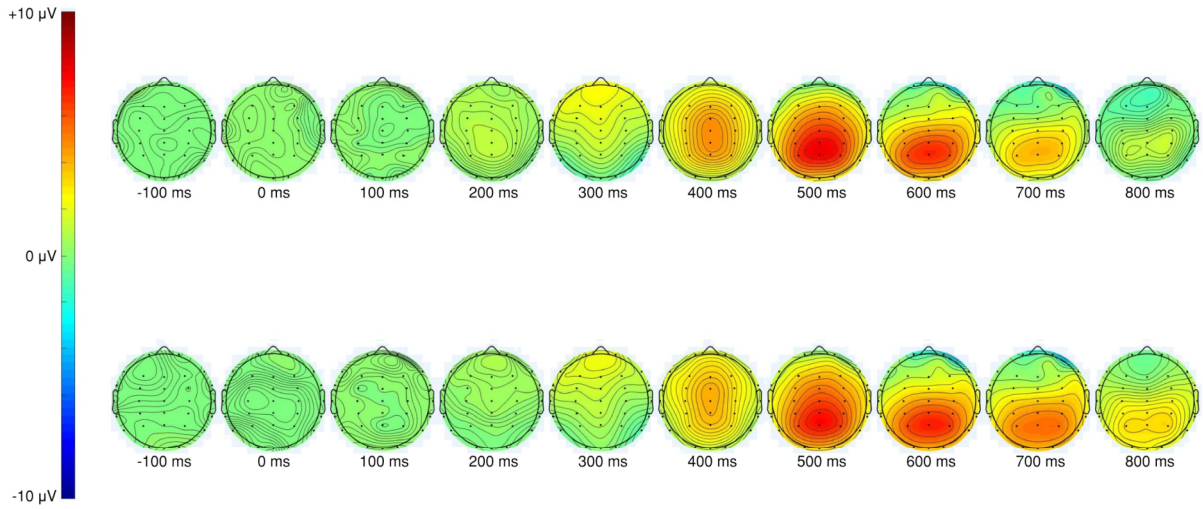

Figure 7.4. Topographic P3 amplitude distribution for (a) Rare Untrustworthy minus Frequent Untrustworthy difference wave and (b) Rare Neutral minus Frequent Neutral difference wave.

A difference score wave between the two scalp topographies plotted in Figure 7.4 is shown in Figure 7.5.

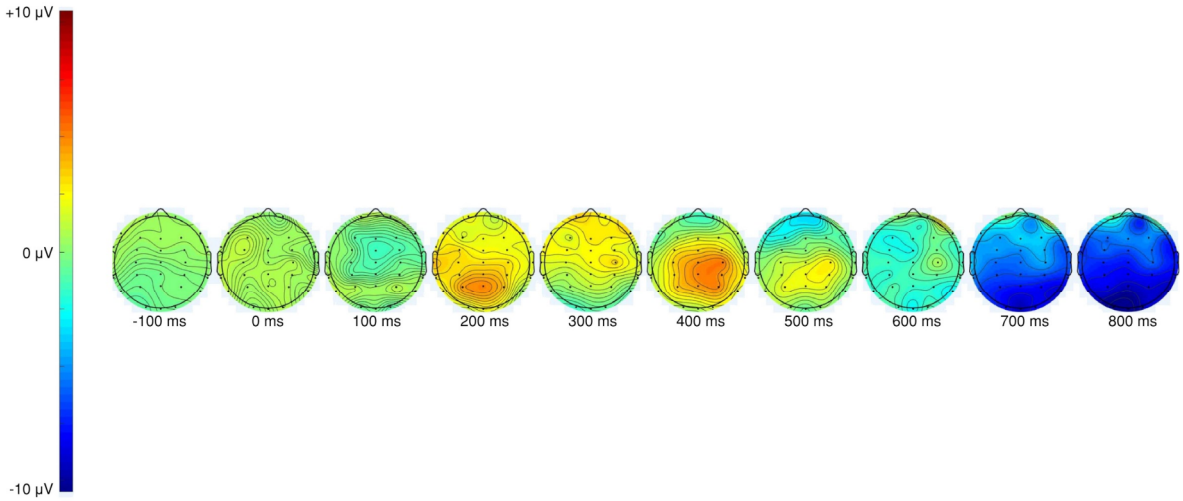

Figure 7.5. Topographic P3 amplitude distribution for the difference score wave between the P3 effect to Untrustworthy faces minus the P3 effect to Neutral faces.

7.5.4 Individual Differences Results

As can be seen in Figure 7.6 an individual difference measure of the P3 signal was extracted for each participant to assess relations with attachment style and general anxiety. Person's correlations were performed between P3 amplitudes and each independent variable (i.e., anxious-attachment, avoidant-attachment, trait-anxiety and state-anxiety). Although all the correlation effects were in the predicted direction, they did not reach statistical significance $-0.2 < rs < -0.01$, all $ps > .05$. Critically, compared with Study 1 and Study 2, the current study had a smaller sample size due to the nature of conducting EEG research (sample size of N= 56 participants, compared to N= 179 and N= 167 in Study 1 and Study 2, respectively). The correlations reported here are of the same magnitude of prior studies with larger sample sizes. Moreover, the present results are consistent with the possibility that individuals that are less secure and more anxious do not discriminate untrustworthy from neutral faces as effectively and this effect seems to be localized to the P3 response (see Figure 7.6). This nonsignificant, but compelling, possibility should be tested in a future replication study with a larger sample size.

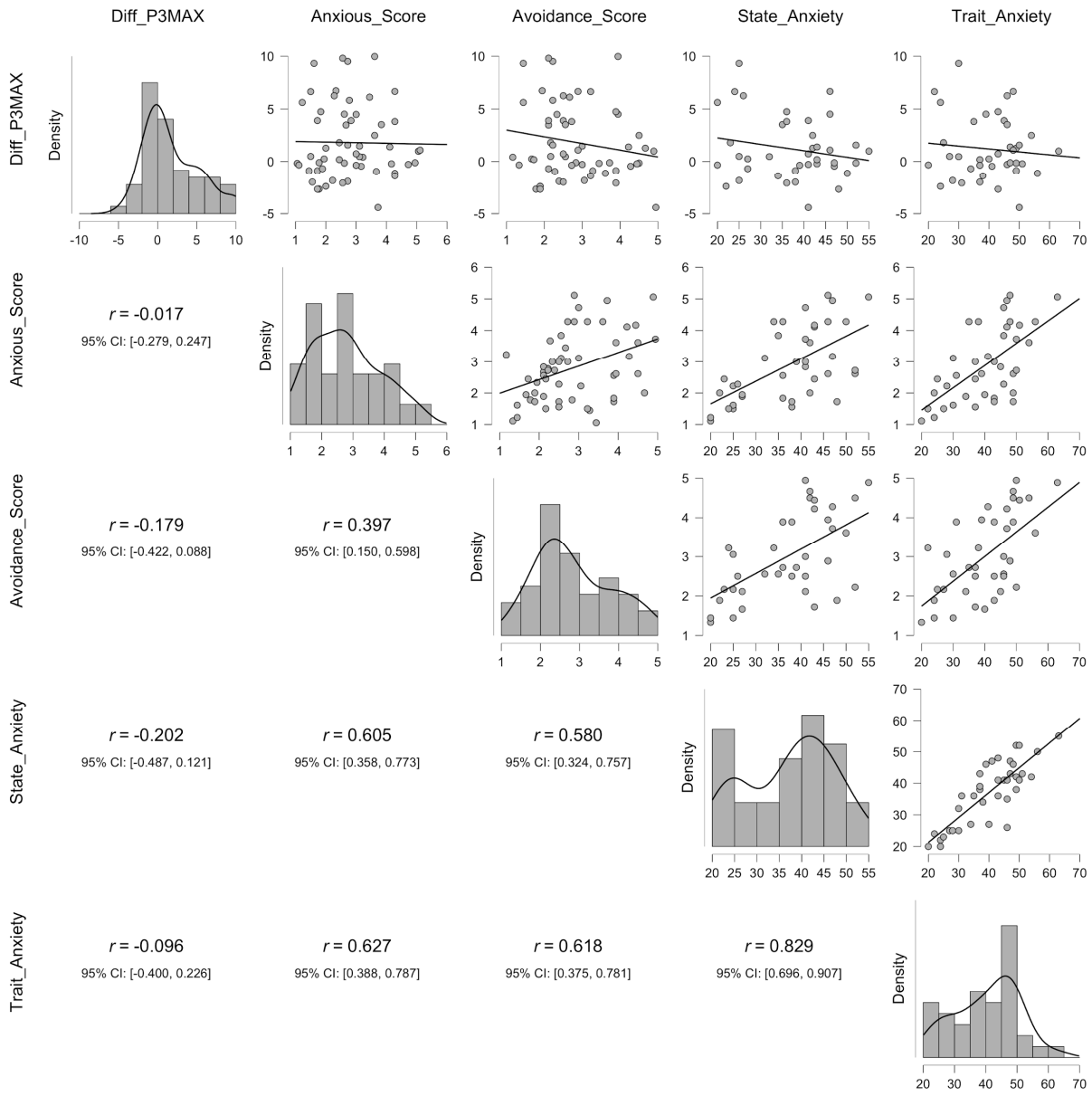

Figure 7.6. Distributional characteristics and correlations between mean amplitude of the P3 response, attachment style (Anxious and Avoidant scores) and (State and Trait) anxiety scores.

7.6 Discussion

In the present study, we used (ERP) technique with an oddball paradigm to examine whether and how adults with different attachment orientations may have differential electrophysiological responses to untrustworthy faces. Our results indicate a cognitive processing difference for untrustworthy-looking faces across all participants. Specifically, P3 (350-600 ms) amplitude was more pronounced in response to

untrustworthy than neutral faces. The amplitude of the P3 is directly related to the amount of information provided by a novel stimulus, and it increases with the amount of attention resources allocated for a stimulus. Thus, it indicates that untrustworthy faces are more salient to all individuals. Recent studies revealed that untrustworthy faces elicit higher P100 response (at approximately 60-100 ms) than trustworthy faces (Marzi et al., 2014).

We did not find any reliable differences in this P3 effect for individuals with different attachment styles. In light of attachment-related processing bias differences found in our previous and others studies, it may seem odd that, in the present study, individuals with different attachment representations did not differ in their ERPs in response to untrustworthy compared to neutral-looking faces. The current study had a small sample size, a possible lack of extreme scores on the attachment style dimensions, and these shortcomings may have contributed to us not finding a statistically significant P3 effect for individuals differing in attachment styles. P3 modulation by threat stimuli has been observed in previous ERP studies on non-selected populations, and we did in fact find main effects of deviant/rare versus standard stimuli, as well as an interaction where deviant untrustworthy faces were processed differentially from deviant neutral faces. However, there are relatively few studies examining links between attachment style and late ERP components such as the P3 in response to expressive faces. It seems that further study with a larger sample size is needed to specify the influence of mental attachment representations on late ERP components elicited by faces varying in trustworthiness.

The current study has some limitations. First, we only used two types of faces (untrustworthy and neutral) since we were mainly interested in exploring late (processing) ERPs elicited in response to negative/threatening stimuli in the general context of the hypothesized “negativity bias”. We followed other ERP studies with emotional faces which focused on the same ERP components as in the current study and found a negativity bias in response to angry (but not fearful and neutral) faces (Mark et al., 2012) and negative (but not positive) pictures (Zilber et al., 2007) in both insecurely attached and anxious individuals. In order to further examine attachment-related differences in late ERP activation, future studies should include more extreme faces that vary in trustworthiness (i.e., faces that were morphed to look more untrustworthy than -3SD and trustworthy-looking faces). More extreme faces may help increase the effect size of the interaction and lead to better discovery of a correlation between the interaction P3 score and

attachment style, if it is in fact present. Second, we used an implicit emotional task, and participants were naive with respect to the specific question investigated. Hence, their conscious, more explicit processing was deliberately distracted from the valence aspect of the face. It is possible that we would have found attachment style differences in the ERP patterns would have instructed participants to explicitly respond to the trustworthiness of the face.

In conclusion, the present study represents an important preliminary investigation of late processing brain mechanisms in the research field of trustworthiness face perception.

CHAPTER 8

CONCLUSION

One of the core tenets of attachment theory is that attachment experiences, and the cognitive emotional schemas shaped from them, generalize to influence behaviors and interactions with other people. In the absence of substantial information about others, individuals will rely on existing knowledge from past histories (by tapping into their internal working models of attachment) in coming to estimate and understand their interactions with these unfamiliar people (Dykas & Cassidy, 2011). From this perspective, attachment styles are viewed as organizational rules that can bias the acquisition and use of affective information related to peers, romantic partners and strangers. To the extent that trustworthiness judgments are intuitive in nature (Todorov, Gobbini, Evans & Haxby, 2007; Todorov, Pakrashi & Oosterhof, 2009; Porter et al., 2008), and given the importance of such judgments in our social navigation, it seems remarkable that no studies have investigated whether and to what extent individual differences in attachment strategies are related to the way in which (un)trustworthy facial cues are processed. Using behavioral, cognitive tasks and ERP methodology, the present dissertation aimed to examine the potential impact of attachment style in the perception and attentional processing of facial trustworthiness.

In Study 1, we hypothesized and found that both attachment insecurity and trait-anxiety were related to tendencies to rate others as more untrustworthy. Our results contribute to the growing literature on negative interpretational and facial decoding biases, where insecurely-attached individuals were found to interpret ambiguous facial cues with considerable suspicion and perceive others as less friendly, unpleasant and mistrustful (e.g., Magai, Distel & Liker, 1995; Meyer, Pilkoris & Beeners, 2004; Rognoni et al., 2008; Vrticka & Vuilleumier, 2012). This perceptual difference on (un)trustworthiness processing can have enormous consequences for the interpersonal interaction that follows the facial trait appraisal. For example, the perception (perhaps by an anxiously-attached individual) that others are consistently seen as untrustworthy will motivate the individual to avoid social and interpersonal interactions, further corroborating the negative view that insecurely attached individuals have about others and, more generally, about the world.

In our second study, we investigated the impact of mental representations of attachment on the process of selective attention to (un)trustworthy facial cues. We found that people with an insecure style of attachment tend to focus their attention on, and have difficulty disengaging from, faces that resemble untrustworthiness. Together with Study 1, our second study suggested sensible differences in how individuals with an insecure attachment style process and attend to untrustworthy faces. These attention biases have been regarded as maintaining insecure types of attachment style (Mikulincer & Shaver, 2012). Our findings add to a growing body of evidence that suggests that insecurely-attached individuals selectively attend to threatening information, strongly prioritizing attention to threat over neutral or positive information (Amir, Klumpp & Przeworski, 2003; Mikulincer, Gillath & Shaver, 2002; Mikulincer & Shaver, 2019; Salemiuk et al., 2007) In our third study we were able to identify a specific neural correlate (the P3) related to the processing of untrustworthy faces, corroborating the fact that such faces hold special saliency in the brain (Kovács-Bálint et al., 2014; Marzi et al., 2014; Meconi et al., 2013; Yang et al., 2011).

In general, and in line with previous research on attachment and emotion (Maier et al., 2005), the present dissertation suggests that insecurely attached individuals are biased toward the processing of untrustworthy faces. Our findings extend previous studies by demonstrating evidence for a consistent negative bias in judgments, attention and ERP signatures for processing untrustworthy faces. These results have important

implications for models of social judgment that have a great emphasis on target/trustee cues (e.g., Oosterhof & Todorov, 2008). Our demonstration of the role of individual differences in shaping individual's trustworthiness estimation is a crucial extension of previous work on trust, as our results are consistent with the prediction of the emotion overgeneralization hypothesis. In an effort to establish a better understanding of these judgment processes, we proposed and found that two important factors in trustworthiness processing are a person's dispositional attachment representation and trait levels of anxiety. This illustrates another domain in which attachment insecurity and elevated levels of trait anxiety can bias one's evaluations and subsequent social interactions with others (Cassidy, Lichtenstein-Phelps, Sibrava, Thomas, & Borkovec, 2009; Read, Clark, Rock & Coventry, 2018).

Some limitations of the present dissertation ought to be noted, including the reliance on a convenience sample of undergraduates. Hence, more systematic research into the link between attachment styles and (clinical) anxiety might involve clinical samples, which could provide interesting new insights on how psychopathology and emotional states interact with the processing of trustworthiness in faces. It is important to recognize that the correlational nature of this study precludes us from concluding that attachment insecurity and trait anxiety directly affects judgments and attentional processes of trustworthiness, and no causal inference can be made. Additional limitations are the use of faces that only varied on one dimension of facial appearance (i.e., trustworthiness), which limits our ability to estimate the extent to which the observed interpretational and attentional biases are generalized to other facial traits. Future research assessing these social judgments in real life scenarios may assist in extending the generalizability of these findings and demonstrate their ecological validity. Nevertheless, the present dissertation adds to the literature in that it is perhaps the first to examine attachment styles and biases in trustworthiness processing. Importantly, because our methods involved the perception of trustworthiness in faces rather than lexical items (i.e. trust-related words) or other types of stimuli, it has a high degree of ecological validity. An important task of social life is understanding the motivational states of others, and cues to those states are often extracted from faces.

In spite of the acknowledged limitations of this research, we believe that two claims are supported by its findings. First, attachment patterns and trait anxiety does indeed appear to influence the lower level cognitive processes of perception; in particular the

evaluation and attentional mechanisms of facial trustworthiness in others. The observed pattern of results seems sensibly related to the typical motivations associated with attachment orientation revealed by past research on emotion regulation and behavior. Second, differences in the organization of the attachment system appears to influence the processing of facial cues that signal trustworthiness in different ways. In both our studies, the processing of untrustworthy, but not trustworthy, faces differed over attachment style, despite the fact that both facial types were emotionally neutral. Clearly, the role of attachment pattern and general anxiety in processes of perception and attention and the interpretation of facial traits to individuals with different attachment orientations are of great interest for future research.

In sum, our studies contribute to the growing evidence that differences in the organization of the attachment system are involved in shaping interpersonal beliefs about others. Much research is now needed to determine how the cognitive-motivational schemas a person brings to a given social interaction impacts his or her behavior during the interaction, and to determine whether and how these predispositions mediate the relation between attachment insecurities and interpersonal behavior (Shaver & Mikulincer, 2011).

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